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ORGANIC AND BIO-FERTILIZERS IMPACT ON YIELD, NUTRIENT CONTENT AND AVAILABLE NUTRIENTS OF FABA BEAN-MAIZE CROPPING SYSTEM

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ABSTRACT

Two field experiments were conducted to determine the effect of organic fertilizers application in combination with bio-fertilizers on the yield, nutrient availability and uptake of faba bean-maize cropping system under sprinkler irrigation. A split plot design was employed with three replicates per treatment which include Control, chemical fertilizer and organic fertilizer (farmyard manure [FYM]; town refuse and biogas manure) combined with bio-fertilizers (effective microorganism (EM) and N fixer Compomax (CoM)).The direct effects of applied manure as soil along with EM resulted in significant differences with regard to yield parameters (100 seed weight, Seed yield and foliage yield) of bean plants. Application of FYM combined with EM recorded the highest yield parameters followed town refuse application and the lowest value was recorded in the treatment receiving Biogas manure. The yield and yield attributing characters *viz.* 100 grain weight, grain yield and stover yield of maize also exhibited response to manure application. Maize crop is more stable under combined organic and bio fertilization compared with mineral fertilization enhancing organic matter in soils and increases yield of maize. Significant differences among the treatments were noticed with respect to available NPK and uptake by bean due to manure application. Application of FYM combined with EM recorded the highest available and uptake of NPK and significantly superior over rest of the treatments and the lowest value were obtained in control. Similar trend of available and uptake of NPK was also observed with the residual crop (maize).
Keyword: Faba bean, Maize, organic manure, biofertilizer,soil nutrients availability

INTRODUCTION

Shifting cultivation, as practiced by the traditional farmers to restore soil fertility in sustaining cropping can no longer meet up with the increased need for food supply due to high population pressure. The primary function of soil productivity and fertility restoration through fallow is less effective since intensive cropping is now more common. The use of inorganic fertilizers alone has not been helpful under intensive agriculture because it aggravates soil degradation (Sharma and Mittra, 1991).

Maintaining and improving soil quality is crucial if agricultural productivity and environment quality are to be sustained for future generations (Reeves, 1997). Intensive agriculture has had negative effects on the soil environment over the past decades (*e.g.* loss of soil organic matter, soil erosion, water pollution) (Zhao *et al.*, 2009).

Management methods that decrease requirements for agricultural chemicals are needed in order to avoid adverse environment impacts (Bilalis *et al.*, 2009). The use of manure and mulching are two of the basic cultivation techniques of organic agriculture (Efthimiadou *et al.*, 2009). Moreover, emerging evidence indicates that integrated soil fertility management involving the judicious use of combinations of organic and inorganic resources is a feasible approach to overcome soil fertility constraints (Abedi *et al.*, 2010). Combined organic/inorganic fertilization both enhanced C storage in soils, and reduced emissions from N fertilizer use, while contributing to high crop productivity in agriculture (Pan *et al.*, 2009).

Prabu and Uthaya (2006) concluded that organic manures play a vital role in maintaining physical, chemical and biological conditions of soil and supply macro and micronutrients to crops besides maintaining humic substances in soil and also the wastes are effectively utilized for crop production. Addition of organic sources could increase corn yields through increased soil productivity and higher fertilizer use efficiency.

Farmyard manure is a potentially important source of nitrogen (N), phosphorus (P) and potassium (K). As such, significant increase in total N, available P and K contents with FYM addition in our results is directly related to the large content of these nutrients in this compost. This is in agreement with the findings of Plaza et al. (2004) and Sadej and Przekwas (2008). Bio-fertilizer help in increasing crop productivity by way of increased Biological Nitrogen Fixation (BNF), increased availability or uptake of nutrients through solubilization or increased absorption stimulation of plant growth through hormonal action or antibiosis, or by decomposition of organic residues. These potential biological fertilizers would play key role in productivity and sustainability of soil and also protect the environment as eco-friendly and cost effective inputs for the farmers. With using the biological and organic fertilizers, a low input system can be carried out and it can be help achieving sustainability of farms (Khosro and yousef, 2012).

