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Phosphorus Availability, Uptake and use Efficiency of Barley & Maize Yields as affected by Green Manures

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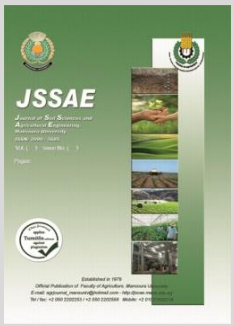

ABSTRACT

Green manures refer to soil fertility building crops, which may be broadly defined as crops grown for the benefit of the soil.They have been use in traditional agriculture for thousands of years but today's they are still limited utilized by farmers.A Lysimeters experiment was conducted at Sakha Agricultural Research Station,Egypt to assess the effect of green manures, and phosphorus fertilizer on some soil properties, phosphors use efficiency and yields of barley (in winter season 2016/2017) following by maize (in summer 2017). The experiment was arranged in split plot design with three replicates. The main plots were devoted to green manures: control (without green manure), as Lentil plants (*Lens culinaris Medikus*) and as Rocket plants (*Eruca sativa* L.); the sub plots were arranged in four rates of mineral phosphorus fertilizers: control: (without addition),7.5, 11.25 and 15.5 kg P_2O_5 fed^{-1}.The obtained results illustrated that using green manures i.e., lentil and rocket before planting barley significantly improved soil properties; increased the availability of the nutrients (NPK), and total porosity. Interaction between green manure as a rocket with mineral P-fertilizer rate at 15.5 kg P_2O_5 fed^{-1} attained the highest values of biological yield, harvest index, grain weight, and nutrients-uptake of NPK of barley and maize. The use of rocket as green manures with mineral phosphorus fertilizer at a rate of 11.25 kg P_2O_5 fed^{-1}(75% of RD)maximized barley and maize yields and phosphorus use efficiency.So,the study concluded the importance of using green manures to improve soil fertility and properties and mineral phosphorus fertilizer use efficiency.

Keywords: Green manures, Soil properties, phosphorus fertilizer efficiency, barley and maize yields.

INTRODUCTION

The residues and ploughed-in green plants of grasses, as preceding crops, have a significantly effect on the formation of productivity elements of cereal crops in the first year and also in the second year. (Skuodien & Nekrošien, 2007). Green manuring indicate to agriculture of plant species for biomass production. After harvesting, plant species are added to the soil to promote soil protection, increase its organic matter content and recycle nutrients (Hasaneen *et al*., 2009 and Souza *et al*., 2012)

After decomposition, Green manure is supplying soil with humus that plays important roles in improving soil properties; its fertility and thus, consequently plant growth. In general, it may be said that green manures improve poor soil because of their action on the physical, chemical, and bacteriological conditions. Ploughed-in green material improves soil with organic matter, which as a result of microbiological processes releases elements for plants (Ziblim *et al.,* 2013). The organic phosphorus (P) and potassium (K) bound in the green manure crop may provide an easily accessible form of P and K to succeeding crops (Eichler-Lo¨bermann *et al.* 2009).

The use of green manure with adequate residue management and crop rotation is important to conserve or increase content of soil organic matter , promote nutrient cycling to be benefit for crops, as increase organic acids which decrease soudium adsorpition ratio (SAR). (Mazzoncini and Barberi, 2002). Green manure had significant increase in soil EC Abdollah (2015). The decrease in the bulk density might be due to increase soil content of organic carbon that improves aggregation of particles (Othman *et al*., 2011; Yang *et al*., 2012). Decomposition of crop residues inreached soil organic matter and drives the elements return from plant litter to soil (Lupwayi *et al*. 2005), which determines the availability of elements for plant uptake. The phosphorus use efficiency is between ranged (15 – 20%) in cultivation fields point out that most of the soil-applied P remains unavailable to plant and leaches into surface and ground water leading to eutrophication (Smith 2003). The availability of low phosphorous in soil is one the major concern for the production of legume crop in the country. Being a legume, it fixes nitrogen from atmosphere through root nodules by Rhizobium bacteria (Humprey *et al*, 2001), which helps in reducing the pressure of nitrogenous fertilizers application.

Integrated plant nutrient management with efficient recycling of OM in combination with mineral fertilizers is one of the options to increase crop production. The integration of organic and synthetic sources of elements not only led to essential nutrients but also has some positive synergistic relations leading to increase crop yield Amanullah and Maimoona, (2007). Incorporation of green manure crops with P-fertilizer significantly increased soil content of total nitrogen , phosphors and potassium compared with weedy fallow which could be attributed to improving soil with organic materials and nutrients which produced by green manures decomposition (Achu *et al.*, 2013; Adesoji *et al.*, 2014).

A lot of studies about vegetable foods have shown that many plants of the Brassicaceae family contain

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phytochemicals such as glycosinolates and flavonoids (Jin *et al*., 2009).

The objective of the present study is to demonstrate the direct and residual impacts of green fertilization (as rocket and lentil plants) with mineral phosphorus fertilizer rates on soil fertility, phosphors use efficiency and yield for two successive seasons; winter (barley crop) and summer (maize crop).

MATERIALS AND METHODS

A Lysimeters experiment was carried out at Sakha Agricultural Research Station, Kafr El- Sheikh Governorate, Egypt (Latitude 31˚ 05¯ N, and Longitude 30˚ 75¯ E) during winter season of 2016/2017 and summer season of 2017. Lysimeters experiment station had an elevation of about 6 meters above the sea level. Lysimeter shape was a circular (one meter diameter * 60 cm height with filter of sand and gravels about 10 cm); each lysimeter was filled by 626 kg of clayey soil. Experiment included 72 Lysimeter; divided into 3 groups for green manures; every group included 24 lysimeter.

Experimental design and treatments

The experiment was conducted in Spilt plot design, with three replications. The main plots were devoted to three types of green manure G1 (control; without green manure), G2 (Lentil plants) and G3 (Rocket plants). The sub plots were arranged in four rates of mineral phosphorus fertilizers P1 (control: without addition), P2 (7.5 kg P_2O_5 fed^{-1}), P3 (11.25 kg $P_2O_5 fed^{-1}$) and P4 (15.5kg P_2O_5 fed^{-1}, i.e., 100 % of recommended dose for barley).

Soil sampling and analysis

Soil samples were taken from the surface layer (0–30 cm) before soil preparation; some physical and chemical properties of soil were analyzed according to shown in Table (1). Particle size distribution was determined according to the international piptte method. Available nitrogen of the soil was extracted by 1N potassium chloride and determined by Kjleldhl method, phosphorus was extracted by 0.5N sodium bicarbonate and calorimetrically measured by spectrophotometer. Available Potassium was extracted by 1N ammonium acetate and measured by flame photometer . Soil pH, EC and soluble cation and anions were determined in soil past extract. All determine was according to Buurman *et al* (1997).

For green manures treatments; seeds of lentils and rocket were sowing at the first week of October 2015 and after 30 days all plants inside the plot were incorporated into the soil (0- 30 cm). Barley *(*Giza 2000) was planted on 25th November 2016, and harvested on 15th April 2017. At the same plots with the same frequency, maize (single hybrid 10) was sown on 1st May 2017 and harvested on 5th October 2017. The other required cultural practices for crop barley and maize were followed properly as recommended.

Table 1. The mean values of some physical and chemical properties of the experimental soil before cultivation.

Properties	Particle size distribution				Bulk density	Total porosity	Void ratio	OM	$CaCO_3$	SAR
Soil depth	Sand %	Silt %	Clay %	Texture class	(kg m^{-3})	%	(Vr)	%	%	
0-15cm	17.92	32.23	49.85	Clayey	1.24	53.20	1.14	1.38	2.53	9.58
15-30cm	18.23	230.41	51.36	Clayey	1.31	50.57	1.02	1.05	2.39	10.54
30-45cm	22.86	29.36	47.78	Clayey	1.39	47.55	0.91	0.65	2.21	11.01

Properties	pH (in 1:2.5 soil: water suspension), EC (in soil paste extract),soluble cations and anions (meq/L soil)										Available NPK (mg kg^{-1})		
Soil depth	pH	EC dSm^{-1}	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{-}	HCO_3^{-}	Cl^{-}	SO_4^{--}	N	P	K
0-15cm	7.79	3.25	6.83	3.91	22.20	0.50	N.D	2.00	16.51	15.03	30.75	5.92	256
15-30cm	8.05	3.89	7.22	5.72	26.80	0.60	N.D	2.5	19.56	18.28	27.63	4.35	228
30-45cm	8.32	4.32	8.11	6.24	29.5	0.81	N.D	3.0	21.63	20.03	14.45	3.89	185

Phosphorus fertilizer was applied as (single calcium superphosphate fertilizer 15.5% P_2O_5) with soil tillage before sowing barley. N fertilizer was applied as urea (46.5% N) a rate of 75 kg $N.fed^{-1}$. Potassium was applied at a rate of 100 kg fed^{-1} potassium sulfate fertilizer (48% K_2O) as one dose before sowing.

