J. Agric. Sci. Mansoura Univ., 31 (11): 7347 - 7362, 2006

CHANGES IN SOIL PHYSICO- CHEMICAL PROPERTIES AND MACRONUTRIENTS CONTENTS OF PEA AND TOMATO PLANTS DUE TO ORGANIC MANURE AND SOME NATURAL MINERALS FERTILIZATION

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ABSTRACT

Two field experiments were carried out for two seasons 2004 and 2005 at Ismailia Agric. Res. Station to study the effect of organic manure with application of natural mineral on some physical properties of soil (Bulk density, field capacity and available water) and chemical properties of soil (pH, EC and available of macronutrients). Macronutrient contents of both tomato and pea plants and productivity were studied. The experiments were designed in a split-split design with three replications. Two forms of organic manure (Farmyard manure and chicken manure) and tow rates of natural mineral (bentonite and feldspar in combination with rock phosphate) in presence of biofertilizers (a mixture of *Azotobacter Chroccoum*, *Bacillus Megatherium* namely (phosphatek) and *Bacillus Pasteurii* namely (Biopotash).

Data indicate that application of natural minerals and organic manure decreased the values of soil bulk density, soil reaction (pH) and E.C, in spite of increased the macronutrient availability in soil. The soil bulk density was inferior at application of FYM in combination with 100% of bentonite + rock phosphate, an opposite trend being obtained for soil moisture, pH and E.C values. Data showed high significant increases in available N and P due to the application of FYM in combination with 75% of bentonite + rock phosphate, in spite of the significant highest values of K available in soil obtained with FYM in combined with 75% of feldspar + rock phosphate. With regarding the inoculation with bacteria, data had recorded lowest the bulk density, pH and E.C values but highest the field capacity, available water and macronutrients availability in soil.

N, P and K contents in studied plant parts as well as yield components for both tomato and pea plants generally increased with application of organic manure and natural minerals. In addition, obtained results indicated that applied FYM in combination with low rate (75%) of bentonite + rock phosphate recorded high values of macronutrient contents and yield components of two studied plants.

INTRODUCTION

The importance of organic matter to Egyptian agriculture comes directly next to water importance. At the same time, organic amendments are added usually to soils to improve their physical, chemical and biological properties and / or provide plants with nutrients. Farmyard manure (FYM) has an important role in the continuous supply of well – balanced diets of nutrients to crops, and represents an important component of the nutrients cycle in agricultural ecosystems. However, the use of FYM alone may not be enough to meet the enormous nutrient requirements of present – day high yielding cultivars. Thus, integrated nutrient management, in which both organic manures and inorganic fertilizers are used simultaneously, has been suggested as the most effective method to maintain a healthy and sustainable soil system with relatively high crop productivity (plam et al., 1997).

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Choudhary et al. (2004) showed that the application of FYM at a rate of 20 ton ha^{-1} improved the soil condition for plant growth by decreasing soil PH. Also, Ali et al. (2005) indicated that PH and EC values were slightly decreased with application FYM at rate 2 or 3% to sandy soil after harvesting maize. On the other hand, EL Maghraby et al. (1997) indicated that the long – term application of farmyard manure improved soil PH, EC and humus content, which reflected on increasing the N, P, K as well as trace elements content either in straw or in grains of wheat.

Due to the aforementioned about suitable characteristics of sandy soil, several studies have assured the roles of organic amendments as an improving agent. The improvement of soil physical and chemical properties as well as nutrients status depends to a great extent on the rational use of organic materials as amendments. Furthermore, bentonite and feldspar as natural deposits in Egypt were frequently used for conditioning sandy soil. El-Halawany et al. (1991) reported that bentonite application resulted in a highly significant increase in soil porosity and available water content, contrary to bulk density and hydraulic conductivity where their values were significantly decreased.

Seddik and Laila (2004) found that addition of rice straw compost or chicken manure to the soil decreased bulk density and hydraulic conductivity and increased total porosity, field capacity and available water. Also, they added that adding vermiculite or bentonite with chicken manure or rice straw compost to soil increased significantly peanut, carrot yields and improve soil physical properties such bulk density, total porosity and moisture retention characteristics.

In recent years, biofertilizers have emerged as an important component of the integrated nutrient supply system and hold a great promise to improve crop yields through environmentally better nutrient supplies. However, the application of micobial fertilizers in practice, somehow, has not achieved constant effects. The mechanisms and interactions among these microbes still are not well understood, especially in real applications. Wu et al. (2005) Performed studies on the effect of four biofertilizers containing an arbuscular mycorrhizal fungus (*Glomus mosseae* or *Glomus intraradices*) with or without N_2-fixer (*Azotobacter Chroococcum*), P solubilizer (*Bacillus megaterium*) and K solubilizer (*Bacillus mucilaginows*) on soil properties and the growth of Zea mays. The treatments included control (no fertilizer), chemical fertilizer, organic fertilizer and two types of biofertilizer. The application of biofertilizer containing mycorrhizal fungus and three species of bacteria significantly increased the growth of Zea mays.

