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SOIL FERTILITY AND POTATO PRODUCTION AS AFFECTED BY CONVENTIONAL AND ORGANIC FARMING SYSTEMS

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ABSTRACT

A field experiment was conducted during the winter season of 2007/2008 at the Experimental Station of the Faculty of Agriculture, Mansoura University, Egypt, to evaluate the ability of water and ethanol-alcohol for extracting the nutrients from mature farmyard manure. In addition to assessing the effect of mature (FYM), sediments (separated from extract), and both foliar application of extracts of farmyard manure (as organic farming technique) and mineral fertilizer treatment (as conventional cultivation system) on the quality and yield of potato (*Solanum tuberosum,* L.) and soil health (physical, chemical and biological properties) after harvesting stage.

Nine treatments were arranged in a complete randomized block design with four replicates, (mineral NPK, mature FYM, watery FYM extract, watery sediment, watery FYM extract with sediment, ethanolic FYM extract, ethanolic sediment, ethanolic FYM extract with sediment, and control treatment). FYM extracts were sprayed on plant foliage, while others were added as soil application.

The soil application of mineral fertilizer (as conventional system) has the highest significant values for all vegetative growth parameters, yield, yield components, of potato comparing with other organic treatments. In contrary, the soil application of FYM achieved the highest values for improving soil health after harvesting stage (including soil physical, chemical and biological, properties), also reducing the accumulation of NO_3^- and NO_2^- contents in potato tuber.

FYM application methods (as organic system) enhanced all studied potato vegetative growth parameters, quality and quantity of the yield and also improve soil health, compared to the untreated treatment. For all potato plant growth parameters, FYM application methods can be arranged in the order: spraying of ethanolic FYM extract with its sediment> spraying of watery FYM extract with its sediment> spraying ethanolic FYM extract> spraying watery FYM extract> mature FYM> watery sediment> ethanolic sediment. While, for improving soil health parameters the soil application of mature FYM gave the highest values followed by spraying of watery FYM extract with its sediment> ethanolic FYM extract with its sediment> watery sediment> ethanolic sediment. Furthermore, it was observed that ethanol as extractor was more effective than water and consequently spraying ethanolic FYM extract with its sediment or alone achieved higher values for all potato growth parameters compared to spraying of watery FYM extract either with or without its sediment.

INTRODUCTION

Potato consumption has increased in the developing countries, and over the last decade, global potato production has increased at an annual average rate of 4.5 percent (FAO, 2007). Potato (*Solanum tuberosum,* L.) is one of the most important vegetables in Egypt. It gained a considerable importance as an export crop to European markets and one of the national income resources.

There is no doubt that chemical fertilizers are essential in most cropping systems. However, in long-term field experiments where mineral fertilizers have only been used, some problems could be arise, especially

increasing soil erosion, soil compaction, environmental pollution and public health risks (Top *et al*. 2002). Therefore, it is essential to adopt a system of organic farming in vegetables due to increasing the objectives against the conventional farming as a main source of soil and water pollution as well as food products.

Often organic fertilizers are bulky or are necessary in large quantities. This can make shipping expensive and is one of the reasons for which organic farming is more viable for small-scale farms and on farm inputs are preferred (Adediran, *et al*., 2004; Hochmuth, *et al*., 2000). Problems associated with potato production include excessive rate and incorrect timing of nitrogen fertilizer application leading to runoff and groundwater pollution as well as N_2O emissions (Beckwith *et al*., 1998).

Organic farming system has become economically and industrially important over the past few decades. For organic potato producers the two main challenges are disease and nutrient management. Both factors are limited by regulations that on the one hand prohibit the use of chemical fertilizers, especially nitrogen and, on the other hand, synthetic pesticides, "EU-regulation 2092/91" (Finckh *et al*., 2006).

Plant nutrition in organic farming therefore relies on carefully designed crop rotations and the addition of organic fertilizers such as solid and liquid animal manures, green manures, composts and compost tea. With the exception of liquid manure these fertilizers are usually slow release and highly dependent on the soil moisture and temperature for mineralization processes that make the nutrients available to the plants (Van Delden, 2001; Gruber *et al*., 2003). Organic agriculture improves the physical, chemical, and biological characteristics of the soil by addition of organic matter to the soil. Compost use in organic farming system should be mature and the nutrient content should be known. Immature compost may take nitrogen from the soil in order to complete the composting process, causing nitrogen deficiencies in plants (Hochmuth, *et al*., 2000). Animal manures as well as cover cropping have been shown to be successful organic fertilizers (Gareau, 2004; Munoz, *et al*., 2005).

Riffaldi, (1988), examined water extracts of fresh and 3-month stabilized FYM. The maturation process produced a significant increase in the water-soluble dry matter, organic C and N, pH and EC. No significant difference was found in phenol content, whereas spectroscopic measurements of the extract indicated a higher condensation of organic components with the ageing of the materials. However ethanolic extract showed positive test for presence of alkaloids, protein, amino acid, carbohydrate, glycosides, phytosterols, tannins and phenolic compounds (Kokate, 1994).