Chamberlain *et al.* (1999) concluded that EM bio-fertilizer has a significant effect on the corn yield and some components of the yield, such as the weight of the ear, diameter of the ear, and weight of the rachis. These results show that the corn plants treated with EM tended to grow more efficiently. Available nutrients were utilized to increase leaf surface area which led to improved photosynthetic capabilities which in turn resulted in a statistically significant increase in yield over the control.

A growing number of studies show that organic farming leads to higher soil quality and more biological activity (microbial populations and microbial respiration rate) in soil than conventional farming (Girvan et al., 2004). Application of organic materials such as chicken manure, sheep manure and filter mud cake are emphasized by their beneficial effects on soil characteristics, macro and micro nutrients availability and plant growth. Application of combined organic manures and effective microorganisms was positively affected of growth and yield of wheat plant (Youssef, 2011).

The main objective of this study is to evaluate the effect of organic fertilizer (i;e FYM, biogas and town refuse) combined with bio-fertilizer (effective microorganism [EM] and the N_2 fixer Compomax [CoM]) on yield components and nutrients availability and uptake (total content) by faba bean and Maize under faba bean –maize cropping rotation.

MATERIALS AND METHODS

A field experiment was carried out at experimental Farm of the Agricultural Research Station, EL-Ismailia Governorate, (30°37' 01.01'N 32° 14' 26.57' E elevation 16 m) Agric. Res. Centre (ARC), Egypt during two winter seasons 2009/2010 and 2010/2011 and two summer seasons 2010 and 2011, which were conducted in an alternative cropping system under sprinkler irrigation system to study the effect of organic fertilizers in combination with bio-fertilizers on the production of faba bean (*Vica faba* L.) variety balady as the main crop and maize (*Zea maize* L.) variety fardy 10 as the following crop. Some physical and chemical properties of the investigated soil and water irrigation were carried out according to stander methods of (Rebecca, 2004), Table (1).

Also, the composition of manure used in the experiment is presented in Table (2).

Table 1: Chemical characteristics of the studied soil (0-30 cm) and water irrigation

Sample	EC dS/m	pH	Soluble ions (meq/l)								SAR
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$	
Soil	0.36	7.64	1.61	1.28	1.02	0.18	--	1.53	1.92	0.64	0.85
Water	0.45	7.91	1.24	1.76	1.29	0.14	--	0.52	1.92	1.99	1.06

Some physical characteristics of the studied soil (0-30 cm).

Particle size distribution %					Organic matter %	$CaCO_3$ %
Coarse sand	Fine sand	Silt	Clay	Texture class		
31.82	61.61	1.22	5.35	Sandy	0.44	1.42

Table 2: Chemical composition of organic manures used in field experiments

Analysis	Biogas manure	Farmyard manure	Town refuse
Moisture (%)	24.20	26.10	20.00
Density (g/cm^3)	0.32	0.21	0.68
pH (1:10)	7.18	7.24	7.88
EC (1:10) dSm^{-1}	1.98	2.12	1.87
$N-NH_4$ (ppm)	43.00	52.00	78.00
$N-NO_3$ (ppm)	29.00	38.00	12.00
Total Nitrogen %	1.28	2.23	1.47
Total phosphorus %	0.41	0.54	0.46
Total potassium %	1.61	1.22	0.83
Total Carbon %	41.14	36.13	33.57
C/N Ratio	32.14	16.20	22.84
Available p %	0.25	0.36	0.24
Available K %	1.25	1.28	2.18
DTPA-Fe (ppm)	1580	1760	1346
DTPA-Mn (ppm)	0.82	0.75	239
DTPA-Zn (ppm)	6.84	5.75	250

The experimental treatments were in split plot design with three replicates. The treatments include control (no fertilizer added), mineral fertilizer (recommended dose of N, P &K) and organic fertilizer (farmyard manure [FYM]); town refuse and biogas manure) each applied alone and\or combined with bio-fertilizers (effective microorganism [EM] and the N_2 fixer Compomax [CoM]). The soil was carefully prepared and divided into plots of nine square meters (3 x 3 m). The mineral nitrogen fertilizer applied in the form of ammonium nitrate (33.5 % N) at the rate of 80 kg fed^{-1} in two equal split doses, the first was before planting and the second was at the tillering stage 40 days after sowing of wheat crop.

