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Effect of Moringa Residues on Nutrients Availability and Wheat Production in Sandy and Calcareous Soils

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ABSTRACT

Using organic substances *i.e. Moringa oleifera* residues (MOR) as soil conditioners is an important management strategy that can improve and uplift soil-quality properties and alter the nutrient cycling through mineralization or immobilization. Two experiments were conducted to study the effect of MOR *i.e.* leaves (ML) and meal seed (MMS) at a rate of 5, 10 and 15 Mg ha^{-1} on soil pH, available N, P and K content during various incubation periods as well as yield and nutrient uptake of wheat *(Triticum aestivum* L cv., Sakha 93) plants grown on sandy and calcareous soils. Soil pH values decreased with increasing application rates of MOR at different periods in the two tested soils. Soil pH values were lower with addition of MMS residues treatment than with ML**.** The highest values of available N, P and K were found in the tested soils when treated with 15 Mg ha^{-1} of MMS followed by 15 Mg ha^{-1} of ML at different periods. While the lowest ones were obtained with untreated soils followed by 5 Mg ha^{-1} ML. Available N was showed a highest increase after 90 days of incubation for the sandy soil and after 120 days for calcareous soil under application of MOR**.** Available P and K contents were increased gradually up to 120 days and then decreased for the two soils. The highest values of yield, biological yield, 1000-grain weight, protein content, straw and grain yields as well as N, P and K uptake of wheat were found in the tested soils owing to treated with15 Mg ha^{-1} of MML followed by 15 Mg ha^{-1} of ML.

Keywords: Moringa Leaves, Moringa meal seed, Sandy and Calcareous Soils, Incubation Periods, Wheat.
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INTRODUCTION

Desertic soils in Egypt are mostly calcareous or sandy soils. These soils, generally, attended some problems, related to their physical properties, salinity and low potentiality for productivity. There are several means for solving their problems; one of them is the use of soil conditioners. Soil conditioning means improve the physical conditions of such soils by using small amounts of natural or artificial products to promote germination, increasing the water holding capacity and reducing evaporation from the surface of soil under arid conditions. However, minor attention was paid to the effect of conditioners on the statues of nutritive elements as well as the chemistry of their intergradient, during the improvement of the desert soils. Conditioning sandy and calcareous soils became a necessity to increase agricultural production and to overcome the deficiency in food requirements (Hassanien *et al.,* 2004 ; Telep, 2008; Baldi and Toselli, 2014 and Hueso-González *et al.,* 2014). Organic matter plays a prominent role in increasing soil fertility level, a source of humus and plant nutrients and sustaining the productivity of soils (Kumar *et al.,* 2011 and Rady *et al.,* 2016).

Moringa oleifera is a highly nutritive multipurpose plant growth for fresh vegetable, livestock fodder, green manure, biogas, medicine, bio pesticide and seed production (Fuglie, 2000 and Ejaz *et al.,* 2017). Different parts of this plant contains a profile of important nutients, amino acids, antioxidants , vitamins, carotene, phenolics and provide a rich and rare combination of zeatin with several flavonoid pigments (Siddhuraju and Becker, 2003 ; Anwar *et al* ., 2007 ; Jacob and Shenbagaraman, 2011; Merwad, 2015 a; Merwad, 2018 ; Desoky *et al.,* 2017 and Sodamade *et al.,* 2017). Moringa leaves sampled from various parts of the world were found to have zeatin concentration of between 5µg /g and 200 µg /g of leaves (El Awady, 2003 ; Merwad, 2015b and Ejaz *et al.,* 2017). FAO, (2010), suggested that using organic fertilizers derived from MMS processed can increase the density and richness of organisms, beneficial arthropods and earthworms as well as improve the biological properties of soil.