Recently, Cakmakci et al. (2006) investigated the seed inoculation of sugar beet, with five N_2-fixing and two phosphate solubilizing bacteria in comparison to control and mineral fertilizers. They found that the inoculation with plant growth-promoting rhizobacteria (PGPR) increased sugar beet root weight by 2.8-46.7% depending on the species. Leaf, root and sugar yield were increased due to bacterial inoculation by 15.5-20.8, 12.3-16.1 and 9.8-

14.7%, respectively, in an experiment of low and high OM soil. The effect of PGPR was greater at early growth stages than at the later ones.

The objective of this study was to determine the efficiency of using different sources of natural mineral, i.e., feldspar and bentonite in combination with rock phosphate, as well as their rates under varied organic manure, i.e., Farmyard and chicken manure, conditions adopted for two cultivars, tomato and pea, grown on a light textured sandy soil.

MATERIALS AND METHODS

Two successive field experiments were carried out at Ismaillia agricultural Research station, Agric. Res. Center (ARC) during summer season 2004 with Tomato (*Lycopersicon esculentum*) and winter season 2005 with Pea (*Pisum sativa, Cv. Master*) to study the effect of natural conditioners combined with a biofertilizers (a mixture of *Azotobacter Chroccoum*, *Bacillus Megatherium* namely (phosphatek) and *Bacillus Pasteurii* namly (Biopotash) on chemical and physical properties of sandy soils under Tomato- Pea cropping system. Some physical and chemical characteristics of the tested soil samples are shown in Table (1).

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

Soil characteristics	Values
Particle size distribution %	
Coarse Sand	50.4
Fine sand	40.4
Silt	3.20
Clay	6.00
Texture	Sandy
Chemical properties	
$CaCO_3$ %	1.4
pH (1 :2.5 soil -water suspension)	7.92
EC dS/m (saturated paste extract)	0.37
Organic matter %	0.40
Cations and anions in sat. extract (meq/l)	
Ca^{++}	0.95
Mg^{++}	0.89
Na^{+}	1.51
K^{+}	0.45
HCO_3^{-}	1.42
CO_3^{--}	-
Cl^{-}	1.02
SO_4^{--}	1.36
Available nutrients (ppm)	
N	85
P	25
K	125

Natural conditioners tested include two organic manures, i.e., farmyard manure (FYM) and chicken manure (ChM) and two natural clay minerals, i.e., bentonite (Ben) and feldspar (Fed). Organic manures were applied at rate 20 m^3/fed. While clay minerals and rock phosphate (RP) were applied at two rates (75 % and 100%). They were applied alone or in combination with organic manures.

The analysis of organic manures and different minerals were carried out according to standard methods described by **Page et al. (1982)** and values are shown in Table (2).

Table (2):- Some characteristics of organic manures (FYM and chicken) and natural minerals (Feldspar and bentonite) used in the experiment

Determination	FYM	Ch.M	Feldspar	Bentonite
EC dS/m	4.20*	7.08	0.44**	3.80**
PH	8.70*	8.30	8.56**	7.80**
O.M %	28.8	8.24	-	-
Available nutrients (ppm)				
N	414	435	166	216
P	827	170	5.76	2.10
K	760	223	400	951

*EC (1:10) FYM : water extract ** EC(1:5) natural minerals: water extract
*pH (1:10) FYM : water suspension ** pH (1:2.5) natural minerals water suspension

Natural conditioners were added by thoroughly mixing with the surface soil layer before 15 days from tomato (First season) and pea planting (second season).

The experiment was designed in a split-split design with three replicates. The main plots were for organic manures (Farmyard and chicken), while the sub-main plots were inoculated and non-inoculated with biofertilizers. The sub-sub plots were clay minerals with two levels (75, 100%).

In case of inoculation, tomato seedlings were dipped in liquid culture of biofertelizers for one hour, and then transplanted into soil. After one month, some treatments had received another dose of the biofertilizers as soil drench. While pea seeds were spread immediately mixed with the biofertilizers inoculum and allowed to adhere to the seeds when rinsed with a liquid Arabic gum and then air dried for one hour.

The plots received mineral fertilizers as follows: ammonium sulfate (20.6% N), superphosphate (15% P_2O_5) and potassium sulfate (48% K_2O) at rates of half dose (40, 30 and 24 kg/fed.) of N, $P_2O_5$and K_2O for pea and 50, 20 and 24 of N, P_2O_5 and K_2O Kg /fed. for tomato plants, respectively.

Mineral fertilizers (MF) were applied at full dose for control treatment, while, these mineral fertilizers were added to the applied treatments as a half of the recommended dose for both pea and tomato plants. Phosphorus and potassium fertilizers were added last before pea and tomato cultivation while ammonium sulphate was added weekly in ten equal split doses through the growing season of pea and tomato.