The organic manures applied during the soil preparation before planting of wheat at different rates as full recommended dose (100 %) based on their nitrogen content as source of nitrogen. Both phosphorus and potassium applied at relative rates of 40 Kg P_2O_5/fed and 60 Kg K_2O/fed in the form of single super phosphate (15% P_2O_5) and potassium sulphate (48 % K_2O), respectively. Phosphorus applied basically during soil preparation, while potassium applied after 30 days from planting of wheat.

Effective microorganism (EM) and Compomax N_2-fixer (CoM) sprayed twice at a rate of 4 Liter fed^{-1}, once every month starting from planting. The main microbial species included in EM prepared according Kato *et al.* (1999). The chemical and microbial analyses of N_2-fixers (Compomax) and EM are given in (Table 3).

Table 3: Composition of biofertilizer used in field experiments

Effective micro-organisms (EM) composition		**Compomax N-fixers (CoM) composition**	
Bacteria:	**Yeasts:**	***Azotobacter choroccum***	**Total N : 3.5%**
Lactobacillus plantarum	*Saccharomyces cerevisiae*	*Azospirillum lipoferm*	P_2O_5 : 2.5%
Lactobacillus casei	*Actiomycetes:*	*Bacillus polymexa*	K_2O: 0.4
Streptococcus lactis	*Streptomyces albus*		Zn: 14 ppm
Rhodopseudomonas palustris	*Streptomyces griseus*		Fe: 18 ppm
Radobacter sphaeraides	**Fungi:** *Aspergillus oryze*		Mn: 10 ppm

Observation on yield components of faba bean and maize were recorded in five randomly selected plants from each net plot. Seeds and foliage of faba bean and grain and Stover yields of maize were recorded after complete sun drying from each net plot. Then, samples of faba bean and maize were oven dried ground and digested for the determination of NPK contents as described by Motsara and Roy (2008). Available nutrients in the soils of both faba bean and maize at harvest were extracted as described by Rebecca (2004), i.e. nitrogen by 2N potassium chloride, Phosphorus by 0.5M sodium bicarbonate and potassium by 1N ammonium acetate. All obtained data were subjected to statistical analysis according to Snedecor and Cochran (1989), where mean values were compared using L.S.D at 5% level.

RESULTS AND DISCUSSION

1. Yield of first crop (faba bean)

The determined yield components of faba bean crop such as 100 seed weight, seed and foliage yields influenced significantly by manure application practices (Table 4).

Yield components of faba bean were affect of significantly by farmyard manure (FYM) compared to mineral fertilizer, town refuse and biogas manure. The treatment of FYM + EM application increased significantly the 100-seed weight (88.7 g), seed yield (1620 kg fed^{-1}) and foliage yield (4229 kg fed^{-1}), over the treatment receiving FYM alone and the rest of the applied treatments.

Such favorable effects on yield and yield components could be attributed to the stimulation effect of NPK on number and weight of nodules and nitrogen metabolism, which in turn reflected positively on faba bean yield attributes. These increases in yield and its components as a result of application of the farmyard manure over Biogas and town refuse application may be attributed to high content of micronutrients, which might enhance the activity of photosynthesis and protein synthesis in the leaves. This in turn encourages photosynthetic process. The elemental composition of the organic manure applied especially their content of N, P, K, Fe, Mn, Zn and Cu may account for such finding. Beneficial microorganisms in bio-fertilizers accelerate and improve plant growth and protect plants from pests and diseases (El-yazeid *et al.*, 2007).