Samples of each treatment from soil were taken at harvesting of barley and maize. Also, samples of each treatment were taken at harvest of barley crop, to determine the biological yield ($t.fed^{-1}$) and chemical analysis of grain and straw. Also, samples of maize crop were taken from each treatment at harvest to determine grain yield (ardab fed^{-1}; where ardab = 140 kg), straw yield ($t.fed^{-1}$), 100-grain weight (g) and chemical analysis for grain samples.

Chemical analysis of Plant and nutrient uptake

Samples were digested using sulfuric and perchloric acids mixture; then total N was determined using micro Kjeldahl method (Chapman and Pratt, 1982). Phosphorus was determined using spectrophotometer and potassium using flame photometer. The uptake of NPK was calculated by multiplying the content (%) by dry yield. The following equations were used to calculate the fertilizer efficiency. Recovery of P fertilizer (RPF) and phosphorus use efficiency (PUE) were calculated for each treatment according to the following equations according to Finck (1982).

Recovery of P fertilizer (%) = [(Total P uptake from fertilizer treatment - Total P uptake from control treatment) / Quantity of P fertilizer applied]*100

Phosphorus use efficiency (kg yield/kg P applied) = [(yield for P applied - yield for P control) / Quantity of P fertilizer applied]

The results were analyzed statistically according to Gomez and Gomez (1984) and means values were compared against least significant difference test (L.S.D.) at 5% level.

RESULTS AND DISCUSSION

A- Barley-maize yields and their components:

1. Barley-maize yield:

Data in Table 2 and Figs (1, 2, 3 and 4) demonstrate that application of green manures before barley sowing significantly affected yields and their components of barley and maize. The biological yield of barley increased by 6.97 and 13.66 % with the applications of green manures: lentils and rocket as compared with control. Also, The biological yield of maize increased by 16.26 and 37.18 % at the applications of green manures: lentils and rocket as

compared with control (without green manure). The highest values of grain and straw yields of barley and maize were observed with G3 (rocket); 10.53, 20.28 ardb grain.fed^{-1} from barley and maize, and 1.90, 3.80 ton.fed^{-1} straw from barley and maize, respectively.

Also, data reveal that biological, biological (grain and straw) yields of barley and maize significantly increased with increasing rate of mineral P fertilizer application up to 100% from RD of Phosphorus fertilizer (P4) with related increments of (31.16, 39.58 and 25.80%) from biological, grain and straw yields of barley respectively, and (51.98, 29.23 and 74.32%) from biological, grain and straw yields of maize over the control treatments (P1: without P fertilizer).

This results due to phosphorus fertilizer which is the key nutrient for increase production because it is involved in root development, stalk strength, flower and seed formation, crop production and its quality, N-fixation. It plays an important role to stimulate biological activities, N fixation and nutrient uptake in soil and rhizosphere environment resulting in higher yield of legume crops. Phosphorus application ameliorates the negative effects of drought on physiological parameters and has ability to improve yield under water stress conditions (Singh *et al.*, 2005)

Also, these results agree with Sarker and Karmoker (2009), who showed that green manure of Lentil is valued for their high protein content, which is double than that in cereals. Also concentrate source of dietary protein. lentil contains 59% carbohydrates1.8%, 23.25% protein, oil, 0.2% ash and trace of iron, Ca, P and Mg.

Dawlatabad *et al*, 2015, studied the effect of green manure on soil organic matter and some growth indices of maize in Rafsanjani Region and they found that sowing rocket plant significantly increased leaf area index, biological yield and crop growth rate of maize 50 days after sowing,.

Table 2. Effect of green manures, phosphorus fertilizer rates and their interaction on biological yield, grain and straw yields of barley and maize crop rotation.

Treatments		Barley			Maize		
		Biological yield Kg.fed^{-1}	Grain yield ardb.fed^{-1}	Straw yield ton.fed^{-1}	Biological yield Kg.fed^{-1}	Grain yield ardb.fed^{-1}	Straw yield ton.fed^{-1}
A-Green manures treatments (G):							
G1		2786	9.36	1.66	4839	16.64	2.51
G2		2981	9.89	1.79	5626	18.28	3.07
G3		3167	10.53	1.90	6638	20.28	3.80
L.S.D 0.05		37.5	0.086	0.041	148.6	0.197	0.137
F. test		**	*	**	**	**	**
B-Phosphorus fertilizer rates (P):							
P1		2538	8.26	1.55	4424	15.77	2.22
P2		2908	9.29	1.79	5422	17.77	2.93
P3		3137	10.62	1.86	6234	19.66	3.48
P4		3329	11.53	1.95	6724	20.38	3.87
L.S.D 0.05		55.3	0.189	0.052	229.8	0.049	0.216
F. test		**	*	**	**	**	**
C-The interaction between G and P:							
G1 (control)	P1	2435	8.10	1.46	3695	4.40	1.68
	P2	2694	8.89	1.63	4413	16.05	2.17
	P3	2928	9.98	1.73	5488	17.89	2.98
	P4	3088	10.47	1.83	5758	18.20	3.21
G2 (lentils)	P1	2518	8.15	1.54	4422	15.97	2.19
	P2	2930	9.31	1.81	5405	17.39	2.97
	P3	3156	10.72	1.87	5953	19.26	3.26
	P4	3320	11.37	1.96	6723	20.48	3.86
G3 (Rocket)	P1	2663	8.53	1.64	5154	16.96	2.78
	P2	3099	9.68	1.94	6449	19.87	3.67
	P3	3326	11.16	1.99	7259	21.83	4.20
	P4	3580	12.75	2.05	7690	22.45	4.55
L.S.D 0.05		95.7	0.328	0.328	-	0.382	0.382
F. test		*	**	**	N.S	**	**

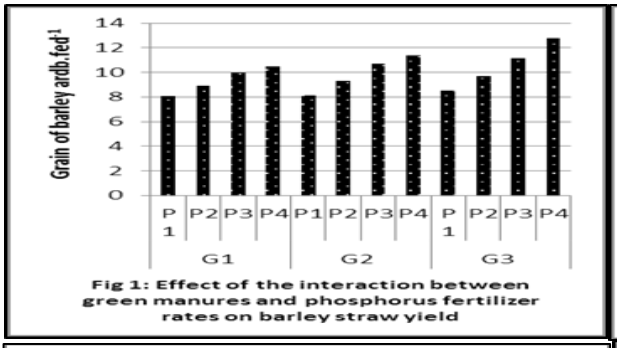

Fig 1: Effect of the interaction between green manures and phosphorus fertilizer rates on barley straw yield

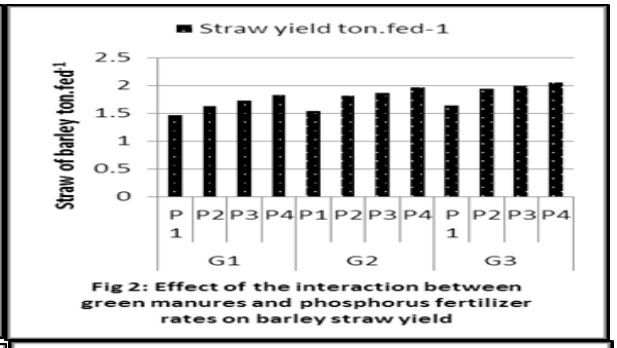

Fig 2: Effect of the interaction between green manures and phosphorus fertilizer rates on barley straw yield

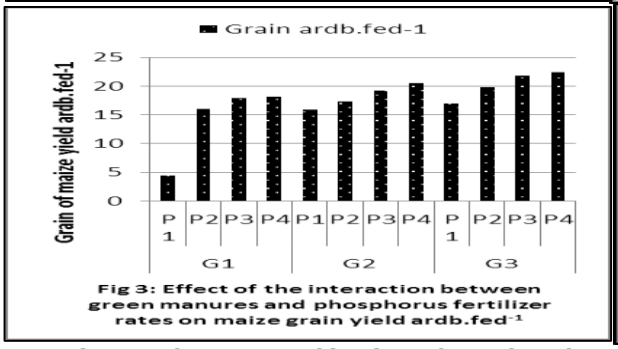

Fig 3: Effect of the interaction between green manures and phosphorus fertilizer rates on maize grain yield ardb.fed^{-1}