At maturity (120, 150 days), pea and tomato plants were harvested and the yield components (grains and straw for pea and fruits and shoots for tomato) of each plot were recorded. Plant samples of pea and tomato were collected from each plot, weighed, oven dried at 70 °C, ground and prepared for digestion using H_2SO_4 and H_2O_2 method described by Page et al. (1982). The digests were then subjected for measurement of macronutrients (N, P and K) using the procedures described by Cottenie et al. (1982). Also, soil chemical and physical properties were determined.

Obtained results were subjected to statistical analysis according to Snedecor and Cochran (1980) and the treatments were compared by using least significant difference (L.S.D.) at 0.05 level of probability.

RESULTS AND DISCUSSION

1- Influence of organic manure, rates of natural minerals forms and inoculation with bacteria on some soil physical and chemical characteristics

A- Physical properties

1- Soil bulk density

Due to the fact that the ability of plant roots to penetrate the soil is a function of its compressibility and consequently the characteristics of its pore-space, therefore, the impact of the applied natural minerals and organic manures treatments on bulk density (BD) was taken into account.

Data presented in Table (3) show that values of soil bulk density significantly decreased due to the application of mineral natural and organic manure as compared to control at both tested seasons. The application of organic manure in combination with natural minerals decreased the values of BD as compared to natural minerals alone. Also, data show low significant decreases in BD due to the application of FYM in combination with 100% of bentonite + rock phosphate in presence of inoculation.

Moreover, application of organic manure in combination with high rate of natural mineral led to decrease the values of BD as compared to low rate of natural minerals.

As far as added forms of natural mineral, results reveal that bentonite + rock phosphate at both rates decreased the BD either they applied alone or in combination with organic manures. This finding is expected according to the effect of applied composts on soil bulk density, aggregation parameters and other structure parameters. In fact, the obtained trend agrees with those stated by El- Halawany et al. (1991).

Concerning the effect of treatments after the second season, the obtained results show that the addition of any treatments causes a slightly decrease in the values of soil bulk density as compared to those obtained after the first season. This is due to increasing the decomposition rate of organic matter by time and to the indirect effect of organic matter on soil biochemical and physical properties. These results are in agreement with those obtained by Aziz et al. (1999).

2- Soil moisture characteristics

Moisture constants namely, field capacity (FC) and available water (AW) (Table 3) had increased with addition of both organic manure forms and rates of natural minerals as compared to control at both tested seasons. The high significant increase for FC and AW due to the application of FYM in combination with 100% of bentonite + rock phosphate in presence inoculation was observed either at first or second season.

As far as added natural mineral, results reveal that bentonite + rock phosphate at both rates improved FC and AW in soil either they applied alone or in combination with organic manures. Also, results show that high rate of natural mineral recorded significantly an increase in FC and AW.

Regarding bacterial inoculation, bacteria had recorded highest values of FC and AW in soil for both two seasons.

Concerning the effect of organic manure and natural mineral after the second season, the obtained results show that the addition of any treatments causes slight decreases in the values of soil bulk density as compared to those obtained after the first season. This is due to increasing the decomposition rate of organic matter by time and to the indirect effect of organic matter on soil biochemical and physical properties. An opposite trend was obtained for field capacity and available water values.

Table (3): Responses of physical properties to applications of either organic manure forms or natural minerals forms and rates at harvesting stage for tomato and pea cultivation

Organic manure	Natural minerals		Bulk density		Field capacity		Available water	
			Inoculation					
	Forms	Rates	With	With-out	With	With-out	With	With-out
First seasons (Tomato cultivation)								
	Control		1.61	1.66	8.20	8.00	6.00	5.75
0	Fed + RP	75%	1.72	1.76	8.80	8.00	6.50	6.20
	Ben + RP		1.66	1.70	9.60	9.00	7.10	6.60
	Fed + RP	100%	1.68	1.72	9.00	8.40	6.80	6.40
	Ben + RP		1.62	1.70	10.0	9.00	7.90	6.80
FYM	Fed + RP	75%	1.52	1.57	13.7	11.5	9.30	8.00
	Ben + RP		1.47	1.52	15.4	13.7	11.2	10.1
	Fed + RP	100%	1.48	1.50	16.2	15.0	13.0	11.3
	Ben + RP		1.40	1.46	18.7	16.8	14.4	12.0
ChM	Fed + RP	75%	1.55	1.59	13.2	11.0	8.90	7.90
	Ben + RP		1.48	1.53	14.0	12.6	10.2	9.00
	Fed + RP	100%	1.50	1.54	15.0	13.0	12.8	11.0
	Ben + RP		1.44	1.50	16.4	14.3	14.0	12.7
	L.S.D. 5%		0.005		1.24		0.25	
Second seasons (Pea cultivation)								
	Control		1.62	1.65	8.50	8.20	6.50	6.10
0	Fed + RP	75%	1.68	1.70	11.0	10.0	6.20	6.00
	Ben + RP		1.65	1.68	12.0	11.0	7.00	6.20
	Fed + RP	100%	1.62	1.68	11.5	10.2	6.50	6.00
	Ben + RP		1.60	1.66	12.6	11.3	8.00	6.50
FYM	Fed + RP	75%	1.50	1.48	14.2	12.0	10.9	9.40
	Ben + RP		1.41	1.48	16.0	14.5	12.4	10.6
	Fed + RP	100%	1.40	1.47	16.8	15.6	14.1	12.2
	Ben + RP		1.30	1.40	19.3	17.1	15.5	13.0
ChM	Fed + RP	75%	1.50	1.52	14.0	12.5	9.60	8.00
	Ben + RP		1.43	1.49	15.3	14.0	11.0	9.30
	Fed + RP	100%	1.44	1.50	16.5	13.7	13.0	11.8
	Ben + RP		1.37	1.46	17.8	15.0	14.6	13.0
	L.S.D. 5%		0.016		0.052		0.052	