Ethanol could increase plant biomass, and act as a supplemental carbon source. Previous studies using supplemental ethanol for plant propagation have reported various effects. Rowe *et al*. (1994) found a positive effect of ethanol spray on the growth of tomato plants. Peltonen, (1997) reported that foliar applications of ethanol (30 % and 60 %) decreased the disease symptoms on the leaves of wheat. Ethanol treatments did not damage the treated leaves.

Extracts produced from composted organic matter have been used for centuries for their beneficial effects on plant health (Abbasi *et al*., 2002). Compost tea is being used increasingly as an alternative plant disease control measure in organic agriculture (Anonymous, 2004). Most extracts are prepared from animal wastes based composts (Abbasi *et al*., 2002), although extracts from other types of composts have also been effective against plant diseases (Al-Mughrabi, 2003).

Makaraviciute (2003) illustrated that farmyard manure (FYM) application increased dry matter and starch contents in the tuber, where potato tuber yield increased by 20% with FYM. The response of tuber yield to farmyard manure was not consistent over growing season, possibly the positive yield response was due to K rather than N.

Therefore, the main objectives of the present study is to evaluate the using of water and ethanol alcohol extracts for the nutrients from mature farmyard manure, and using mature, sediment, and extract of farmyard manure as soil and foliar application for potato production (*Solanum tuberosum,* L.), cultivar Spunta, and the soil fertility (physical, chemical and biological characterization) for each treatment as a farming system compared to mineral fertilizer (as conventional system) and untreated soil (control).

MATERIALS AND METHODS

Location of the experiment:

A field experiment was conducted during the winter season of 2007/2008 at the Experimental Station of the Faculty of Agriculture, Mansoura University, Egypt, to (i) evaluate the ability of water and ethanol-alcohol for extracting the plant nutrient elements from mature farmyard manure (FYM) and (ii) assess the effect of mature FYM, sediments (separated from extract), and foliar application of both extracts of farmyard manure (as organic farming technique) and mineral fertilizer (as conventional cultivation system) on both the quality and yield of potato (*Solanum tuberosum,* L.) and soil health (physical, chemical and biological properties) after plant harvest.

Samples of soil were collected from the surface layer (0-30 cm depth) to determine their physical and chemical properties, according to the methods described by Page (1982), and the data obtained are presented in Table 1.

Table 1: Some physical and chemical properties of the experimental soil plant cultivation

Soil property		Value	Soil property		Value
Particle Size Distribution	Coarse Sand%	2.88	Soluble Cations (meq L^{-1})	Ca^{++}	5.77
	Fine Sand%	15.73		Mg^{++}	3.28
	Silt%	25.37		K^{+}	7.19
	Clay%	56.02		Na^{+}	2.22
	Texture Class	Clay	Soluble Anions (meq L^{-1})	$CO_3^{=}$	nd
Some Physical & Chemical properties	H.C. cm h^{-1}	2.25		HCO_3^{-}	3.80
	pH*	7.74		Cl^{-}	9.10
	EC** dS m^{-1}	1.64		SO_4	5.56
	$CaCO_3$ %	2.54	Available Macro-nutrients (m kg^{-1})	N	54.21
	OM%	2.18		P	18.65
	SP	68.79		K	284.32

*pH was determined in soil paste

**EC and soluble ions were determined in soil paste extract

Organic fertilizer used:

Mature farmyard manure (FYM) was taken from dairy farm near El Mansoura City (Meet Anter Village). The chemical analyses of the farmyard manure (mature, sediment and extract) was determined using standard methods described by the Association of Official Analytic Chemists (A.O.A.C.,1990). The results of these analyses are presented in Table 2.

Mature FYM extract preparation:

From the mature FYM, 10 kg was taken and blended with ethanol or water with a ratio of 1: 10 (w/v). Then the mixture was turned daily and filtrated after 5 days. One liter of the FYM extract was diluted by the extractant used with 1:10 ratio (v/v) according to Abbasi *et al*., (2002). The chemical characteristics of mature FYM, ethanolic and watery FYM extracts and both sediments are shown in Table (2).