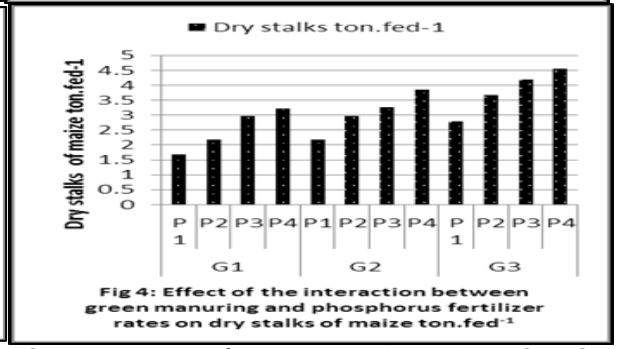

Fig 4: Effect of the interaction between green manuring and phosphorus fertilizer rates on dry stalks of maize ton.fed^{-1}

Also in the same Table data show that the interaction of green manures and P fertilizer rates significantly affected barley and maize yields. The highest values of such parameters were obtained by the interactions of (G2*P4) and (G3*P4). The highest values of grain and straw barley-maize ardb.fed^{-1} were resulted by the interaction of treatments (G3*P4) with related increments of 49.47, 32.37% from grain barley and maize yields; and 25, 63.66% from straw barley and maize yields, respectively.

Therefore Amanullah and Maimoona, (2007) found that integrated plant elements management with efficient

recycling of O.M (organic matter) in combination with mineral fertilizers is one of the options to increase crop production. The combination between organic and mineral sources of elements led to essential nutrients and also has some positive synergistic relations leading to increase yields of crop.

The highest barley yield was obtained from application of 46 kg N + 40 kg P + 50 kg K and 20 t ha^{-1} FYM over the application of 100% recommended rate of NPK fertilizer alone and the control (Abay and Tesfaye 2012)

Kler *et al*. (2007) reported that thousand grain weight was significantly higher when 10 tons of FYM ha^{-1} with 80% of recommended mineral NP was applied on wheat.

Data in Table 3 show that the effect of green manures i.e.; rocket & lentils plants, and P fertilizer rates on harvest index of maize only, 1000 grain weight of barley and 100 weight of grain maize. Green manure of lentil plants treatment gained the highest harvest index only but non-significant effect on harvest index of barley. Also, data demonstrated that G3 treatment had attained the highest values of 1000-grain weight of barley (45.94 g) and 100 grain weight of maize (43.66 g) as compared with the control treatment (without green manure).

Harvest index of barley and maize yields significantly increased with increasing the rate of mineral P fertilizer application up to 15.5kg P_2O_5 fed^{-1} (P4). Data showed that P4 treatment had the highest values of harvest index % from barley and maize (41.52 and 50.45%, respectively) as compared with the control treatment (P1: without P fertilizer addition). Also, the same treatment had the highest value of 1000 grain weight of barley (48.15 g) with related increments of 22.58%, and had the highest value of 100 grain weight of maize (42.94 g) with related increment of 8.79 % over the control treatment.

Also, Data in Table 3 and Figs (5, 6, 7 and 8) reveal that interaction between treatments understudies had significant effect on harvest index (%) and 1000grain weight of barley, but non-significant effect on harvest index % and 100 grain weight of maize. From the data it was observed that interactions of (G2* P4) and (G3*P4) treatments gained the highest value of harvest index % and 1000 grain weight of barley, while the interaction of G3*P4 was better than the interaction of (G2* P4), it was gave the highest values of harvest index (42.76 %) and 1000 grain weight (48.51 g) of barley as compared with the control treatment.

Table 3. Effect of green manures, phosphorus fertilizer rates and their interaction on harvest index of barley and maize rotation, 1000 grain weight of barley and 100 grain weight of maize.

Treatments		Barley		Maize	
		Harvest index %	1000 grain weight(g)	Harvest index %	100 grain weight(g)
A-Green manures treatments (G):					
G1		40.29	44.96	48.9	36.70
G2		39.73	45.50	45.93	43.10
G3		39.71	45.94	43.07	43.66
L.S.D 0.05		-	0.1713	1.4313	0.3332
F. test		N.S	**	**	**
B-Phosphorus fertilizer rates (P):					
P1		39.08	39.28	42.62	39.47
P2		38.40	46.55	44.38	40.54
P3		40.64	47.58	46.42	41.66
P4		41.52	48.15	50.45	42.94
L.S.D 0.05		0.91184	0.0945	1.7197	0.2916
F. test		**	**	**	**
C-The interaction between G and P:					
G1 (control)	P 1	39.96	38.76	54.63	34.89
	P2	39.57	46.15	50.98	35.88
	P3	40.93	47.11	45.68	37.42
	P4	40.68	47.83	44.31	38.61
G2 (lentils)	P1	38.86	39.29	50.62	41.51
	P2	38.13	46.94	45.12	42.85
	P3	40.75	47.67	45.32	43.41
	P4	41.11	48.11	42.66	44.64
G3 (Rocket)	P 1	38.43	39.80	46.09	42.02
	P2	37.49	47.46	43.17	42.90
	P3	40.25	47.97	42.13	44.15
	P4	42.76	48.51	40.89	45.58
L.S.D 0.05		1.5793	0.1643	-	-
F. test		*	**	N.S	N.S

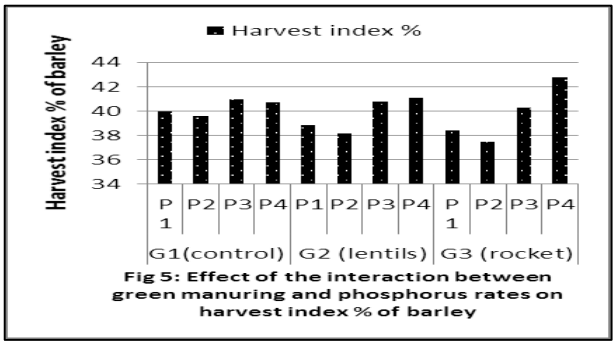

Fig 5: Effect of the interaction between green manuring and phosphorus rates on harvest index % of barley

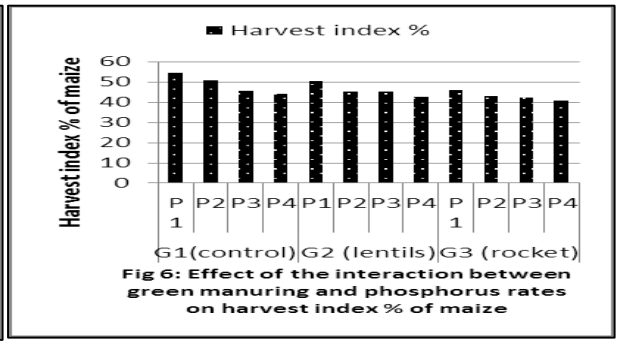

Fig 6: Effect of the interaction between green manuring and phosphorus rates on harvest index % of maize

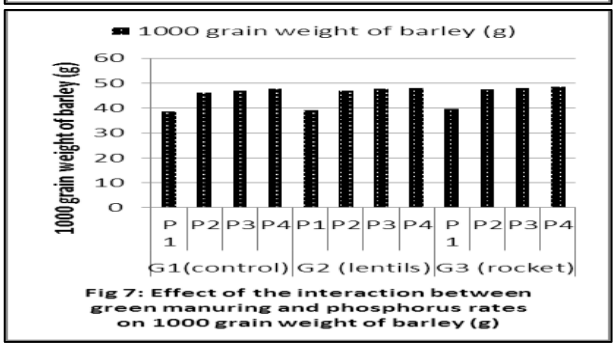

Fig 7: Effect of the interaction between green manuring and phosphorus rates on 1000 grain weight of barley (g)

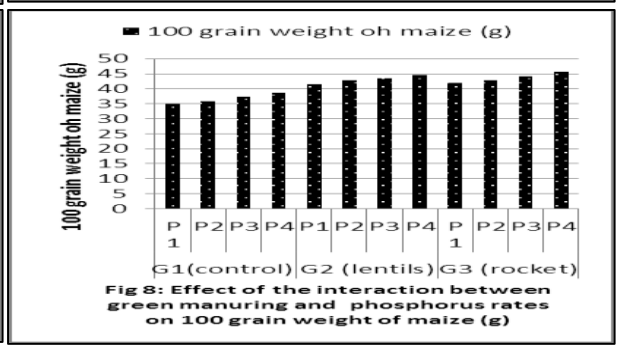

Fig 8: Effect of the interaction between green manuring and phosphorus rates on 100 grain weight of maize (g)

Similarly, Khalid *et al*., (2011) reported that application of 8 t ha^{-1} FYM with 50% recommended rate of mineral (NP) resulted in 88% and 55% yield advantage of wheat through the control treatment and the application

of 100% recommended NP fertilizer rate alone, respectively.