B- Chemical properties

1- Soil reaction (pH)

Data presented in Table (4) indicate that application of natural minerals individually increased slightly the pH values either for inoculation or non-inoculation, in spite of they when combined with organic manure led to decrease the pH values as compared with control at both tested seasons. The values of pH were lower, for first and second seasons, with application of FYM and ChM compared to treatments without organic manure particularly with inoculation of bacteria. This result may be due to the production of organic acids, which formed as a result of soil inoculation with bacteria and organic matter decomposition (Ali et al., 2003).

On the other hand, the values of pH increased with increasing rates of natural minerals either for individually or combination with organic manure at both seasons.

Table (4): Responses of chemical properties in soils to application of either organic manure forms or natural minerals forms and rates at harvesting stage for tomato and pea cultivation

Organic manure	Natural minerals		pH		EC ds/m		Available macronutrients (ppm)					
							N		P		K	
	Forms	Rates	Inoculation									
			With	Without	With	Without	With	Without	With	Without	With	Without
First seasons (Tomato cultivation)												
Control			7.82	7.96	0.65	0.78	180	165	30	28	176	166
0	Fed+RP	75%	7.80	7.87	0.63	0.67	176	165	30	26	176	160
	Ben+RP		7.90	8.20	0.67	0.72	183	166	34	28	174	162
	Fed+RP	100%	7.90	8.30	0.65	0.69	178	166	32	26	182	165
	Ben+RP		7.91	8.40	0.70	0.75	185	168	36	30	178	164
FYM	Fed+RP	75%	7.43	7.80	0.61	0.70	210	180	45	33	235	200
	Ben+RP		7.38	7.62	0.59	0.67	220	190	50	38	228	196
	Fed+RP	100%	7.62	7.73	0.64	0.72	190	180	37	28	218	190
	Ben+RP		7.55	7.58	0.61	0.70	196	186	40	30	200	181
ChM	Fed+RP	75%	7.44	7.62	0.65	0.74	200	190	42	31	224	192
	Ben+RP		7.41	7.62	0.60	0.72	206	191	45	34	215	192
	Fed+RP	100%	7.52	7.64	0.68	0.74	185	165	39	27	200	184
	Ben+RP		7.40	7.63	0.65	0.70	190	171	41	30	190	179
L.S.D. 5%			0.209		0.173		11.7		0.19		2.01	
Second seasons (Pea cultivation)												
Control			7.71	7.85	0.60	0.63	165	157	26	22	160	151
0	Fed+RP	75%	7.82	8.00	0.70	0.74	168	157	24	20	168	150
	Ben+RP		8.10	8.30	0.72	0.78	172	162	26	22	160	151
	Fed+RP	100%	8.00	8.30	0.72	0.76	170	160	26	23	164	153
	Ben+RP		8.20	8.40	0.74	0.80	173	164	28	24	161	151
FYM	Fed+RP	75%	7.40	7.76	0.50	0.60	196	176	35	27	192	171
	Ben+RP		7.30	7.70	0.45	0.58	205	188	42	31	180	164
	Fed+RP	100%	7.60	7.70	0.60	0.65	180	162	30	25	173	162
	Ben+RP		7.52	7.74	0.56	0.62	185	171	33	22	165	158
ChM	Fed+RP	75%	7.49	7.62	0.53	0.62	187	182	30	21	182	170
	Ben+RP		7.42	7.56	0.48	0.56	193	175	36	27	176	166
	Fed+RP	100%	7.50	7.59	0.56	0.63	170	166	28	20	174	164
	Ben+RP		7.37	7.50	0.50	0.65	176	164	30	24	170	160
L.S.D. 5%			0.05		0.02		11.7		1.88		1.93	

2- Electrical Conductivity (EC)

Obtained results show that values of EC in soil at first and second seasons, generally, were relatively lower when the different rates of natural mineral were applied either individually or in combination with organic manure (FYM and ChM) as compared to the control, an exception being obtained with natural mineral applied individually at second season (Pea cultivation).

Moreover, application of organic manure and low rate of natural mineral decreased the values of EC in the soil. Inoculation with bacteria also decreased the values of EC at both seasons.

It is of worth to mention that values of EC were slightly lower after pea harvested than of tomato at all organic manure a combined with rates of natural mineral either for inoculation or non- inoculation treatments. This lowering of soil salinity could be due to that the incorporation of organic substances into the soil, which creates a good condition of drainage. Also, these results were Similar to those obtained by Ali (2004).