Table (2): Some chemical properties of organic fertilizers used:

Characteristics	Mature FYM	Watery FYM		Ethanolic FYM	
		Extract	Sediment	Extract	Sediment
pH*	8.61	7.70	8.12	7.40	7.79
EC**	0.64	0.41	0.58	0.61	0.67
Organic carbon (%)	44.76	10.28	35.73	13.96	31.89
C:N ratio	22.05	17.72	23.35	16.62	22.45
Total macro-nutrients concentration (%)					
N	2.03	0.58	1.53	0.84	1.42
P	0.68	0.18	0.49	0.24	0.43
K	2.40	0.71	1.82	0.91	1.49
Mg	1.15	0.25	0.92	0.34	0.79
Ca	2.64	0.76	2.67	1.12	2.25
Total micro-nutrients (mg kg^{-1})					
Fe	174.30	31.29	145.87	52.47	125.78
Mn	146.50	24.65	123.54	33.75	109.75
Cu	16.40	3.68	13.54	5.67	10.84
Zn	142.40	18.97	129.65	27.68	113.64
Application rate	15 (Mg fed^{-1})	20 (L fed^{-1})	15 (Mg fed^{-1})	20 (L fed^{-1})	15 (Mg fed^{-1})

*pH was measured in 1: 10 suspension for FYM

**EC was measured in (1: 10) extract of FYM.

Experimental Layout:

Treatments arrangement and experimental design: The experiment was performed in a complete randomized block design with four replicates. Each individual plot area was 10.5 m^2. Seed comprising of 5 rows 60 cm width and 3.5 m length was used. Tuber pieces were placed at a uniform distance a part (20 cm) and each plot contained 85 cuts.

The experimental treatments of mineral and organic fertilizers in single or combined applications were nine as follows: Mineral fertilizers (NPK), mature farmyard manure (FYM), water FYM extract, water FYM sediment, water Ext. + sed., ethanol FYM extract, ethanol FYM sediment, ethanol Ext. + sed., and the control (untreated with fertilizer).

Application of Fertilizers program: The mature FYM and the sediments were applied during soil plowing, and the soil was then irrigated and left for 14 days before planting. Mineral fertilizer was applied at the recommended dose of the Ministry of Agriculture for N, P and K nutrients (180, 75 and 95 kg fed^{-1}, respectively). Super phosphate was applied before soil preparation at rate of (75kg P2O5 fed^{-1}). Ammonium nitrate fertilizer was applied at rate of 180kg N fed^{-1} in two equal doses, the 1^{st} dose was added before the 1^{st} irrigation and the 2^{nd} dose before the 2^{nd} one after planting. Potassium fertilizer was applied in one dose before the 2^{nd} irrigation after planting at 95kg K2O fed^{-1} as potassium sulphate. FYM extracts either by water or ethanol, were applied as foliar application by spraying **o**n plant shoots at two times, after 45 and 60 days from planting.

Planting and harvesting: Potato tuber pieces were planted in October 13, 2007 and harvested in January 28, 2008. The plants were irrigated 7 times after planting. The tubers of potato were harvested after 110 days from planting.

Studied characters:

Vegetative growth parameters: The following parameters: plant height (cm), number of leaves per plant, leaf area (m^2/plant) was calculated based on area unit using disk method according to (Koller, 1972), shoot dry weight (g/plant), number of tubers/plant and tuber weight (g/plant) were measured.

Yield, yield components and its quality parameters: Total tubers yield was recorded as (Mg fed^{-1}), total soluble solids (TSS) was determined using a hand refractometer method as described by Cox and Pearson (1962). Specific gravity (SG) was estimated according to Smith (1975). Vitamin C (mg/100g FW) was determined by using the indophenol method (2,6 dichlorophenol indophenol) as described by Ranganna (1979). Starch content in tubers was determined in the dry matter according to AOAC (1990). Crud Protein (%) was calculated according to (AOAC, 1990). Nitrate and nitrite in tuber were determined by using the method described by Singh (1988). The elemental (N, P and K%) composition of leaves and tubers were determined according to Jackson, (1967).

Soil physical, chemical and biological characteristics: Soil physical characteristics [saturation percentage (SP %), hydraulic conductivity (H.C. cm h^{-1})] were determine using the methods of Singh (1980). Soil chemical characteristics [available N, P and K (ppm) and OM %] were determine by the methods outlined by Hesse, (1971). Soil biological characteristic, total count bacteria x 10^6 were determined as outlined by Page, (1982).

Statistical analysis:

The statistical analysis of the obtained data was done according to the methods described by Gomez and Gomez (1984) using LSD and Duncan to compare the means of treatments values.

RESULTS AND DISCUSSION

1- Vegetative growth parameters and chemical composition of potato leaves:

Vegetative growth parameters: Table 3 showed the effects of using mineral fertilizers (as conventional farming system) and organic fertilizers (as organic farming system) on vegetative growth parameters represented by plant height, numbers of leaves and leaf area per plant, during the two growth stages of 70, 90 days after sowing (DAS). These results significantly stated that vegetative growth parameters of potato plants tended to increase with adding mineral fertilizer and application of different forms of organic manure (FYM). This increase was highly significant as compared to the control. Data show that application of mineral fertilizer had the highest significant increase in the vegetative values comparing with other organic treatments.