This result was in line with that of Lorry *et al.* (2006) who reported that application of mineral fertilizers rapidly releases nutrients during the early growth stages and the organic fertilizer release nutrients gradually up to the later developmental stages.

Data in Table 4 reveal that application of green manures before barley–sowing with mineral P fertilizer rates significantly affected relative increase percentage (RI%), phosphorus fertilizer use efficiency (PUE as kg yield/kg P applied) and recovery of P fertilizer (RPF%). Data show that the highest RI% for the biological yield, PUE and P fertilizer (RPF) of barley was recorded with interaction of mineral P fertilizer rate P4 (15.5 kg P_2O_5 fed^{-1}) with lentil plants as green manure (G3*P4) where it was (34.47% , 9.18 and 4.22%, respectively).

On the other hand, data in the same Table show that the treatment of interaction G1*P4 gave the highest value of RI for the biological yield of maize, where it was 55.82%. However, the interaction of treatments G3*P2 was attained the highest value of PUE and RPF of maize, where it was 57.82 and 3.97, respectively.

Table 4. Effect of the interaction between green manures and phosphorus fertilizer rates on RI %, PUE and RPF% of barley and maize yields.

Treatments		Barley			Maize		
		RI%	PUE	RPF%	RI%	PUE	RPF%
G1 (control)	P1	0.00	0.00	0.00	0.00	0.00	0.00
	P2	10.65	5.19	0.34	19.41	7.17	0.49
	P3	20.23	6.57	0.36	48.51	11.95	0.87
	P4	26.81	4.93	0.37	55.82	10.31	0.77
G2 (lentils)	P1	0.00	0.00	0.00	0.00	0.00	0.00
	P2	16.37	8.24	2.32	22.23	16.80	0.82
	P3	25.34	8.51	3.43	34.63	17.33	1.21
	P4	31.86	8.02	3.22	52.04	20.15	1.46
G3 (Rocket)	P1	0.00	0.00	0.00	0.00	0.00	0.00
	P2	16.38	8.72	2.3	25.12	57.82	3.97
	P3	24.94	8.85	3.51	40.84	33.88	2.29
	P4	34.47	9.18	4.22	49.20	24.07	1.68

RI %: relative increase percentage. ** PUE: phosphorus fertilizer use efficiency (kg yield/kg P applied. * RPE %: Recovery of P fertilizer.**

Barley-maize components:

Data in Table 5 and Figs (9, 10, 11 and 12) demonstrate that the uptake of nitrogen, phosphors and potassium of barley & maize yield significantly affected by applications of green manures and mineral P fertilizer rates; where the highest uptake of N, P and K was obtained with treatments of G3 and P4.

Data show that the highest values of nitrogen, phosphors and potassium uptake of barley (21.06, 5.70 and 31.92 kg fed^{-1}, respectively) were obtained with G3 treatment as compared with the control treatment (G1). Also, the maximum uptake of N, P and K from of maize (40.56, 11.40 and 29.05) kg fed^{-1}, respectively) were obtained with the treatment of green manure G3.

In the same Table, results show that barley and maize yields uptake of NPK significantly increased with increasing the application rate of mineral P fertilizer. The maximum barley and maize yields uptake of N (23.06, 40.76kg fed^{-1} respectively), P (5.85, 11.61 kg fed^{-1} respectively) and K (38.06, 32.26 kg fed^{-1}, respectively) were obtained with mineral P fertilizer rate P4.

Table 5.Effect of green manures and phosphorus fertilizer rates and their interaction on uptake of N, P and K (kg fed^{-1}) of barley and maize rotation.

Treatments		Barley			Maize		
		N-uptake	P-Uptake	K-uptake	N-uptake	P-uptake	K-uptake
A-Green manures treatments (G):							
G1		18.72	4.98	24.94	27.45	7.53	20.23
G2		19.78	5.37	26.33	28.98	9.21	26.33
G3		21.06	5.70	31.92	34.78	11.40	29.05
L.S.D 0.05		0.086	0.041	0.633	0.197	0.137	0.167
F. test		*	**	**	**	**	**
B-Phosphorus fertilizer rates (P):							
P1		16.52	4.65	15.74	18.32	6.66	17.78
P2		18.58	5.37	23.36	26.43	8.79	23.49
P3		21.24	5.58	33.76	36.05	10.44	27.28
P4		23.06	5.85	38.06	40.82	11.61	32.26
L.S.D 0.05		0.189	0.052	0.464	1.339	0.216	0.198
F. test		*	**	**	**	**	**
C-The interaction between G and P:							
G1 (control)	P 1	16.20	4.38	14.17	16.33	5.04	15.22
	P2	17.78	4.89	21.2	24.26	6.51	18.37
	P3	19.96	5.19	28.57	31.40	8.94	21.49
	P4	20.94	5.49	35.83	37.38	9.63	25.86
G2 (lentils)	P1	16.30	4.62	15.63	17.23	6.57	18.05
	P2	18.62	5.43	22.53	25.03	8.91	25.06
	P3	21.44	5.61	31.28	34.76	9.78	28.93
	P4	22.74	5.88	35.87	38.90	11.58	33.28
G3 (Rocket)	P 1	17.06	4.92	17.43	21.40	8.34	20.06
	P2	19.36	5.82	26.33	30.00	11.01	27.05
	P3	22.32	5.97	41.43	42.00	12.60	31.42
	P4	25.50	6.15	42.47	45.73	13.65	37.66
L.S.D 0.05		0.328	-	0.804	2.319	-	0.343
F. test		**	N.S	**	*	N.S	**

In general, there was a significant increase in grain and straw N content or total plant N uptake. In line with this result, Aziz *et al*., (2010) demonstrated that root growth in plants receiving farm yard manure (FYM) was higher and hence would increase nutrient uptakes. Yassen *et al*., (2010) observed that farm yard manure (FYM) application increased the movement of nutrients between the solid phase and soil solution which could also be a reason for the highest nutrient uptakes. The increased activity of soil microorganisms higher farm yard manure treatment could have increased nutrient uptake.

This result was also in agreement with that of Hossain *et al*. (2010) who illustrated that higher nitrogen and phosphorus uptakes in rice with farm yard manure treatment over control and mineral fertilizers alone.

Application of 5 t FYM ha^{-1} combined with (75%) recommended rate of mineral NP had significantly the highest 1000 grain weight, total above ground dry biomass yield and grain yield of barley. Moreover, the application of 5 t ha^{-1} farm yard manure combined with 75% mineral NP has resulted in the highest grain, straw and total plant uptake of both N and P over the other treatments.

The interaction between green manures and mineral P fertilizer rates (Table 5) and Figs 13, 14 & 15 significantly affected the uptake of N and K. The maximum uptake of N and K of barley (25.50 and 42.47 kg fed^{-1},) and maize (44.90 and 37.66) respectively were obtained with the interaction of G3 *P4. Furthermore, data in the same table showed that, all treatments non-significantly affected on P uptake.

The release of P and other nutrients from decomposing green manures residuals may be well timed with plant uptake, possibly increasing P uptake efficiency and crop yield. Accordingly, green manures are considered an important part of farming system as they help in building soil fertility in the long term and are particularly useful when growing crops need higher demand of P (Canali *et al*., 2010; Achu *et al*., 2013).