Modern organic agriculture builds on principles of improving soil fertility through incorporation of legumes and compost materials (Okoh, 2010 and Rady *et al.,* 2016). Organic farming based on using MMS as fertilizer on a maize farm achieved significant improvement on available nutrients in soil and increased the yield of maize. Emmanuel *et al*. (2011) found that MMS has great support for available nutrients, microbial growth, yield and certain nutrient *i.e.,* Mn, Cu, K and Ca compared to control plot. Davis *et al.* (2006) stated that addition of MOR as a green manure significantly improved soil fertility and plant growh. ML can serve as alternative source of soil organic matter and nutrients, or a replacement for inorganic fertilizers, with facilitating effect on soil pH and plant nutrients release for optimum production of garden egg, moringa leaves, at the rate of 20 Mg ha^{-1}, are a promising soil amendment for the remediation of soil acidity and for sustainable production of garden egg. (Undie *et al.,* 2013 and Merwad, 2015b). Adekiya *et al.,* 2017 found that addition of various green manures *i.e.,* pawpaw, neem leaves and moringa leaves increased soil organic matter, yield and nutrient accumulation of okra compared with the control. The aim of the present work is to study the change in soil pH, available N, P and K during various incubation periods as well as yield and nutrients uptake by wheat plants as affected by moringa *oleifera* residues , MOR (leaves and meal seed as ML and MMS,) added at different rates to sandy and calcareous soils.

MATERIALS AND METHODS

Two experiments were conducted to study the change in soil pH, available N, P and K during various incubation periods (0, 30, 60, 90, 120 and 150 days) at the first experiment and yield, N, P and K uptake of wheat plants at the second experiment as affected by different rates of *Moringa oleifera* residues, MOR (leaves and meal seed as ML and MMS, respectively) added to sandy and calcareous soils.

1- An incubation experiment

Two surface (0-30 cm) soil samples were collected from two different locations in Egypt to be used in this work. The first sample represents a sandy soil from El-Khattara region, Sharkia Governorate and the second sample representing a calcareous soil from El-Noubaria region at Northern part of Tahreer Province, Egypt. Soil samples were air dried, crushed, sieved through a 2 mm plastic screen, thoroughly mixed and stored in plastic bags for analysis and experimental work. The physical and chemical properties of the used soils are determined according to Piper, 1951; Black, 1968 and Jackson, 1973 and shown in Table 1. Portion of both soil samples, each weighing thousand -grams placed in small plastic containers. ML and MSS at a rate of 5, 10 and 10 Mega gram ha^{-1}(Mg ha^{-1}) were mixed thoroughly with soil samples. Some characteristics of MOR are shown in Table 2. Also, Ammonium sulphate (205 g N kg^{-1}) at a rate of 200 mg N kg^{-1} soil as N-source , ordinary super phosphate (65 g P kg^{-1}) at a rate of 10 mg P kg^{-1} soil as P-source and potassium sulphate (410 g K kg^{-1}) at a rate of 40 mg K kg^{-1} as K-source were added to the soil samples.

The experimental treatments were as follow:

- Without moringa residues (Control)
- 5 Mg ha^{-1} moringa leaves (ML)
- 10 Mg ha^{-1} , ML
- 15 Mg ha^{-1} , ML
- 5 Mg ha^{-1} moringa meal seed (MMS)
- 10 Mg ha^{-1} , MMS
- 15 Mg ha^{-1} , MMS

Treatments were replicated three times and containers were kept under laboratory condition in the Faculty of Agriculture, Zagazig University, Egypt. The soil moisture content was adjusted to be around 100% of field capacity through the experimental period. The plastic containers were covered through the experimental time and incubated at room temperature (±29 ˚C approximately). Soil samples were taken at intervals of 0, 30, 60, 90, 120 and 150 days of incubation where pH, available nitrogen, phosphorus and potassium were determined. Available nitrogen was determined using the method described by Cottenie *et al.,* (1982), 5 grams of each soil sample was shaken with 50 ml 2 N KCl solution and filtered then determined by stean-distillation procedure MgO-Devarda alloy using Micro-kjeldahl methods. Available phosphorus was determined using Watanabe and Olsen, (1965) method, 5 grams of soil sample being shaken with 50 ml 0.5 M $NaHCO_3$ solution (pH 8.5) with one gram activated charcoal for 0.5 hour and filtered then determined calorimetrically. Available potassium being extracted by 1 N NH_4OAC solution and assayed by flamephotometer (Jackson, 1973).