Among application of the FYM forms treatment, spray of ethanol extract with its sediment as soil application gave the highest values, followed by same treatment by water extract. Furthermore, spraying with FYM ethanol extract revealed higher effect than spraying with FYM water extract and application of mature FYM. The lowest vegetative growth parameters were observed with application of FYM water sediment followed by FYM ethanol sediment.

Table 3 also showed that vegetative growth parameters were increased with increasing plant age and at 90 days was higher than 70 days with same trend for all studied treatments.

Table (3): Effect of mineral fertilizer and different forms of FYM on vegetative growth parameters of potato plant height (cm), number of leaves/plant and leaf area (m^2/plant) at stages of 70 and 90 days after sowing

Treatments		Plant height (cm)		Number of leaves/plant		Leaf area (m^2/plant)	
		70 d	90 d	70 d	90 d	70 d	90 d
Mineral fertilizers (NPK)		57.89 a	63.58 a	35.22 a	46.96 a	0.50 a	0.55 a
Farmyard manure (FYM)		45.28 f	48.78 e	20.67 f	23.44 f	0.33 ef	0.36 e
Water extractor	FYM extract	46.67 e	50.29 d	22.39 e	25.89 e	0.34 e	0.39 d
	FYM sediment	44.33 g	46.97 f	18.44 g	21.95 g	0.31 f	0.35 e
	Ext. + sed.	51.00 c	52.56 c	28.44 c	36.50 c	0.39 c	0.44 b
Ethanol extractor	FYM extract	48.33 d	50.89 d	24.00 d	27.56 d	0.36 d	0.41 c
	FYM sediment	42.17 h	45.47 g	17.33 h	18.78 h	0.27 g	0.30 f
	Ext. + sed.	52.22 b	54.86 b	30.00 b	39.94 b	0.41 b	0.45 b
Control (untreated)		39.14 i	41.24 h	14.12 i	15.48 i	0.21 h	0.24 g
F test		**	**	**	**	**	**
LSD 5%		0.895	1.153	1.045	1.007	0.018	0.021

Growth parameter of potato plant including shoot dry weight, number of tubers/plant and tuber weight at plant age of 70 and 90 days from sowing as affected by mineral and organic fertilizers are recorded in Table 4. There is a high significant increase in all studied growth parameters as compared with

the control treatment in both stages. The highest values of the studied growth parameters were recorded with mineral NPK treatment at both stages as compared with all other organic treatments.

Table (4): Effect of mineral fertilizer and different forms of FYM on plant growth parameters of potato, shoot dry weight (g/plant), number of tubers/plant and tuber weight (g/plant) at stages of 70 and 90 days after sowing.

Treatments		Shoot dry weight (g/plant)		Number of tubers/plant		Tuber weight (g/plant)	
		70 d	90 d	70 d	90 d	70 d	90 d
Mineral fertilizers (NPK)		27.24 a	37.11 a	6.31 a	7.45 a	385.08 a	620.67 a
Farmyard manure (FYM)		18.74 e	22.91 de	3.10 f	3.72 e	122.69 f	250.40 f
Water extractor	FYM extract	19.77 d	24.20 cd	3.68 e	4.17 d	164.28 e	273.13 e
	FYM sediment	17.71 f	21.89 e	2.50 g	3.39 f	109.39 fg	218.40 g
	Ext. + sed.	21.86 c	27.97 b	4.36 c	4.72 c	244.63 c	424.53 c
Ethanol extractor	FYM extract	20.33 d	25.55 c	4.06 d	4.39 d	183.65 d	303.01 d
	FYM sediment	16.14 g	18.92 f	2.00 h	2.95 g	101.67 g	195.97 h
	Ext. + sed.	22.68 b	28.52 b	4.75 b	5.44 b	292.81 b	467.33 b
Control (0 fertilizer)		12.31 h	15.75 g	2.00 h	2.45 g	90.67 g	175.97 i
F test		**	**	**	**	**	**
LSD 5%		0.688	1.813	0.227	0.249	13.51	12.43

Among the applications of organic fertilizers, the highest values of growth parameters were recorded with spraying with FYM extract either with ethanol or water extract with soil application of sediment, followed by spraying FYM extract either with water or ethanol extract, which were insignificant with shoot dry weight and number of tubers/plant at the 2nd stage (90d), followed by mature FYM application. On the other hand, addition of ethanol and water FYM sediment gave the lowest values of all growth parameters.

Chemical composition of leaves: Table 5 reveal that the differences among treatments were significant concerning N, P and K concentration in leaves. The mineral fertilizer treatment recorded the highest value compared to all treatments at both stages (70 and 90 days).

Among the different application forms of FYM, the highest N, P and K concentration in leaves were associated with spraying FYM extract with FYM sediment application, followed by FYM extract. There was insignificant effect between water and ethanol extractors. Results also showed that application of mature FYM gave higher N, P and K concentration in leaves than with FYM sediment, and the lowest values were recorded with ethanol FYM sediment.