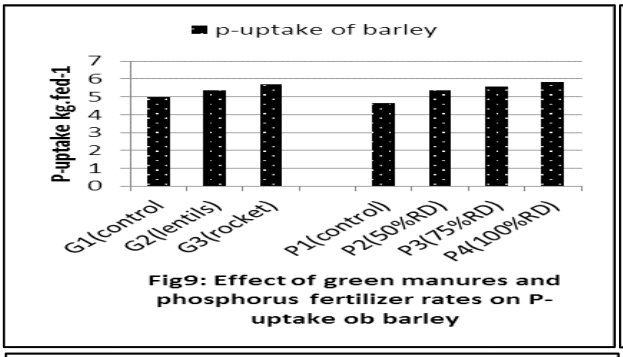

Fig9: Effect of green manures and phosphorus fertilizer rates on P-uptake ob barley

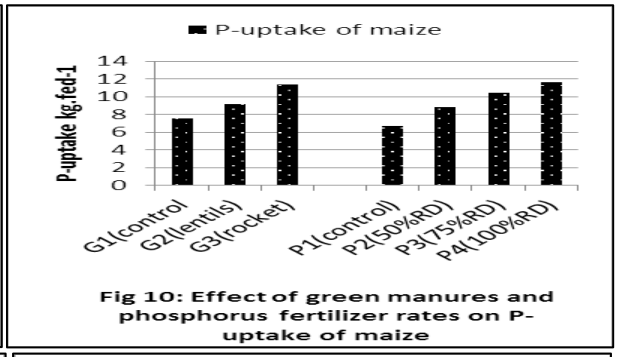

Fig 10: Effect of green manures and phosphorus fertilizer rates on P-uptake of maize

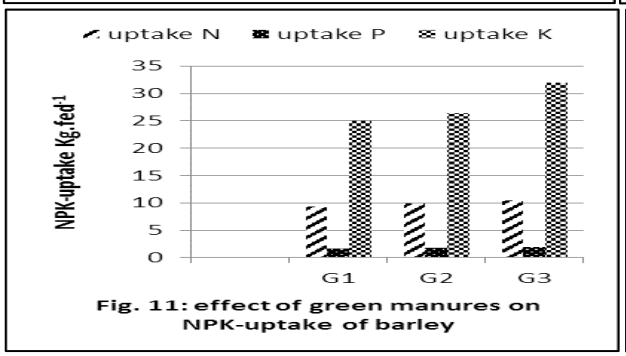

Fig. 11: effect of green manures on NPK-uptake of barley

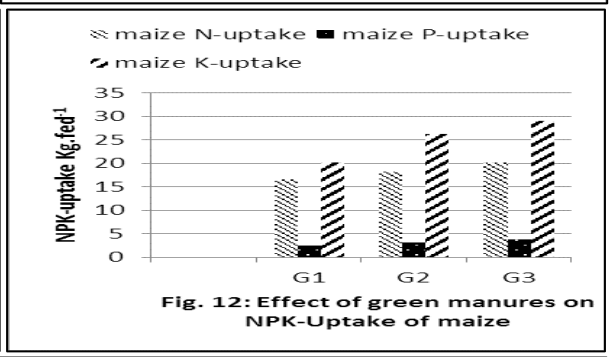

Fig. 12: Effect of green manures on NPK-Uptake of maize

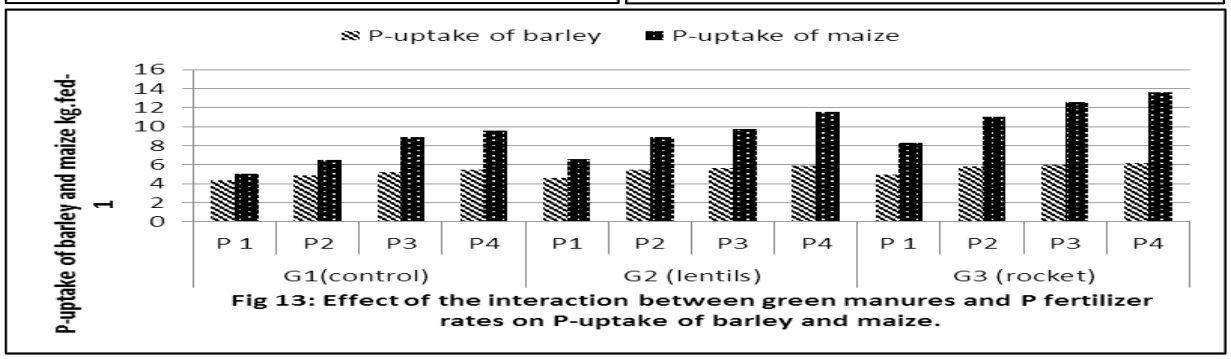

Fig 13: Effect of the interaction between green manures and P fertilizer rates on P-uptake of barley and maize.

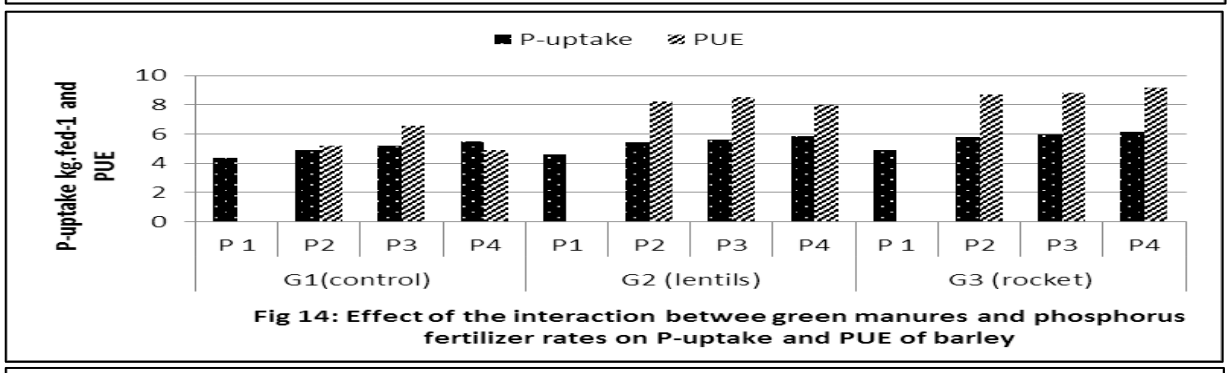

Fig 14: Effect of the interaction betwee green manures and phosphorus fertilizer rates on P-uptake and PUE of barley

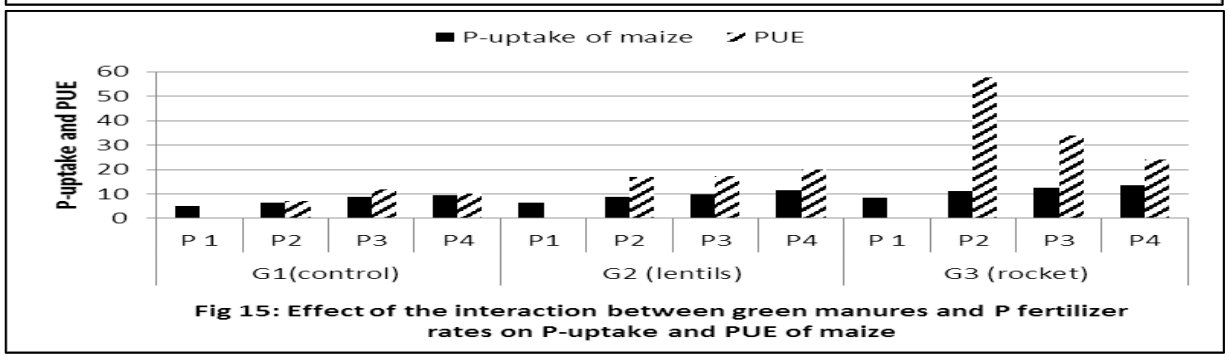

Fig 15: Effect of the interaction between green manures and P fertilizer rates on P-uptake and PUE of maize

B- Soil characters

1. Soil fertility

Data in Table 6 show that green manures as lentils and rocket plants had significant effect on soil content of available N, P and K. The highest soil content of available N, P and K (77.9, 26.6 and 737 mg kg^{-1}) after barley harvest were obtained at treatment of lentils as a green manure (G3). Green manures caused increase in available

nitrogen , phosphorus and potassium after barley harvesting from 30.75 mg kg^{-1} average available N before sowing to 76.37mg kg^{-1} after barley harvesting, P from 5.92 mg kg^{-1} to 26.60 mg kg^{-1} and K from 256 mg kg^{-1} to 737 mg kg^{-1} . Where, these treatments caused sustainable agriculture by increasing soil fertility. Also, data showed that treatment of green fertilization as rocket plants (G3) had superior effect on available N, P and K after harvest of maize, which recorded the highest values (46.86, 6.81 and 263 mg kg^{-1}, respectively) compared with control G1 (without addition).

On the other hand, in respect to phosphorus rates the highest values of available N, P and K in soil after barley (81.24, 23.12 and 728.11) were obtained with P4 (15.5 kg P_2O_5 fed^{-1}), respectively. On the other hand the lowest values were obtained with the control treatment (without mineral phosphorus fertilization). And so on, data observed that treatment of P4 (100% of RD from P fertilizer) had superior effect on available nitrogen, phosphorus and potassium after harvest of maize, which recorded the highest values (54.87, 7.03 and 277.78 mg kg^{-1}, respectively) as compared with control treatments P1 (without addition).