2. Yield of Residual crop (maize)

With respect to the residual effect of applied manures on maize yield and its components (Table 4), application of organic manure had distinctly influenced yield components of maize. The highest values of 100-grain weight (38.0 g), grain (6708 kg fed^{-1}) and stover yield (5180 kg fed^{-1}) were recorded in FYM treatment compared to town refuse followed by biogas manure, respectively. The lowest 100-grain weight, grain and stover yield were recorded for the treatment receiving biogas manure, chemical fertilizer and control. This might be due to higher yield components that are directly responsible for grain yield that appeared to have been determined by physiological characters, both during vegetative and reproductive phase of the crop growth. Mando *et al.* (2005) also found that soil organic matter and crop performance were better maintained by using organic materials with a low C/N ratio (manure) than those with a high C/N ratio (straw). In addition, Zhao *et al.* (2009) reported that farmyard manure combined with chemical fertilizer management resulted in higher increases in maize yield, soil organic matter, available N and available P compared with those found under straw manure combined with chemical fertilizer management.

The treatment of FYM + EM increased significantly 100-grain weight (38 g), grain yield (6708 kg fed^{-1}) and (5180 kg fed^{-1}) and they were significantly superior over the other treatments. The nutrient assimilation of FYM in plants and grains, applied singly or in combination with EM may produce more available nutrients in soil resulted in an increase of maize grain yield. Foliar bio-fertilization by EM and CoM is readily absorbed by the leaves and not lost through fixation, decomposition or leaching. Parasuraman *et al.* (2000) recorded highest grain and straw yields of finger millet (1598 kg ha^{-1} and 2200 kg ha^{-1}, respectively) due to the use of recommended inorganic fertilizer + enriched farmyard manure followed by 75% recommended dose of inorganic fertilizer + biofertilizer (1473 kg ha^{-1} and 2200 kg ha^{-1}) and recommended dose of inorganic fertilizer + biofertilizer (1471 kg and 2100 kg ha^{-1}).

Table 4: Effect of organic manure and biofertilzer on yield parameters (Data are a mean of two seasons)

Treatments	100 seed weight (g) of bean				Seed yield (kg/fed) of bean				Foliage yield (kg/fed) of bean			
	*Without	EM	CoM	Mean	Without	EM	CoM	Mean	Without	EM	CoM	Mean
Control	22.3	30.1	28.1	26.8	260.4	321.0	303.7	295.0	327	711	583	540
Mineral Fertilizer	54.1	67.4	56.4	59.3	510.1	763.3	603.4	625.6	611	1432	1108	1050
Town refuse	81.4	87.7	85.8	84.9	775	1391	1068	1078	885	2821	1681	1796
Biogas manure	78.6	86.9	84.8	83.4	577	1313	1003	965	700	2298	1525	1508
Farmyard manure	83.1	88.7	86.0	86.0	923	1620	1212	1252	1309	4229	1848	2462
Mean	63.9	72.2	68.2		609.1	1082	838		766	2298	1349	
LSD (5 %)	Treatments	0.89			77.94				394.4			
	Biofertilzer	0.50			54.33				309.1			
	Interaction	0.82			NS				507.11			
Treatments	100 Grain weight (g) of maize				Grain yield (kg/fed) of maize				Stover (kg/fed) of maize			
	Without	EM	CoM	Mean	Without	EM	CoM	Mean	Without	EM	CoM	Mean
Control	7.2	9.1	8.1	8.1	1411	2370	2109	1963	1360	1544	1397	1434
Mineral Fertilizer	16.3	23.4	18.7	19.5	3612	4306	3877	3932	2145	3380	2606	2710
Town refuse	30.3	37.0	34.6	34.0	4492	6242	5040	5258	3185	4475	3850	3837
Biogas manure	27.6	36.2	33.4	32.4	3850	5717	4900	4822	2742	4258	3617	3539
Farmyard manure	32.4	38.0	35.3	35.2	4725	6708	5308	5581	3442	5180	3920	4181
Mean	22.8	28.7	26.02		3618	5069	4247		2575	3767	3078	
LSD (5 %)	Treatments	0.51			231.0				109.2			
	Biofertilzer	0.29			205.1				87.7			
	Interaction	0.47			NS				143.8			

***Without: no biofertilizer, EM: Effective microorganism, CoM: N fixer Compo max**

Higher effect of farmyard manure than the other two organic manure (town refuse and Biogas) may be due the narrowest C/N ratio and its higher content of N, P and Fe and Zn (Table 2), Nasef (2004) came to the same results and stated that the positive effect of pigeon manure extract on wheat yield and its components surpassed the organic manure extracts of biogas and chicken manure.