3- Availability of macronutrients

With regard to macronutrient availability in soil, at both seasons, values were increased due to all the applied forms of organic manure and rates of natural minerals as compared to control. Moreover, the addition of composted manure to soil is one mechanism that is thought to reduce volatilizations erosion and leaching losses of nutrients in sandy soils (Mondini et al., 1996). Also, data in Table (4) show high significant increases in available N and P due to the application of FYM in combination with 75% of bentonite + rock phosphate in presence inoculation, while, due to potassium, significant highest values of available K in soil were obtained with FYM combined with 75% of feldspar + rock phosphate. Such increases for N, P and K were 22.2, 66.6 and 33.5 as well as 24.2, 61.5 and 20.0% at first and second seasons, respectively.

As far as added natural mineral alone or combined with organic manure, results reveal that bentonite + rock phosphate at both rates improved N and P available in soil but feldspar + rock phosphate increased values of K available in soil. The inoculation with bacteria also leads to enhance the macronutrient available values as compared to non-inoculation. Moreover, available of macronutrient in soil for first season (Tomato) recorded high values as compared to second season (Pea).

2- Influence of organic manure, rates of natural minerals forms and inoculation with bacteria on Macronutrients in plants

A- Macro nutrients content in shoot and fruit of tomato

Data presented in Table (5) reveal that application of natural minerals (Ben + RP and Fed + RP) individually increased significantly both shoot and fruit macronutrients (N, P and K) content as compared to control treatment (without natural minerals). Also, increasing the rate of natural minerals from 75 to 100% increased significantly N, P and K content in shoot and fruit of Tomato. These results may be due to that increasing rate of minerals led to increase nutrient status in the soil and thereby contribute to enhance nutrients availability to plants. These results are in agreement with EL- Etr et al. (2005) who found that the application of high rate of Feldspar without FYM generally caused high nutrients uptake as compared to lower rate.

Moreover, application of natural minerals in combination with organic manures (FYM or CM) increased significantly both shoot and fruits of tomato N, P and K content as compared to applied natural mineral (Ben+ RP or Fed+ RP) either alone or control treatment (without minerals).
Comparing the effects of natural mineral forms, at both rates of 75 and 100 % combined with FYM and CM, respectively, data show that, the treatment (FYM + Ben + RP at rate 75 %) was superior to N, P and K contents in both shoots and fruits.

Table (5): Responses of macronutrients (N, P and K) contents for tomato cultivars to application of either organic manure forms or natural minerals forms and rates

Organic manure	Natural minerals		Contents of macronutrients					
			N%		P%		K%	
	Forms	Rates	Inoculation					
			With	With-out	With	With-out	With	With-out
Shoots								
Control			2.40	2.20	0.42	0.39	1.45	1.38
0	Fed + RP	75%	2.60	2.30	0.37	0.35	1.47	1.32
	Ben + RP		2.80	2.40	0.40	0.37	1.40	1.30
	Fed + RP	100%	2.90	2.50	0.38	0.35	1.45	1.30
	Ben + RP		3.00	2.60	0.40	0.38	1.42	1.28
FYM	Fed + RP	75%	3.50	2.80	0.60	0.52	1.70	1.57
	Ben + RP		3.70	3.00	0.65	0.56	1.76	1.62
	Fed + RP	100%	3.20	2.00	0.42	0.38	1.52	1.42
	Ben + RP		3.30	2.20	0.50	0.41	1.54	1.44
ChM	Fed + RP	75%	2.80	2.20	0.55	0.48	1.52	1.40
	Ben + RP		3.00	2.60	0.60	0.50	1.61	1.50
	Fed + RP	100%	2.40	2.00	0.40	0.37	1.50	1.40
	Ben + RP		2.50	2.00	0.50	0.40	1.52	1.42
L.S.D. 5%			0.05		0.04		0.05	
Fruits								
Control			4.80	4.40	0.70	0.60	2.00	1.80
0	Fed + RP	75%	5.00	4.50	0.76	0.60	2.10	1.81
	Ben + RP		5.10	4.60	0.78	0.61	2.20	1.83
	Fed + RP	100%	5.16	4.70	0.78	0.63	2.25	1.82
	Ben + RP		5.20	4.73	0.79	0.61	2.28	1.84
FYM	Fed + RP	75%	5.40	4.85	0.86	0.65	2.54	1.95
	Ben + RP		5.60	4.90	0.89	0.68	2.60	1.90
	Fed + RP	100%	5.22	4.80	0.81	0.61	2.40	1.87
	Ben + RP		5.31	4.83	0.83	0.64	2.42	1.88
ChM	Fed + RP	75%	5.20	4.82	0.82	0.60	2.20	1.86
	Ben + RP		5.30	4.81	0.84	0.65	2.30	1.86
	Fed + RP	100%	5.11	4.80	0.81	0.62	2.10	1.90
	Ben + RP		5.15	4.81	0.83	0.64	2.20	1.98
L.S.D. 5%			0.16		0.10		0.19	

This could be attributed to that adding organic manures as fertilizers led to decrease soil pH, which resulted in increasing solubility of nutrients and nutrient availability to the plants. Besides, these organic manures stimulate biodegradation through increasing the population and activities of microorganisms in the soil and minimize the loss of nutrients by leaching (Khalil et al., 2004).