These results agree with Weil and Magdoff, (2004), who found that organic manures are key material of the soil physical & chemical properties and crop yield improvement measures because they carry out many functions in agro-ecosystem.

It is worthy to mentioning that plants of Fabaceae family have the efficiency to live in symbiosis with rhizobia that fix free atmospheric N. The use of lentil as a (green manure) in an organic farm is function by its natural ability to fix atmospheric N.

As indicated in Table 6 and Figs (16, 17 and 18) the soil available N, P and K nutrients have been affected by interaction between green manures (lentils and rocket) with phosphors rates. After barley harvest, both treatments of interaction between green manures and all P fertilizer levels have superior effects on available N, P and K after harvest of barley and maize. The highest values were obtained with interaction between lentils as a green manure with P4 (100% RD from P fertilizer). The highest values of available N (88.67, 61.90 mg kg^{-1}), P (28.67, 7.58 mg kg^{-1}) and K (891.60, 302.33 mg kg^{-1}) after harvest of barley and maize, respectively were obtained at the interaction of treatments G2*P4.

Decay of crop residues increases soil O.M (Boehm & Anderson 2002) and drives the elements return from plant litter to soil (Snoon and Arshad 2002, upwayi *et al*. 2005), which determines the availability of nutrients for plant uptake.

Residual decomposition and phosphorus, potassium release were all influenced by weather conditions (Talgree *at al*. 2014).

Incorporation of green manure crops with P-fertilizer significantly increased soil content of total N and P and K compared with weedy fallow which could be attributed to improving soil with organic materials and nutrients which produced by green manures decomposition (Achu *et al.*, 2013; Adesoji *et al*., 2014).

Also, these results may be due to organic residues decay is a complex process determined by three main interacting groups of factors: chemical (composition of the litter), physical (climate and environment surrounding the litter), and biotic (microorganisms and invertebrates that take part in litter decomposition) (Berg & Laskowski 2006). Incorporation of plant residues into the soil generally stimulates microbial growth and activity. After decay, the organic phosphorus and potassium bound in the green manure crop can provide an easily accessible form of phosphorus and potassium to crops (Eichler-Lo¨bermann *et al*. 2009). In organic farming without possibility to use animal manure, the most important way to improve the nutrient supply for succeeding crops are the green manures.

Organic matter decomposition has studied by Canadian scientists (Lupwayi *et al*. 2006a and b).

In this admiration, (Abril and Roca 2008) showed that a significant increase in available P with increasing application rate of nitrogen fertilizer, might be attributed to the role of N in mediating the utilization of phosphorus, potassium in plant. Also, the results can be led to available P which might be attributed to increase microbial activity induced by the added OM which speeds up P-cycling (Melero *et al*., 2007).

Table 6. Effect of green manures, phosphorus fertilizer rates and their interactions on available N, P and K in soil (mg kg^{-1}) after harvest barley and maize yields.

Treatments		After Barley			After maize		
		N	P	K	N	P	K
A-Green manures treatments (G):							
G1		61.9	13.05	287	35.5	5.39	208
G2		73.3	22.85	534	43.9	6.34	250
G3		77.9	26.60	737	46.9	6.81	263
L.S.D 0.05		1.03	0.748	37.6	0.53	0.119	2.4
F. test		**	**	**	**	**	**
B-Phosphorus fertilizer rates (P):							
P1		62.5	18.11	335	31.4	5.43	209
P2		67.6	20.38	414	36.1	6.06	219
P3		72.8	21.73	600	46.0	6.62	257
P4		81.2	23.12	728	54.9	7.03	278
L.S.D 0.05		1.35	0.508	32.9	0.47	0.073	1.8
F. test		**	**	**	**	**	**
C-The interaction between G and P:							
G1 (control)	P 1	54.3	11.63	154	25.5	4.40	182
	P2	57.5	13.41	231	31.2	5.22	192
	P3	63.7	13.51	272	38.7	5.84	218
	P4	72.0	13.66	493	46.5	6.14	242
G2 (lentils)	P1	65.4	19.37	275	33.9	5.84	214
	P2	70.3	20.93	282	37.2	6.42	228
	P3	74.4	23.80	779	48.3	6.92	270
	P4	83.1	27.30	800	56.2	7.37	289
G3 (Rocket)	P 1	67.8	23.33	576	34.6	6.05	231
	P2	74.8	26.53	730	39.9	6.53	236
	P3	80.3	27.87	749	51.0	7.09	282
	P4	88.7	28.67	892	61.9	7.58	302
L.S.D 0.05		0.551	0.440	21.0	0.82	0.127	3.2
F. test		**	**	**	**	**	**

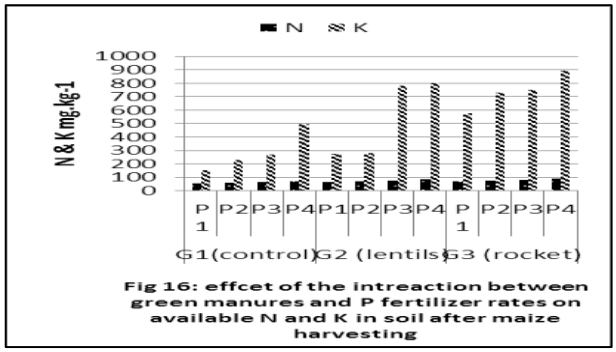

Fig 16: effcet of the intreaction between green manures and P fertilizer rates on available N and K in soil after maize harvesting

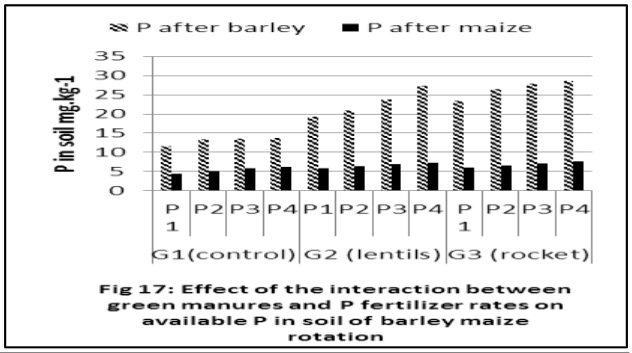

Fig 17: Effect of the interaction between green manures and P fertilizer rates on available P in soil of barley maize rotation

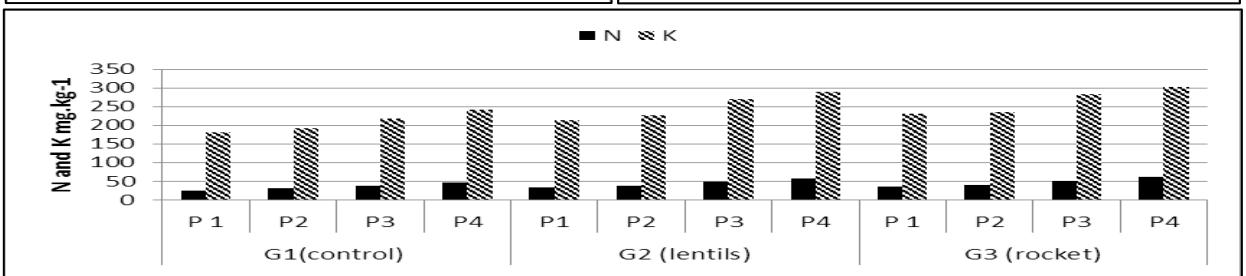

Fig 18: effcet of the intreaction between green manures and P fertilizer rates on available N and K in soil after maize harvesting

2- Soil ECe and SAR:

Data in Table 7 show that the green manure effectively decreased soil salinity (ECe) and sodicity (SAR) in the soil (0-45 cm depth). The mean values of EC and SAR before experiment were 3.82 dSm^{-1} and 10.38, respectively. The highest reduction of ECe values through the two growing seasons (after harvesting of barley and maize crops) were recorded under green manure G2 (Lentils) as comparing with other green manure treatments G1 and G3. EC values after barley crop decreased by 3.14 and 5.76% with G2 and G3 treatments, whereas it decreased after harvesting of maize crop by 4.71 and 9.42% with G2 and G3 treatments as compared with ECe before experiment, respectively.

Table 7. Effect of green fertilization on ECe and SAR of soil, and rate of change before experiment and after harvesting barley and maize yields.