3. NPK uptake by faba bean

The use of organic manure increased significantly N, P &K uptake by faba bean (Tables 5 and 6). The plots received FYM treatment gave significantly higher N, P and K uptake by faba bean seeds (38.2, 4.5 and 8.1kg fed^{-1}) and (7.7, 2.7 and 6.2 kg fed^{-1}) by foliage over those of town refuse and biogas manure, respectively. This trend of higher uptake of N,P & K in the treatments received FYM could be due to the increased N,P &K availability in soil and the direct uptake of N,P &K by leaves resulting in higher production of chlorophyll, dry matter and higher uptake of macronutrients by faba bean crop.

Among organic manure, the use of FYM in combination with EM recorded the highest values of N, P &K uptake by faba bean seeds (86.9, 12.4 and 15.1 kg fed^{-1}) and (35.5, 11.2 and 40.3 kg fed^{-1}) by foliage as compared to those recorded by town refuse and biogas manure, respectively.

The increases in nutrients absorption resulted due to more available nutrients in the soil solution, which is probably promoted the well developed root system in upper zone. Foliar application of EM and CoM in combination with organic manure has become an established procedure to improve nutrients utilization through improving root growth and increasing nutrients uptake and minimize the environmental pollution through reducing the amount of mineral fertilizers added to soil.

4. NPK uptake by maize

Regarding the chemical constituents of maize plants as influenced by the residual effect of organic manure applied to faba bean, data in Tables (5 and 6) show that FYM manure had the most superior effect on N and P contents of both maize Stover and seeds, as well as Potassium uptake followed by town refuse, which occupied the second order, whereas the application of biogas manure and mineral fertilizer gave the least effect due to the uptake of N, P& K by either maize Stover or seeds.

Generally, the increases in N, P& K uptake by maize plants as foliar feeding with EM and CoM may be due to that sprayed solution of nutrients is readily absorbed by the leaves and not lost through fixation, decomposition or leaching. Laxminarayana (2004) stated that integrated application of organic and inorganic manure showed higher uptake of N, P and K compared to that of sole organic manures application due to the increased nutrients availability. The current results may be due to the beneficial effect of organic manure combined with EM on metabolic processes and growth, which in turn reflected positively on chemical content of maize seeds. The use of organic fertilizers not only supplies sufficient nutrients to the plants but also improve soil physical and chemical properties. So, the continuous addition to organic wastes with or without mineral fertilizer will help to maintain the soil organic matter at a reasonable level.

5. Available N, P & K in soil of faba bean

With respect to soil available N, P & K in Table (7), the treatment of FYM recorded the highest values of 20.93 (N), 13.35 (P) and 83.20 (K) kg fed^{-1} as compared to the corresponding town refuse values of 18.90, 11.74 and 75.01 kg fed^{-1}. The lowest available N,P &K recorded in response of biogas manure, mineral fertilizer and control. This could be due to more vegetative growth and root growth, which release hydrogen ions, phenolic compounds and organic acids as well as acidification effect of manure applied that helped in increasing nutrients availability and uptake of N, P & K by faba bean plants. Tiwari *et al.* (2002) have also reported that the inclusion of manure in the fertilization schedule improved the organic carbon status and available N, P, K and S in soil, sustaining soil health. Addition of organic materials of various origins to soil has been one of the most common practices to improve soil physical properties (Celik *et al.*, 2004).