On the other hand, mixing biofertilizers (BF) with organic manures (FYM and CM) and natural minerals (Ben+ RP or Fed + RP) at rates of 75 and 100 % increased significantly both shoots and fruits macronutrients contents of tomato compared to the treatments receiving (FYM or CM) either in combination with natural minerals (without inoculation) or control.

Moreover, the highest values of N, P and K were recorded in case of applying (FYM + Ben + RP 75 % + BF) treatment. This treatment recorded significantly higher values of N, P and K than the other treatments. This is due to organic acid production by organic manures (FYM) and microorganisms that decrease of medium pH, appear to be the major mechanisms for RP, Ben and Fed through protonation and or chelation reactions. The effectiveness RP in increasing P uptake and yield may be due to the slow dissolution of RP increased the opportunity of plant roots to intercept the P before it is transformed to unavailable forms (Butegwa et al., 1996).

The beneficial effects of FYM may be attributed to solubilizing effect of FYM on RP and the release of other nutrients from the decomposition of FYM (Seddik et al., 2005).

Biofertilizers are products containing living cells of different types of microorganisms, which have the ability to convert nutritionally important elements from unavailable to be available through biological processes. (Wu et al., 2005).

B- Macronutrients content in seed and straw of Pea

Regarding the effect of organic manures and natural minerals on macronutrients contents in both straw and seed of Pea plants grown in sandy soil (Table 6), application natural minerals at two rates (75 and 100%) inoculated with or without (BF), increased significantly N,P and K contents over control treatments . This is due to that adding minerals mixed with organic manure led to increase the dissolution of nutrients by formation of organic acids and chelating agents. However, application of either FYM or CM in combination with Ben + RP at two rates (75 and 100%) led to significant increases in N,P and K contents in straw and seeds compared to control treatment.

The highest N, P and K contents (2.8, 0.56 and 1.56) and (5.5, 1.03 and 1.60) in straw and seeds, respectively, was recorded in case of treatment FYM + (Ben + RP 75 %) inoculated with biofertilizers. This value was significantly higher than that recorded by the treatments of natural minerals alone or together with (CM) and with or without inoculation. These findings are good agreement with those of Abdel wahab et al. (2003) who reported that using of enriched organic compost combined with natural minerals (Feldspar and Rock phosphate) led to a significant increase for the nodular tissue , plant dry matter , grain yield and N, P and K concentrations in plant.

Table (6): Responses of macronutrients (N, P and K) contents for pea cultivars to application of either organic manure forms or natural minerals forms and rates

Organic manure	Natural minerals Forms	Rates	N% With	N% With-out	P% With	P% With-out	K% With	K% With-out
			Straw					
Control			1.62	1.50	0.28	0.22	1.32	1.30
0	Fed + RP	75%	1.70	1.60	0.29	0.23	1.40	1.28
	Ben + RP		1.75	1.62	0.31	0.26	1.30	1.22
	Fed + RP	100%	1.80	1.61	0.33	0.25	1.38	1.30
	Ben + RP		1.86	1.64	0.36	0.27	1.31	1.22
FYM	Fed + RP	75%	2.50	1.80	0.48	0.38	1.52	1.43
	Ben + RP		2.80	2.00	0.54	0.42	1.56	1.45
	Fed + RP	100%	2.10	1.70	0.40	0.33	1.43	1.37
	Ben + RP		2.30	1.90	0.46	0.42	1.46	1.40
ChM	Fed + RP	75%	2.20	1.70	0.42	0.35	1.47	1.38
	Ben + RP		2.40	1.90	0.48	0.40	1.53	1.41
	Fed + RP	100%	2.00	1.70	0.37	0.33	1.42	1.34
	Ben + RP		2.20	1.80	0.40	0.30	1.44	1.38
L.S.D. 5%			0.27		0.13		0.06	
			Seeds					
Control			4.40	4.30	0.83	0.80	1.00	1.00
0	Fed + RP	75%	4.051	4.40	0.85	0.70	1.15	0.90
	Ben + RP		4.53	4.45	0.87	0.70	1.18	0.90
	Fed + RP	100%	4.62	4.42	0.88	0.72	1.21	1.00
	Ben + RP		4.65	4.46	0.92	0.74	1.26	1.00
FYM	Fed + RP	75%	5.36	5.10	1.00	0.90	1.60	1.35
	Ben + RP		5.50	5.20	1.09	0.90	1.60	1.22
	Fed + RP	100%	5.18	4.80	0.95	0.80	1.45	1.15
	Ben + RP		5.20	4.90	0.97	0.82	1.32	1.12
ChM	Fed + RP	75%	5.22	5.02	0.96	0.75	1.30	1.00
	Ben + RP		5.30	5.12	0.98	0.76	1.40	1.10
	Fed + RP	100%	5.07	4.70	0.85	0.60	1.25	0.98
	Ben + RP		5.10	4.72	0.90	0.62	1.28	1.00
L.S.D. 5%			0.07		0.09		0.13	

Both FYM and CM have been traditionally applied as a fertilizer of slowly released nutrients, for some crops and to improve the physio-chemical soil properties.