Green fertilization Treatments	EC_e (dSm^{-1}) Soil depth (cm)					SAR Soil depth (cm)				
	0-15	15-30	30-45	mean	Rate of change (±%)	0-15	15-30	30-45	Mean	Rate of change (± %)
Before exp.	3.25	3.89	4.32	3.82	----	9.58	10.54	11.01	10.38	-----
After one season (barley crop)										
G1	3.36	3.92	4.48	3.92	2.62	9.70	10.48	11.20	10.46	0.80
G2	3.20	3.78	4.12	3.70	3.14	9.41	10.29	10.75	10.17	2.02
G3	3.12	3.62	4.05	3.60	5.76	9.35	10.07	10.65	10.02	3.46
After second season (maize crop)										
G1	3.34	3.87	4.41	3.87	1.30	9.67	10.41	11.12	10.40	0.20
G2	3.14	3.67	4.11	3.64	4.71	9.38	10.14	10.73	10.08	2.89
G3	3.02	3.49	3.86	3.46	9.42	9.20	9.89	10.40	9.83	5.30

In the same Table the results demonstrated that the decrease percentage in SAR after harvesting of barley crop were 2.02 and 4.46% for G2 and G3 treatment, respectively compared with the control treatment. Also, it decreased after harvesting of maize crop by 2.89 and 5.30% with G2 and G3 treatments as compared with SAR before experiment, respectively. These results agree with Abdollah (2015) who showed that green manure had significant effect on soil EC.

On the other hand, (Mazzoncini and Barberi, 2002) showed that the use of green manure together with adequate residue management and crop rotation is crucial to conserve or increase soil organic matter content, promote nutrient cycling at farm scale to be benefit for crops, as increase organic acids which decrease SAR.

3- Bulk density and total porosity:

Data in Table 8 show that sowing of green manures before barley-maize rotation increased soil porosity and decreased bulk density. The lowest values of soil bulk density and the highest values of porosity were recorded with treatment of green manure G3 (rocket plants) as compared with control (without green manure) after harvesting of barley and maize. The lowest mean of bulk density values was (1.25 kg m^{-3}) in first season (after barley) and (1.24 kg m^{-3}) in second season (after maize) with G3 treatment compared with the control treatment. The decrease in the bulk density might be due to increase soil content of organic carbon that improves aggregation of particles (Othman *et al*., 2011; Yang *et al*., 2012).

Table 8. Effect of green fertilization on bulk density and total porosity of soil before experiment and after harvest of barley and maize yields.

Green fertilization Treatme	Bulk density (kg m^{-3}) Soil depth (cm)				Total porosity (%) Soil depth (cm)			
	0-15	15-30	30-45	mean	0-15	15-30	30-45	Mean
Before exp.	1.24	1.31	1.39	1.31	53.20	50.57	47.55	50.44
After one season (onion crop)								
G1	1.23	1.30	1.36	1.29	53.58	50.94	48.68	51.07
G2	1.20	1.28	1.33	1.27	54.72	51.70	49.81	52.08
G3	1.19	1.25	1.31	1.25	55.09	52.83	50.57	52.83
After two season (maize crop)								
G1	1.22	1.29	1.34	1.28	53.96	51.32	49.43	51.57
G2	1.18	1.26	1.33	1.25	55.47	52.45	49.81	52.58
G3	1.16	1.24	1.32	1.24	56.23	53.20	50.19	53.20

On the other hand, the highest value of total porosity % was 52.83% after barley harvesting, and 53.20% after

maize harvesting at green manure treatment G3 as compared with the control treatment. Application of inorganic NP in combination with FYM is known to improve various soil physico-chemical properties like water holding capacity, porosity, soil organic carbon, total N etc. resulting in enhanced nutrient absorption or uptake (Pandey *et al.,* 2007).

Also, these results could be due to soil bulk density increase soil content of organic carbon that improves aggregation of particles (Othman *et al.,* 2011; Yang *et al.,* 2012).

Also, green manure might be decrease soil pH and bulk density, as well as increase soil OM and soil microorganisms in a tobacco field (Liu *et al*., 2006). Crop residues and green manure improve the soil chemical and biological properties (Shahz and Rahman 2010; Ziblim *et al*., 2013).

CONCLUSION

It can be concluded from the previous showed results that application of green manures as i.e. lentil or rocket plants before sowing barley (in winter season) had positive significantly effect on use efficiency of mineral phosphorus fertilizer, barley yield and its uptake of nutrient NPK and soil fertility, that had also a residual significant effect on maize yield and its nutrient content in summer season. The interaction of green manures (lentil or rocket) with inorganic phosphorus fertilizer at a rate of 11.25 kg P_2O_5 fed^{-1} (75% of RD) significantly maximized barley and maize yields and phosphors efficiency as compared with treatment control of without green manure and phosphorus fertilizer rate of 15.5 kg P_2O_5 fed^{-1} (100% of RD). So, the study recommended by application of green manures as i.e. lentil or rocket plants before sowing barley in winter season.

REFERENCES

Abay, A. and Tesfaye, D. (2012). Combined application of organic and inorganic fertilizers to increase yield of barley and improve soil properties at Fereze, in Southern Ethiopia. Inn. Sys. Des. and Eng. 22(1): 25-34.

Abdollah, J. (2015). Improvement of soil physicochemical characteristics using legume crops. *Biologic. forum-An Int. J.* **7**(2): 869-874.

Abril, A. and Roca, L. (2008). Impact of nitrogen fertilization on soil and acquifers in the humic pampo, Argentina. *The Open Agric. J.* 2: 22-27.

Achu, F., Kanmi, N. and Katzo, C. (2013). Effect of compost and organic green manure on soil fertility and nutrient uptake in wheat-rice cropping system. *Int. J. of Manures and Fertilizers.* 2(10): 407-412.

Adesoji, A. G.; Abubakar, I. U. and Labe, D. A. (2014). Soil chemical properties as Affected by Incorporated legumes and nitrogen in soil with maize (*Zea mays* L.) in a semi-Arid Environ. Inter. J. of Agric. Innovation and Res. 3(3), 2319-2473.

Amanullah, J. and Maimoona, N. (2007). Response of wheat to farm yard manure and nitrogen under rain fed conditions. Afric. J. Cr. Sci. 8: 37-40.

Aziz, T., Ullah, S., Sattar, A., Nasim, M., Farooq, M. and Khan, M. (2010). Nutrient availability and maize (*Zea mays* L.) growth in soil amended with organic manures. Inter. J. Agri. and Bio., 12 (4): 621-624.

Berg, B., Laskowski, R.(2006). Litter decomposition: a guide to carbon and nutrient turnover. Adv. Ecol. Res. 38:19–71.

Boehm, M. M., Anderson, D.W. (2002). A landscape-scale study of soil quality in three prairie farming systems. Soil Sci. Soc. Am. 61:1147–1159.

Buurman,P., van Lagen, B and Velthorst, E. J. (1997). "Manual For Soil and Water Analysis". Backhuys Publishers, Leiden, The Netherlands.

Canali S., C. Ciaccia, D. Antichi, P. Bàrberi, F. Montemurro and F. Tittarelli (2010). Interactions between green manure and amendment type and rate: Effects on organic potato and soil mineral N dynamic. J. of Food, Agric. & Environ. 8(2): 537-543.

Chapman H. D. and P. F. Pratt (1982). "Methods of Plant Analysis, I. Methods of Analysis for Soil, Plant and Water". Chapman Publishers, Riverside, California, USA.

Dawlatabad, M. P., Hosseini, S. M., Dashti, H. H and Rahimi, A. (2015). The Effect of Green Manure on Soil Organic Matter and Some Growth Indices of Maize (Zea mays L.) in Rafsanjan Region.

Eichler-Lo¨bermann, B., Gaj, R., Schnug, E.(2009). Improvement of soil phosphorus availability by green fertilization with catch crops. Comm. Soil Sci. Plant Anal. 40:70–81.

Finck (1982).*"Fertilizer and Fertilization"*. Weinheim beer field beach florida. Basel: verleg chemical. PP:223.

Gomez, K. A. and A. A. Gomez (1984). *"Statistical Procedures for Agriculture Research"*. 2nd Ed., John Wiley and Sons.

Hasaneen, M., Younis, M. E. and Tourky, S. (2009). Plant growth, metabolism and adaptation in relation to stress conditions salinity-biofertility interactive effects on growth, carbohydrates and photosynthetic efficiency of lactuca sativa. *Plnat Omiccs.* 2(2): 60-69.