Table 5: Effect of organic manure and biofertilzer on nutrient uptake by faba bean seeds and maize grains (Data are a mean of two seasons)

Treatments	N of faba bean seeds (kg/fed)				P of faba bean seeds (kg/fed)				K of faba bean seeds (kg/fed)			
	Without	EM	CoM	Mean	Without	EM	CoM	Mean	Without	EM	CoM	Mean
Control	17.32	30.11	20.43	22.62	1.11	4.70	2.76	2.86	1.81	3.95	1.93	2.56
Mineral Fertilizer	25.11	60.45	37.30	40.95	2.31	6.82	4.21	4.45	5.33	8.74	7.03	7.03
Town refuse	31.76	68.42	47.53	49.24	3.79	9.54	6.04	6.46	6.63	12.88	9.52	9.68
Biogas manure	22.22	63.42	44.05	43.23	2.58	9.01	5.20	5.60	4.84	12.16	8.85	8.62
Farmyard manure	38.21	86.85	55.37	60.14	4.52	12.41	7.87	8.27	8.14	15.13	10.80	11.36
Mean	26.92	61.85	40.94		2.86	8.50	5.22		5.35	10.57	7.63	
LSD (5 %)	Treatments		4.20		0.63				0.73			
	Biofertilzer		2.78		0.39				0.50			
	Interaction		4.56		0.65				NS			
Treatments	N of maize grains (kg/fed)				P of maize grains (kg/fed)				K of maize grains (kg/fed)			
	Without	EM	CoM	Mean	Without	EM	CoM	Mean	Without	EM	CoM	Mean
Control	10.31	16.54	11.73	12.86	2.34	2.81	2.55	2.57	1.32	2.26	1.78	1.79
Mineral Fertilizer	18.22	28.76	24.54	23.84	6.43	11.05	8.17	8.55	2.21	5.74	3.16	3.70
Town refuse	28.30	51.87	37.30	39.15	10.78	25.59	14.62	17.00	3.73	9.42	5.14	6.10
Biogas manure	22.72	44.02	35.77	34.17	8.86	20.01	13.72	14.19	2.35	7.26	4.31	4.64
Farmyard manure	32.27	62.39	39.49	44.72	13.23	51.65	16.46	27.11	3.92	11.14	6.21	7.09
Mean	22.36	40.71	29.77		8.33	22.22	11.10		2.71	7.16	4.12	
LSD (5 %)	Treatments		1.65		1.18				0.26			
	Biofertilizer		1.52		1.09				0.24			
	Interaction		2.50		1.78				0.39			

*Without: no biofertilizer, EM: Effective microorganism, CoM: N fixer Compo max

Table 6: Effect of manure and biofertilzer on nutrient uptake by faba bean foliage and maize Stover (Data are a mean of two seasons)

Treatments	N of faba bean foliage (kg/fed)				P of faba bean foliage (kg/fed)				K of faba bean foliage (kg/fed)			
	*Without	EM	CoM	Mean	Without	EM	CoM	Mean	Without	EM	CoM	Mean
Control	2.03	7.12	5.07	4.74	0.72	2.77	2.56	2.02	0.87	4.25	2.38	2.50
Mineral Fertilizer	3.05	10.32	7.63	7.00	1.10	4.09	3.87	3.02	1.22	6.69	5.08	4.33
Town refuse	4.65	22.85	10.76	12.75	1.68	6.43	3.67	3.93	3.58	22.20	9.89	11.89
Biogas manure	3.78	16.59	9.61	9.99	1.13	5.01	3.18	3.11	1.88	16.71	7.92	8.84
Farmyard manure	7.72	35.52	12.94	18.73	2.73	11.24	4.03	6.00	6.23	40.26	11.35	19.28
Mean	4.25	18.48	9.20		1.47	5.91	3.46		2.76	18.02	7.32	
LSD (5 %)	Treatments		3.32		1.06				3.78			
	Biofertilizer		2.63		0.83				3.02			
	Interaction		4.32		4.32				4.96			
Treatments	N of maize Stover (kg/fed)				P of maize Stover (kg/fed)				K of maize Stover (kg/fed)			
	Without	EM	CoM	Mean	Without	EM	CoM	Mean	Without	EM	CoM	Mean
Control	1.64	5.42	3.02	3.36	0.66	1.81	1.72	1.40	0.44	2.34	1.76	1.51
Mineral Fertilizer	4.13	11.04	8.97	8.05	1.26	3.67	3.11	2.68	1.05	6.04	4.11	3.73
Town refuse	9.56	20.59	15.52	15.22	1.91	5.37	3.08	3.45	3.25	10.92	6.58	6.92
Biogas manure	6.85	19.59	13.38	13.27	1.37	4.26	2.89	2.84	1.95	8.30	6.18	5.48
Farmyard manure	11.01	24.50	17.25	17.59	2.41	10.36	3.53	5.43	5.20	16.42	7.64	9.75
Mean	6.64	16.23	11.63		1.52	5.09	2.87		2.38	8.80	5.26	
LSD (5 %)	Treatments		0.52		0.22				0.37			
	Biofertilzer		0.40		0.18				0.27			
	Interaction		0.66		0.29				0.45			