The effect of organic manures on the vegetative growth parameters (plant height, number of leaves and leaf area) would be related to the role of nitrogen, phosphorus and potassium in building plant tissues which is reflected on vegetative growth and play vital role in photosynthesis, carbohydrate transport, protein formation, control of ionic balance, regulation of plant stomata, water use and activation of plant enzymes and other

processes. These results are in agreement with those of Abou-Hussein *et al*. (2003) who reported that potato leaves area index, shoots weight, plant height and tuber yield can be increased by organic fertilization.

Table (5): Effect of mineral fertilizer and different forms of FYM on N, P and K contents in leaves of potato plants at stages of 70 and 90 days after sowing

Treatments		Leaves N%		Leaves P%		Leaves K%	
		70 d	90 d	70 d	90 d	70 d	90 d
Mineral fertilizers (NPK)		2.27 a	2.12 a	0.42 a	0.41 a	5.48 a	5.81 a
Farmyard manure (FYM)		1.12 de	1.46 e	0.23 d	0.29 c	3.90 d	3.90 f
Water extractor	FYM extract	1.23 cde	1.58 d	0.24 cd	0.30 c	4.19 c	4.07 e
	FYM sediment	1.03 de	1.33 f	0.20 e	0.25 d	3.65 e	3.80 f
	Ext. + sed.	1.49 bc	1.67 c	0.28 b	0.34 b	4.51 b	4.74 c
Ethanol extractor	FYM extract	1.31 bcd	1.59 d	0.25 c	0.31 c	4.29 c	4.24 d
	FYM sediment	0.90 e	1.20 g	0.15 f	0.21 e	3.03 f	3.53 g
	Ext. + sed.	1.58 b	1.72 b	0.29 b	0.35 b	4.60 b	4.89 b
Control (0 fertilizer)		0.71 e	1.12 h	0.12 g	0.17 f	2.18 g	3.11 h
F test		**	**	**	**	**	**
LSD 5%		0.245	0.0458	0.016	0.020	0.193	0.129

Najm *et al*. (2010) reported that cattle manure and mineral fertilizers are two sources of nitrogen, which can affect the growth and quantity of potato. The increase of dry weight, number of tubers and tuber weight per plant due to nitrogen fertilization may be attributed to the role of nitrogen in encouraging cell elongation, cell division and consequently increasing vegetative growth and activation of photosynthesis processes which are reflected on the increases in dry weight (EL-Zehery, 2003). Meanwhile, Perata and Alpi (1991) showed that carrot (*Daucus carota*) cells growing in cell suspension culture can use ethanol and convert it to acetaldehyde, which is further assimilated by the plant. Thus, it is possible to say that ethanol is simply used by the plant as a carbon source, although other functions cannot be ruled out.

2- Yield, yield components, its quality and chemical composition of tubers:

Yield, yield components and its quality: Table 6 revealed significant increase in the values of total yield (Mg fed^{-1}), total soluble solids (TSS), dry matter content (%), specific gravity (SG), vitamin C (Mg/100g FW), starch content % and crud Protein (%),when potato was treated with mineral fertilizers or with different forms of farmyard manure as compared to the control. The highest mean value of tubers yield was obtained with mineral fertilizers compared to all other treatments.

Concerning organic farming system treatments, ethanolic extract FYM with ethanolic sediment FYM have the highest values of yield, yield components and its quality followed by the watery extract FYM with watery sediment FYM. Meanwhile, the lowest mean values of previous attributes were obtained from applying ethanolic sediment followed by watery sediment

of FYM. It is clear also from Table 6 that spraying ethanolic FYM extract gave higher values for yield, yield components and quality of potato than spraying watery FYM extract and both of them were higher than soil application of mature FYM.

Table (6): Effect of mineral fertilizer and different forms of FYM on potato tubers yield and its quality at harvest stage

Treatments		Total yield (Mg fed^{-1})	Total soluble solids (TSS %)	Dry matter content (%)	Specific gravity (SG)	Vitamin C (Mg/100g FW)	Starch content %	Crud Protein (%)
Mineral fertilizers (NPK)		17.12 a	6.41 a	20.32 a	1.23 a	22.67 a	16.48 a	8.02 a
Farmyard manure (FYM)		12.61 f	4.54 e	16.98 d	1.08 bc	14.25 f	12.14 f	5.51 d
Water extractor	FYM extract	13.50 e	4.68 d	17.21 d	1.08 bc	15.13 e	12.51 e	5.69 d
	FYM sediment	12.40 f	4.41 f	16.56 e	1.07 bc	12.80 g	11.46 g	5.36 d
	Ext. + sed.	14.65 c	5.18 c	18.01 c	1.10 bc	18.74 c	13.43 c	6.69 c
Ethanol extractor	FYM extract	14.13 d	4.78 d	17.45 d	1.09 bc	16.44 d	12.99 d	6.34 c
	FYM sediment	11.14 g	4.10 g	15.58 f	1.05 c	11.47 h	11.01 h	4.75 e
	Ext. + sed.	15.18 b	5.51 b	18.49 b	1.11 b	19.67 b	14.11 b	7.46 b
Control (0 fertilizer)		8.79 h	4.41 f	16.56 e	1.07 bc	12.80 g	11.46 g	5.36 d
F test		**	**	**	**	**	**	**
LSD 5%		0.258	0.106	0.391	0.033	0.654	0.198	0.355