Sandy soils response to biofertilizer inoculation are supposed to be due to the poor organic matter contents of these soils, that ensure original low indigenous microorganisms population, which in turn are not able to compete with the microbes in the biofertilizer inoculum (Khalil et al., 2004). Also, P and K solubilizing bacteria may enhance mineral uptake by plants through solubilizing in soluble P and releasing K from silicate in soil (Seddik, 2006).

2- Influence of organic manure, rates of natural minerals forms and inoculation with bacteria on yield components of both tomato – pea crop systems

Data shown in Table (7) reveal that values of both tomato and pea yield components increased significantly with application of natural mineral as compared to control treatment (non-natural mineral) either inoculated with biofertilizers or non-inoculated.

Table (7): Responses of yield components for both tomato and pea cultivars to application of either organic manure forms or natural minerals forms and rates

Organic manure	Natural minerals		Tomato yield (Ton fed.-1)				Pea yield (Ton fed.-1)			
			Shoots		Fruits		Pods		Straw	
			Inoculation							
	Forms	Rates	With	Without	With	Without	With	Without	With	Without
Control			4.20	4.00	9.00	8.30	2.30	1.80	1.60	1.30
0	Fed + RP	75%	4.60	4.20	9.20	8.80	2.00	2.10	1.80	1.50
	Ben+ RP		4.70	4.30	9.50	9.00	2.40	2.20	1.90	1.60
	Fed + RP	100%	4.80	4.30	9.00	8.80	2.60	2.40	2.00	1.70
	Ben+ RP		4.90	4.30	9.80	9.10	2.70	2.50	2.00	1.70
FYM	Fed + RP	75%	5.50	4.90	16.0	15.2	4.00	3.20	2.40	1.90
	Ben+ RP		5.80	5.00	17.2	16.0	4.50	3.50	2.60	2.00
	Fed + RP	100%	4.90	4.40	11.0	10.0	2.90	2.10	2.00	1.80
	Ben+ RP		5.00	4.60	12.0	10.7	3.20	2.50	2.30	1.80
ChM	Fed + RP	75%	5.00	4.50	14.0	12.4	3.40	2.70	2.20	1.90
	Ben+ RP		5.40	4.90	15.8	14.2	3.90	3.00	2.40	1.90
	Fed + RP	100%	5.00	4.60	9.00	9.30	3.00	2.40	2.10	1.80
	Ben+ RP		5.10	4.80	10.6	9.70	3.00	2.80	2.00	1.80
L.S.D. 5%			0.05		0.18		0.25		0.31	

Regarding the application of natural minerals alone at the rate 100% there was positive effects on tomato and pea yield as compared to the rate 75% and/ or (non-natural minerals).

Also, results indicate that addition of farmyard manure or chicken manure in combination with two rates (75% and 100%) of feldspar + rock phosphate (Fed + RP) and bentonite + rock phosphate (Ben+ RP) were highly significant on tomato and pea components (shoot, fresh fruit and pods and straw) as compared to applied natural mineral either alone or inoculation with biofertilizer.

With respect to the effect of natural minerals forms, results show that tomato and pea yield were generally superior when using farmyard manure combined with bentonite + rock phosphate and feldspar + rock phosphate at the rate 75% and 100% respectively. This finding is in close agreement with El-Etr et al. (2005) who found that the highest significant increases of carrot yield and macronutrients uptake (N,P and K) were obtained when feldspar was applied at rate 75% of the recommended dose along with *penecillum expansum* inoculation. The structure of K-feldspare is a three dimenensional framework of linked SiO_4 and Al_2O_3 tetrahedra, with sufficient opening in the framework to accommodate K to maintain electro-neutrality (Seddik, 2001). In the K-feldspar structure, one out of every four Si atoms in the framework is replaced by Al. This substitution imparts a negative charge to the framework, which is neutralized by the incorporation of other positively charged ions, such as K^+. Blakanova et al. (1985) and Seddik (2001) noted that the microorganisms having the ability to biodegrade aluminosilicate could be grouped into two classes with respect to mechanisms of action, those, which solubilize the minerals by direct enzymatic attack and these, which promote the degradation through their metabolites.