Hossain, A. T., Rahman, F., Saha, S. K. and Solaiman, A. R. (2010). Effects of different aged poultry litter on the yield and nutrient balance in Boro rice cultivation. Bangla. J. Agri. Res. 35(3): 497-505.

Humphrey, D.R., Cummings, S.P. and Andrews, M. (2001). Comparison and tentative identification of *Rhizobiaceae* isolated from nodules of lentil grown in New Zealand and the United Kingdom. *Aspects App Bio* 63: 101-20.

Jin, J., Koroleva, O. A., Gibson, T., Swanston, J., Magan, J., Zhang, Y., Rowland, I. R., Wagstaff, C. (2009). Analysis of phytochemical composition and chemoprotective capacity of rocket (Eruca sativa and Diplotaxis tenuifolia) leafy salad following cultivation in different environments. J. Agric. Food Chem., 57(12): 5227-5234.

Khalid, N., Arif, M., Shahl, P., Rab, A., Khan, M. and Khan, K. (2011). Effect of FYM, potassium and zinc on phenology and grain yield of wheat in rain fed cropping systems. Pak. J. Bot. 43(5): 2391-2396.

Kler, F., Sharma, C. R. and Sharma, J. (2007). Effect of rock phosphate enriched FYM on wheat (*Triticum aestivum* L.)-rice (*Oryza sativa* L.) cropping sequence in acid alfisol. Him. J. Agri, Res. 25: 13-18.

Liu, G. S., Luo, Z. B., Wang, Y., Li, H. L., Wang, G. F. and Ma, J. M. (2006). Effect of green manure application on soil properties and soil microbial biomass in tobacco field. *J. Soil Water Conserve.* 20: 95-98.

Lorry, J., Massey, R. and Joern, B.(2006). Using Manure as a Fertilizer for Crop production. http://www.epa.gov. Accessed on 20/02/2015.

Lupwayi, N.Z., Clayton,G.W., Harker,K.N., Turkington,T.K., Johnston,A.M.(2005). Impact of crop residue type on potassium release. Better Crops. 89:14–15.

Lupwayi, N.Z., Clayton, G.W., O'Donovan, J.T., Harker, K.N., Turkington ,T.K., Soon, Y.K.(2006a). Potassium release during decomposition of crop residues under conventional and zero tillage. Can. J. Soil Sci. 86:473–481.

Lupwayi, N.Z., Clayton, G.W., O'Donovan JT, Harker KN, Turkington TK, Soon YK. (2006b). Soil nutrient stratification and uptake by wheat after seven years of conventional and zero tillage in the Northern Grain belt of Canada. Can. J. Soil Sci. 86:767–778.

Mazzoncini, M. and Barberi, P. (2002). Lagestione della fertilila del suolo. *AZ Bio*, 10, 58-64.

Melero, S., Made jon, E., Ruiz, J. C. and Herencia, J.F. (2007). Chemical and biochemical properties of a clay soil under dry land agriculture system as affected by organic fertilization, *European J. of Agronomy*. 26**:** 327-334.

Othman J.; R. Zidan and N. Khalil (2011). The effect of green manure and biofertilizer on some soil properties and productivity and quality of potato (*Solanum tuberosum*.L). *J. of Damascus University, Agriculture Sci., Syria*, 27(1): 305-321.

Sarker, B.C. and Karmoker, J.L.(2009). Effects of phosphorus deficiency on the root growth of lentil seedlings (Lensculinaris Medik) grown in rhizobox. Bangladesh J. Bot. 38: 215-218.

Shahz, A. S. R. and Rahman, H. U. (2010). Soil microbial biomass and activities as influenced by green manure legumes and N fertilizer in rice-wheat system. *Pak. J. Bot.* 42**:** 2589-2598.

Singh, K.K., Srinivasarao, Ch. and Ali, M. (2005). Root growth, nodulation, grain yield, and phosphorous use efficiency of lentil as influenced by phosphorus, irrigation, and inoculation. Commun. Soil Sci. Plant Anal. 36: 1919-1929.

Skuodiene, R. and Nekrošiene, R. (2007). Impact of perennial legumes and timothy as greenmanure on productivity of *Secale cereale* L. and *x Triticosecale* Wittm and on occurrence of cereal diseases. *Agronomy Research* 5 (1), 59–71.

Smith VH (2003) Eutrophication of freshwater and coastal marine ecosystems: a global problem. Environ. Sci Pollut Res Int 10:126–139

Souza, C.M.; Pires, F.R.; Partelli, F.L.; Assis, R.L .; Adubação verde e rotação de culturas. (2012). Viçosa, MG: Ed. UFV, 108 p.

Talgre, L., lauringson, E., Roostalue, H., and Makke, A.(2014). Phosphorus and potassium release during decomposition of roots and shoots of green manure crops. J. Biolog. Agric. & Horti. 30:4.

Weil, R. R. and Magdoff, F. (2004). Significance of Soil Organic Matter to Soil Quality and Health. CRC Press, Boca Raton, FL, USA.

Yang Zeng-Ping, X. V., Ming-gang, Z. H., Jun, N., Ju-Sheng, G. and Yu-Lin, L., XI E, J. (2012). Effect of long-term winter planted green manure on physical properties of Reddish paddy soil under a double-rice cropping system. J. of Integrative Agric. 11(4): 655-664.

Yassen, A., Khaled, A., Sahar, S. M. and Zaghloul, M. (2010). Response of wheat to different rates and ratios of organic residues on yield and chemical composition under two types of soil. J. Amer. Sci. 6(12): 858-864.

Ziblim, I. A., Paul, G. S. and Timothy, K. A. (2013). Assessing soil amendment potentials of *Mucuna prriens* and *Crotalaria juncea* when used as fallow crops. J. Soil Sci. Environ. Manage. 4: 28-34.

تأثير التسميد الاخضر على تيسر وامتصاص الفوسفور و كفاءة استخدامه لمحصولي الشعير والذرة .

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يشير التسميد الأخضر إلى المحاصيل التي تُعمل على بناء خصوبة التربة والتي يمكن تعريفه على نطاق واسع بأعتبارها محاصيل تزرع لصالح التربة؛ فقد تم استخدامها في الزراعة التقليدية منذ آلاف السنين، ولكن لا يزال اليوم استخدامها محدودًا من قبل المزارعين؛ لذا أجريت تجربة حقلية بمحطة البحوث الزراعية بسخا - مصر لتقييم تأثير السماد الأخضر والسماد الفوسفاتى على بعض خواص التربة وكفاءة استخدام السماد الفوسفاتى وإنتاجية محصولي الشعير (الموسم الشتوي 2016- 2017) يعقبه محصول الذرة الشامية في الموسم الصيفي 2017؛ نفذت التجربة في تصميم القطع المنشقة مرة واحدة في ثلاث مكررات تمثلت معاملات السماد الأخضر في القطع الرئيسية (ثلاثة: كنترول بدون سماد اخضر والعدس و الجرجير كأسمدة خضراء) في حين تمثلت اربعة معدلات من السماد الفوسفاتى في القطع المنشقة (كنترول "بدون اضافة" ، 7,5 ، 11,25 و 15,5 كجم خامس أكسيد الفوسفور P2O5 / للفدان وتمثل 50، 75 و 100 % من الموصي به للشعير). أوضحت النتائج المتحصل عليها أن استخدام التسميد الأخضر كنباتات العدس والجرجير قبل زراعة الشعير أدى لتحسن كبير في خصائص التربة، وزيادة صلاحية وتيسر العناصر الغذائية (النيتروجين والفوسفور والبوتاسيوم) والمسامية الكلية؛ هذا وقد حقق التفاعل بين التسميد الأخضر (الجرجير) مع معدل السماد الفوسفاتى 15,5 كجم P 2O5 للفدان أعلى قيم للمحصول الكلى ودليل المحصول ووزن الحبوب والممتص من العناصر الغذائية النيتروجين والفوسفور والبوتاسيوم لكلا من الشعير والذرة؛ وكما ادى استخدام الجرجير كسماد أخضر مع السماد الفوسفاتى بمعدل 11,25 كجم P2O5 للفدان (تمثل 75 ٪ من الموصي به) الى تعظيم محصولي الشعير والذرة وكذلك زيادة كفاءة التسميد الفوسفاتي؛ ولذلك خلصت الدراسة إلى أهمية استخدام التسميد الأخضر لتحسين خصوبة التربة وخصائصها ورفع كفاءة استخدام السماد الفوسفاتي المعدني.