These results can be discussed according to the limitation of nitrogen which can considerably effect the growth of potato plant and the tuber yield. So, for beneficial growth and maximum tuber yield, nitrogen must be added in organic or inorganic form (Goffart *et al*., 2008; White *et al*., 2007). Mineral nitrogen fertilization can increase shoots weight, leaf area, plant height and subsequently total yield (Kumar *et al*., 2007; Zelalem *et al*., 2009).

In addition, taken up the other nutrients (P and K) which are necessary for plant growth and deficient tissue mineral content limits potential growth. Therefore, manure plays a consequential role in improving these growth characteristics as a result of supplying a fraction of these nutrients and improving the solubility of some elements especially micronutrients (Rashid *et al*., 2005; Zebarth and Rosen 2007). Studies showed that ethanol may partially be taken up through plant stomata, and the radiolabelled carbon was translocated to other parts of the treated plant, especially newly emerging leaves (Haakanaa *et al*., 2001).

Organic fertilizers are claimed to produce higher nutritional quality of vegetables in forms of vitamin C, TSS, dry matter and total acidity (Youssef *et al*. 2001; Bayoumi 2005). Research has documented that compost teas suppress diseases in organic systems (Haggag and Saber, 2007; Hibar *et al*., 2006). Compost tea is also thought to increase the microbial activity in the soil. Other benefits of compost tea are the stimulation of root and vegetative growth (Hibar *et al*., 2006). Compost tea have been also found to increase crop yields and improve high quality (Haggag and Saber, 2007). Abou-Hussein *et al*. (2003) reported that potato tubers yield and its specific gravity increased with combined application of cattle manure and chicken litter. Pervez *et al*. (2004) revealed that specific gravity and yield of potatoes increased by using combined application of farmyard manure and potassium.

Chemical composition (N, P and K %) of potato tuber: Table 7 showed that applying mineral N, P and K fertilizer and organic fertilizers (mature farmyard manure, watery and ethanolic extract and sediment of FYM) produced significant differences in nitrogen, phosphorus and potassium concentrations in potato tubers. However, the control treatment gave the lowest concentrations of N, P and K in potato tubers compared with other mineral and organic treatments. The highest value was recorded with mineral N, P and K fertilizers treatment among organic treatments. With this concern, it is also observed that ethanolic extractor is better than watery extractor. The concentration of N, P and K in tubers differed among organic fertilization treatments, and was ordered as follows: sediment> spraying FYM extract > soil application of mature FYM > soil application of sediment alone.

Table (7): Effect of mineral fertilizer and different application forms of FYM on tubers nitrogen, phosphorus, potassium, nitrate and nitrite content at the harvest stage.

Treatments		N (%)	P (%)	K (%)	NO_3 (ppm)	NO_2 (ppm)
Mineral fertilizers (NPK)		2.29 a	0.46 a	3.34 a	60.14 a	0.30 a
Farmyard manure (FYM)		1.12 de	0.24 f	2.48 c	30.82 f	0.15 de
Water extractor	**FYM extract**	1.23 cde	0.26 e	2.53 c	33.23 e	0.16 d
	FYM sediment	1.03 de	0.22 f	2.41 c	26.51 g	0.15 e
	Ext. + sed.	1.49 bc	0.33 c	2.78 b	38.89 c	0.18 c
Ethanol extractor	**FYM extract**	1.31 bcd	0.31 d	2.59 c	36.04 d	0.16 d
	FYM sediment	1.01 e	0.21 g	2.10 d	24.79 h	0.14 f
	Ext. + sed.	1.58 b	0.35 b	2.84 b	44.25 b	0.19 b
Control (0 fertilizer)		0.93 f	0.20 g	2.05 e	21.79 i	0.11 i
F test		**	**	**	**	**
LSD 5%		0.259	0.016	0.138	0.907	0.009

The improvement of plant growth and yield due to organic fertilization could be attributed to the enrichment of soil with organic matter and, therefore, improving soil quality. Similar results were reported by Awad and Griesh (1992), and Bitro and Hadley (1993). Moreover, organic materials added to soils increased P availability by decomposition of the organic residues and subsequently release of inorganic and organic acids which enhanced the solubility and availability of P. Other possibilities could be: (a) effect of organic residues on lowering the fixation of phosphorus through several mechanisms such as chelation and formation of organic complexes which are relatively available for plants (b) effect of organic matter through coating the $CaCO_3$ particles as a protective mechanism against precipitation and adsorption of various elements, and (c) carbon production from humus could exchange the adsorbed anions such as phosphates and thus should be available (El-leboudi *et al*., 1988).