*Without: no biofertilizer, EM: Effective microorganism, CoM: N fixer Compo max

Table 7: Effect of manure and biofertilzer on available nutrients in soil (Data are a mean of two seasons)

Treatments	Available N (kg/fed), faba bean soil				Available P (kg/fed), faba bean soil				Available K (kg/fed), faba bean soil			
	*Without	EM	CoM	Mean	Without	EM	CoM	Mean	Without	EM	CoM	Mean
Control	4.01	5.88	4.77	4.89	2.33	3.41	3.05	2.93	14.87	31.26	25.51	23.88
Mineral Fertilizer	9.31	17.32	16.11	14.25	5.44	8.37	5.24	6.35	40.22	67.12	60.20	55.85
Town refuse	18.90	40.83	21.70	27.14	11.74	20.16	16.14	16.01	75.01	113.49	93.60	94.03
Biogas manure	14.47	24.97	21.23	20.22	8.81	19.24	14.74	14.26	69.94	105.04	90.35	88.44
Farmyard manure	20.93	45.33	22.63	29.63	13.35	21.65	16.57	17.19	83.20	120.28	98.80	100.76
Mean	13.52	26.87	17.29		8.33	14.57	11.15		56.65	87.44	73.69	
LSD (5 %)	Treatments		1.35		1.40				2.83			
	Biofertilzer		3.2.9		1.25				1.66			
	Interaction		5.39		NS				2.73			
	Available N (kg/fed), maize soil				Available P (kg/fed), maize soil				Available K (kg/fed), maize soil			
Treatments	Without	EM	CoM	Mean	Without	EM	CoM	Mean	Without	EM	CoM	Mean
Control	2.04	4.12	2.88	3.01	1.67	3.09	1.98	2.25	8.12	9.34	8.34	8.60
Mineral Fertilizer	6.43	10.25	9.86	8.85	3.73	6.82	5.33	5.29	12.12	16.55	14.06	14.24
Town refuse	14.67	22.00	17.67	18.11	6.49	12.15	9.18	9.27	26.99	39.00	32.49	32.83
Biogas manure	13.33	20.00	17.33	16.89	5.44	11.01	8.28	8.24	24.35	34.48	31.49	30.11
Farmyard manure	16.70	24.50	18.30	19.83	7.18	13.64	10.32	10.38	28.62	87.75	33.16	49.84
Mean	10.63	16.17	13.21		4.90	9.34	7.02		20.04	37.42	23.91	
LSD (5 %)	Treatments		0.15		0.12				0.59			
	Biofertilzer		0.45		0.37				0.64			
	Interaction		0.74		NS				1.05			

*Without: no biofertilizer, EM: Effective microorganism, CoM: N fixer Compo max

6. Available NPK in soil of maize

The residual effect of applied manure increased significantly the available N,P & K in soil of maize (Table 7). However, the organic fertilizers, FYM treatment recorded the highest values of 16.70, 7.18 and 28.62 kg fed^{-1} for soil available N,P &K, respectively, followed by those recorded by town refuse (14.76 (N), 6.46 (P) & 26.99 (K) kg fed^{-1}). While, the lowest soil available N, P &K values recorded with biogas manure (13.33, 5.44 and 24.35 kg fed^{-1}) for available N, P & K, respectively.This trend could be explained by the role of FYM as natural chelating agent resulted in increasing N, P &K availability in soil. Biofertilizers are important components for the integrated nutrients management.