This chemical degradation could proceed either by acidolysis or by complexolysis. Acidolysis of minerals involves the solubilization of the rock constituents in ionized form and the major role is played by proton activity, summarized by the following general reaction:

$$\text{(Mineral) } M^{+} + H^{+} R^{-} \rightarrow \text{(mineral) } H^{+} + MR$$

R= $NO3^{-}$, COO^{-}, $CO3^{--}$, $SO4^{--}$

On the other hand, complexysis of minerals is the process of formation of soluble metal organic complexes or metal organic chelates where the complexing or chelating agents are produced by the microorganisms and the metal is thus removed from the mineral as represented by the following equations:

$$\text{(Mineral) } M^{+} + H^{+}L^{-} \rightarrow \text{(mineral) } H^{+} + LM$$

$$H^{+} L^{-} + LM \rightarrow (L2\ M) + H^{+}$$

Where L is an organic ligand. Also, mechanisms of degradation of silicate minerals by microorganisms resulted from their ability to produce organic acids such as (citric, oxalic and tartaric acids) and phenols such as (salicylic and benzoic acids).

Also, application of both FYM and chicken manure in combination with natural minerals increased tomato and pea yield as compared to control treatment either the minerals applied alone or combined with biofertilizers inoculation. This is true, in spite of FYM was more favorite as compared to chicken manure when natural minerals were applied at low rate (75%).

With regard to inoculation with biofertilizers (mixture inoculum), it was indicated that inoculation in general, gave the highest values of tomato and pea yield. This is due to biofertilizer are products containing living cells of different types of microorganisms, which have an ability to convert nutritionally important elements from unavailable to available form through biological processes. Also, biofertilizers have emerged as an important component of the integrated nutrient supply system and hold a great promise to improve crop yield through environmentally better nutrient supplies. (Vessey, 2003).

From the abovementioned results , it can be concluded that the application of natural minerals especially (Ben + RP) at the rate 75 % in combination with FYM either inoculated with biofertilizers or non inoculated decreased significantly bulk density of sandy soil and increased significantly field capacity , available water, yield components and macronutrients contents (N , P and K) of tomato and Pea.

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التغيرات فى الخواص الطبيعية و الكيميائيةللتربة و محتوى العناصر الكبرى لنباتات البسلة والطماطم نتيجة التسميد بالسماد العضوى وبعض المعادن الطبيعية

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أجريت تجربتين حقليتين فى محطة البحوث الزراعية بالاسماعيلية (مركز البحوث الزراعية) لموسمين ٢٠٠٤-٢٠٠٥ لدراسة تاثير اضافة المخلفات العضوية مع المعادن الطبيعية على بعض الخواص الطبيعية للارض (الكثافة الظاهرية – السعة الحقلية – الماء الميسر) و الخواص الكيميائية (pH , EC – Macronutrient availabilaty) . وقد درس أيضا محتوى العناصر الكبرى فى كل من نباتى الطماطم و البسلة و انتاجيتهما. وقد صممت التجربة فى قطعة منشقة فى ثلاث مكرارات للمعاملة حيث أضيف صورتين من المخلفات العضوية (مخلفات الماشية – مخلفات الدواجن) و معدلين من المعادن الطبيعية (البنتونيت – الفلسبار متحد مع صخر الفوسفات) فى وجود التسميد الحيوى (مخلوط من بكتريا مثبتة للنيتروجين و بكتريا مذيبة للفوسفور و أخرى مذيبة للبوتاسيوم (a mixture of *Azotobacter Chroccoum*, *Bacillus Megatherium* namely (phosphatek) and *Bacillus Pasteurii* namly (Biopotash).

أوضحت النتائج ان اضافة المعادن الطبيعية و المخلفات العضوية خفضت قيم كل من الكثافة الظاهرية، pH ، EC للتربة وعلى العكس من ذلك زادت قيم العناصر الكبرى الميسرة بالتربة. الكثافةالظاهريةانخفضت باضافة مخلفات الماشية متحدا مع معدل ١٠٠% من البنتونيت و صخر الفوسفات وقد اخذت قيم رطوبة التربة، pH ، EC اتجاها معاكسا. أظهرت النتائج زيادة معنوية عالية فى تيسر كل من النيتروجين و الفوسفور بسبب اضافة مخلفات الماشية متحدا مع معدل ٧٥% من البنتونيت و صخر الفوسفات، بالرغم من ذلك فان قيم البوتاسيوم الميسر كانت عالية المعنوية باضافة مخلفات الماشية متحدا مع معدل ٧٥% من الفلسبار و صخر الفوسفات. وفيما يختص بالتلقيح البكتيرى فان النتائج اوضحت ان قيم الكثافة الظاهرية، pH ، EC سجلت انخفاضا ملحوظا و لكن السعة الحقلية و الماء الميسر و العناصر الغذائية الكبرى الميسرة سجلت ارتفاعا.

كذلك فان محتوى العناصر الكبرى N، P ، K فى النباتات المدروسة بالاضافة الى مكونات المحصول لكل من نباتى الطماطم و البسلة، عموما قد زادت باضافة المخلفات العضوية و المعادن الطبيعية. و كذلك فان النتائج المتحصل عليها دلت على ان اضافة مخلفات الماشية متحدا مع المعدل المنخفض (٧٥%) من البنتونيت و صخر الفوسفات سجل قيم مرتفعة لمحتوى العناصر الكبرى و مكونات المحصول للنباتين المدروسين.