Regarding to nitrate content, Clark *et al*. (1999) found that nitrate content in tomato fruits was the lowest in the organic system and highest in the conventional system and the differences were highly significant.

3- Soil physical, chemical and biological characteristics after plant harvest:

Soil chemical and biological characteristics: There is no doubt that the amounts of available N, P and K contents in the experimental soil were increased due to applying organic fertilizers which enriched nitrogen, phosphorus and potassium in soil. Table 8 revealed that the values of available N, P and K content were significantly increased when farmyard manure was added to the soil and highly significantly decreased with applying FYM as sediments, combinations or as a farmyard extracts either by water or ethanol extractors, respectively. The lowest values of available N, P and K content were observed with mineral fertilizers treatment.

Table (8): Effect of mineral fertilizer and different application forms of FYM on some soil physical, chemical and biological properties after potato harvest

Treatments		Available nutrient (mg kg^{-1})			OM %	Total Cou. B. $x10^6$	SP (%)	H.C. (cm/h)
		N	P	K				
Mineral fertilizers (NPK)		41.22 e	17.99 h	278.4 f	1.39 f	35.33 f	62.66 e	2.57 f
Farmyard manure (FYM)		78.94 a	29.70 a	333.6 a	1.67 a	72.66 a	77.56 a	6.97 a
Water extractor	FYM extract	50.17 d	19.02 g	278.4 f	1.42 e	35.89 f	63.34 e	2.91 ef
	FYM sediment	68.45 b	25.53 c	333.6 a	1.54 c	53.11 c	74.53 bc	4.84 c
	Ext. + sed.	75.45 a	26.70 b	284.8 e	1.59 b	64.00 b	76.67 ab	5.96 b
Ethanol extractor	FYM extract	53.28 d	19.94 f	307.2 c	1.46 d	39.00 f	66.20 d	3.05 ef
	FYM sediment	62.22 c	20.91 e	318.4 b	1.47 d	44.22 e	72.45 c	3.28 e
	Ext. + sed.	65.34 bc	23.52 d	291.2 d	1.51 c	49.00 d	73.65 c	4.00 d
Control (0 fertilizer)		24.51 f	10.87 i	242.9 g	1.12 g	33.12 f	61.66 e	2.25 f
F test		**	**	**	**	**	**	**
LSD 5%		3.536	0.859	5.61	0.028	3.218	2.297	0.436

Concerning organic matter percentage and total count of bacteria in potato experimental soil at harvest stage as affected by conventional and organic farming systems. Data reported in Table 8 illustrated that there are a significant differences among the treatments in OM and total count of bacteria as influenced by organic fertilizers applications compared with the control (untreated treatment). The results showed that FYM have the highest values followed by watery FYM sediment with its extract and watery FYM sediment then ethanolic FYM sediment with its extract and ethanolic FYM sediment only. It is clear that extract treatments have the lowest values among the studied organic treatments. On the other hand, the mineral fertilizer treatment achieved the lowest values of OM and total count of bacteria.

Organic amendments geared towards maintenance of soil organic matter content and fertility (Van Bruggen and Termorshuizen 2003, Bailey and Lazarovits 2003, Möller and Reents 2007). Ocia *et al*. (1991) reported that microbial biomass and microbial activity is closely related to organic matter content is positively influenced by organic matter such as post-harvest residues and organic manures. Microbial biomass is positively correlated with the amount of organic matter supplied in a longer period, but it is also responded to a single application of organic manure.

Soil physical properties: Data illustrated in Table 8 clearly showed that soil physical properties (SP and HC) were significantly affected with applying various organic treatments compared with mineral or the control treatments. Application of mature FYM fertilizers caused high significant differences in the studied soil physical properties, followed by adding FYM sediments to soil either with its extract or alone and the watery extractor was more efficient than ethanolic extractor. The physical properties were not improved by adding FYM extracts alone, while no change was observed with mineral fertilizer compared to the untreated soil (control). This increasing can be attributed to the relatively soil organic matter content. On the other hand, increasing organic carbon (OC) concentration causes relatively more increase in soil moisture content (Armand and Black 1992). In addition, soil application of organic manure provide the humic substances which are considered permanent aggregate-binding agents involved in the stabilization of soil micro-aggregate <250um (Dayegamiye and Angers, 1993).

Rotenberg *et al*. (2005) reported that additions of organic amendments (composts) to agricultural soils lead to improved soil quality and reduced severity of crop diseases. Organic fertilizers, such as cattle manure, contain large amount of nutrients and influences plant growth and production via improving soil physical, chemical and biological fertility (Ahmad and Quadri, 2009; Benke *et al*., 2009 and Fuleky and Benedek, 2010).