These potential biological fertilizers would play a key role in productivity and sustainability of soil and also act as environmentally eco-friendly and cost effective inputs for the marginal farmers. Biofertilizers are products containing living cells of different types of microorganisms, which when, applied to seeds, plant surface or soil, colonize the rhizosphere or the interior of the plant and promote growth by converting nutritionally important elements (nitrogen, phosphorus) from unavailable to available form through biological process such as nitrogen fixation and solubilization of rock phosphate (Rokhzadi *et al.*, 2008).

Conclusion

The current study can lead to that, organic fertilizers particularly farmyard manure (FYM) in combination with EM have better impact on the yield components and nutrient availability of faba bean and maize sequenced cropping system and in turn improving the physico-chemical properties of the soil than the other organic amendment. Foliar feeding with EM and CoM in combination with organic manure has become an argumental procedure to improve nutrient utilization through improving root growth and increasing nutrient uptake and minimize environmental pollution through reducing the amount of mineral fertilizers added to soil. There is need for a wider study area on the beneficial aspects of these significant microbes in organic farming systems. This will enable augmentation and promotion of organic agriculture in the region.

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تأثير الأسمدة العضوية والحيوية على المحصول ومحتوى العناصر المغذية والميسرة للفول البلدي- الذرة في نظام الزراعة المتتالية

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أقيمت تجربتين حقليتين لدراسة تأثير إضافة الأسمدة العضوية بالتداخل مع الأسمدة الحيوية على المحصول، وتيسر ومحتوى العناصر المغذية للفول البلدي-الذرة في نظام الزراعة المتسلسل تحت نظام الري بالرش.

تم تصميم التجارب إحصائياً بنظام التجربة المنشقة في ثلاث مكررات لكل معاملة، وكانت المعاملات كالآتي:-

معاملة المقارنة، معاملة الأسمدة الكيماوية، معاملة الأسمدة العضوية، (الأسمدة البلدية- مخلفات المدن وسماد البيوجاز) بالتداخل مع الأسمدة الحيوية (مجموعة بكتريا إي إم وهي خليط من عدة أنواع من الكائنات الحية الدقيقة) ومخلوط بكتريا مثبتة للنيتروجين).

- أدت إضافة الأسمدة العضوية مخلوطة ببكتريا إي إم إلى تأثير مباشر ومعنوي على المحصول ومكوناته ، محصول البذور، وزن الـ ١٠٠ بذرة، المحصول الخضري لنباتات الفول.

- استخدام الأسمدة العضوية بالتداخل مع بكتريا إي إم سجلت أعلى قيمة لصفات المحصول، ويليها مخلفات المدن، وسجلت معاملة سماد البيوجاز أقل قيمة لصفات المحصول.

- أظهرت نتائج نظام الزراعة المتسلسل إستجابة محصول الذرة ، وكذلك صفات المحصول، وزن الـ ١٠٠ حبة، لاستخدام الأسمدة العضوية، وحققت معاملة استخدام الأسمدة العضوية بالتداخل مع الأسمدة الحيوية والمعدنية أفضل محصول الذرة.

- استخدام الأسمدة العضوية والحيوية أدى الى تحسن مستوى المادة العضوية بالتربة، والتي بدورها أدت الى زيادة المحصول.

- أظهراستخدام الأسمدة العضوية البلدية إلى وجود اختلافات معنوية بين المعاملات خاصة فيما يتعلق بتيسر وامتصاص عناصر النيتروجين والفوسفور والبوتاسيوم.

- استخدام الأسمدة العضوية البلدية بالتداخل مع بكتريا إي إم سجل أعلى تيسر لعناصر النيتروجين والفوسفور والبوتاسيوم بشكل كبير على باقي المعاملات وسجلت معاملة المقارنة أقل قيمة لامتصاص العناصر.

- أظهرت نتائج الزراعة المتتابعة زيادة امتصاص نباتات الذرة لعناصر النيتروجين والفوسفور والبوتاسيوم كأثر متبقي مع استخدام الأسمدة العضوية بالتداخل مع الأسمدة الحيوية.

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