Conclusion:

It can be concluded that: FYM application methods (as organic system) enhanced all studied potato vegetative growth parameters, quality and quantity of the yield and also improve soil health, compared to the untreated treatment. For all potato plant growth parameters, FYM application methods can be arranged in the order: spraying of ethanolic FYM extract with its sediment> spraying of watery FYM extract with its sediment> spraying ethanolic FYM extract> spraying watery FYM extract> mature FYM> watery sediment> ethanolic sediment. While, for improving soil health parameters the soil application of mature FYM gave the highest values followed by spraying of watery FYM extract with its sediment> ethanolic FYM extract with its sediment> watery sediment> ethanolic sediment. Furthermore, it was observed that ethanol as extractor was more effective than water and consequently spraying ethanolic FYM extract with its sediment or alone achieved higher values for all potato growth parameters compared to spraying of watery FYM extract either with or without its sediment.

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تأثير نظم الزراعة التقليدية والعضوية على خصوبة التربة وإنتاج البطاطس

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أجريت تجربة حقلية خلال الموسم الشتوي 2008/2007 في محطة التجارب بكلية الزراعة، جامعة المنصورة، مصر، لتقييم قدرة الماء وكحول الايثانول على استخلاص العناصر الغذائية من السماد البلدى الناضج. بالإضافة إلى تقييم تأثير الرواسب المتبقية بعد الاستخلاص، وكلاهما رشا على الأوراق (كتقنية للزراعة العضوية) الأسمدة المعدنية (كنظام للزراعة التقليدية) على نوعية وكمية البطاطس المنتجة وجودة التربة (من حيث خواص التربة الفيزيائية والكيميائية والبيولوجية) بعد الحصاد.

نظمت تسعة معاملات في تصميم كامل العشوائية مع أربع مكررات (سماد معدني مكون من النيتروجين والفوسفور والبوتاسيوم، سماد بلدي ناضج ، استخلاص مائي للسماد البلدي الناضج، رواسب السماد البلدي بعد استخلاصه بالماء، الإستخلاص المائي للسماد البلدي مع رواسبه، مستخلص الإيثانول للسماد البلدي الناضج، رواسب السماد البلدي بعد استخلاصه بالإيثانول، مستخلص الإيثانول للسماد البلدي مع رواسبه، ومعاملة بدون إضافة). معاملات الإستخلاص سواء بالماء أو الإيثانول أضيفت رشا على النبات بينما المعاملات الأخرى أبضيفت أرضية.

تشير النتائج إلى أن الإضافة الأرضية للأسمدة المعدنية (كنظام تقليدي) قد أعطت أعلى القيم بالنسبة لجميع صفات النمو الخضري والمحصول ومكونات المحصول، من البطاطس مقارنة مع معاملات التسميد العضوي الأخرى. وعلى العكس من ذلك ، الإضافة الأرضية للسماد البلدي يعطي أعلى قيم لتحسين خواص التربة بعد الحصاد (بما في ذلك الخواص الطبيعية والكيماوية والبيولوجية)، كما أن التسميد العضوي يحد من تراكم النترات والنيتريت في درنة البطاطس.

وجد أن الطرق المختلفة لإضافة السماد البلدي الناضج (كنظام عضوي) قد عززت جميع صفات النمو الخضري للبطاطس ، ونوعية وكمية المحصول وأيضا تساهم في تحسين صفات التربة، مقارنة مع الكنترول. لجميع صفات النمو لنبات البطاطس كان ترتيب تأثير معاملات السماد العضوي كما يلي: الرش بمستخلص الإيثانول للسماد البلدي مع رسوبياتها> الرش بالمستخلص المائي للسماد البلدي مع رسوبياتها> الرش بمستخلص الإيثانول للسماد البلدي > الرش بالمستخلص المائي للسماد البلدي > الإضافة الأرضية للسماد البلدي الناضج > الرواسب الناتجة بعد الإستخلاص المائي> الرواسب الناتجة بعد الإستخلاص بالايثانول. في حين، تغير ترتيب المعاملات في حالة تحسين صفات التربة لتصبح كالتالي: الإضافة الأرضية للسماد البلدي الناضج الذي أعطى أعلى قيم يليه الرش بالمستخلص المائي للسماد البلدي مع رسوبياتها > مستخلص السماد البلدي بالايثانول مع رسوبياتها> الرواسب بعد الإستخلاص المائي> الرواسب بعد الإستخلاص بالايثانول. وعلاوة على ذلك، لوحظ أن إستخلاص السماد البلدي بالإيثانول كان أكثر فعالية من الإستخلاص المائي للسماد البلدي فالرش بمستخلص الإيثانول مع إضافة رسوبياته أرضية ، أو إضافة مستخلص الإيثانول وحده حققت أعلى القيم لجميع صفات نمو البطاطس مقارنة مع مثيلتها المستخلصة بالمياه.

قام بتحكيم البحث

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