Table 1. Physical and chemical properties of the investigated soils

Soil characteristics	Soil location	
	El-Khattara	El-Noubaria
Soil particles distribution		
Sand ,%	91.50	62.18
Silt,%	6.05	19.78
Clay,%	2.45	18.04
Textural class	Sandy	Sandy loam
Field capacity (FC),%	9.42	20.98
$CaCO_3$, ,(gkg^{-1})	4.6	221
Organic matter,(gkg^{-1})	3.65	6.80
pH*	8.03	7.98
EC dSm^{-1}**	0.65	2.65
Available nutrient(mg kg^{-1})		
N	20.5	26.5
P	6.56	7.42
K	80.6	98.7

*** Soil-water suspension 1: 1**
**** Soil water extract 1: 1**

Table 2. Some characteristics of moringa residues

Moringa residues	Characteristics							
	EC**, dSm^{-1}	pH*	Organic matter, (gkg^{-1})	Total nutrients (gkg^{-1})			C/N ratio	WHC, %
				N	P	K		
Moringa Leaves	1.20	7.56	350	24.0	3.90	14.5	8.45	250
Moringa Meal Seed	0.99	7.45	453	35.0	26.5	18.6	7.50	209

***Manure-water suspension 1: 20 **Manure water extract 1: 20 WHC: Water holding capacity**

2- Biological experiments

A field experiment was conducted on a sandy soil from El-khttara region, Sharqia Government, Egypt and in a calcareous soil from El-Noubaria region at Northern part of Tahreer Province, Egypt during the growth season of 2014/2015 to study the effect of MOR (ML and MMS) added at different rates *i.e.,* 0, 5, 10 and 15 Mg ha^{-1} on yield and NPK–uptake by wheat plants (*Triticum aestivum* L cv., Sakha 93)**.**

The experimental design was a randomized complete block design in three replicates. The crop was planted in plots 3 ×3.5 m consisted of five rows which were 3 m long × 0.7 m width, giving an area of 10.5 m^2. ML and MMS were mixed and thoroughly incorporated in the soil one month before planting at a rate of 5, 10 and 15 Mg ha^{-1}. Nitrogen was added as ammonium sulfate (200 g N kg^{-1}) at the rate of 200 kg N ha^{-1} in three equal splits (after complete germination and after 45 and 60 days from the first dose). During the preparation of soil for cultivation, the recommended doses of P were added for all experimental plots as ordinary super phosphate (65 g P kg^{-1}) at the rate of 31 kg P ha^{-1} and K was added as potassium sulphate (410 g K kg^{-1}) at 100 kg K ha^{-1} in two equal splits, 30 and 45 days after planting in two tested soils.

At harvest, plant samples were separated into straw and grains, dried at 70 ˚C for 72 hours, weighed, digested and analyzed for total N, P and K as discribed by Chapman and Pratt (1961). Total phosphorus was determined calorimetrically using ascorbic acid method (Watanabe and Olsen, 1965). Protein content "yield quality" in grains was calculated by multi plying N-% × 6.25 (Bishni and Hughes, 1979).

Statistical analyses

Data of the current study were subjected to analysis of variance for a split-split bloks design, after testing for the homogeneity of error variances. Statistically significant differences between means were compared at $P \leq 0.05$ using Duncan's Multiple Range Test. The statistical analysis was carried out using

COSTAT computer software (CoHort Software version 6.303, Berkeley, CA, USA).

RESULTS AND DISCUSSION

Soil pH

Data in Fig.1 demonstrate the effect of addition various MOR on soil pH in sandy and calcareous soils during incubation periods. Soil pH values slightly reduced with increasing application rates of MOR at different periods in the two tested soils. These results could be attributed due to the higher content of organic acids in high rate (15 Mg ha^{-1}) of residues and production of CO_2 during decomposition of incorporated MOR Kolawole *et al.,* (2013). Soil pH values in the studied soils were lower with MMS treatment than with ML at different rates. This result is in a good harmony with those obtained by Undie *et al.,* (2013) and Wang *et al.,* (2017). Salahin *et al.* (2013) found that the application of green manure in soils decreased soil pH.

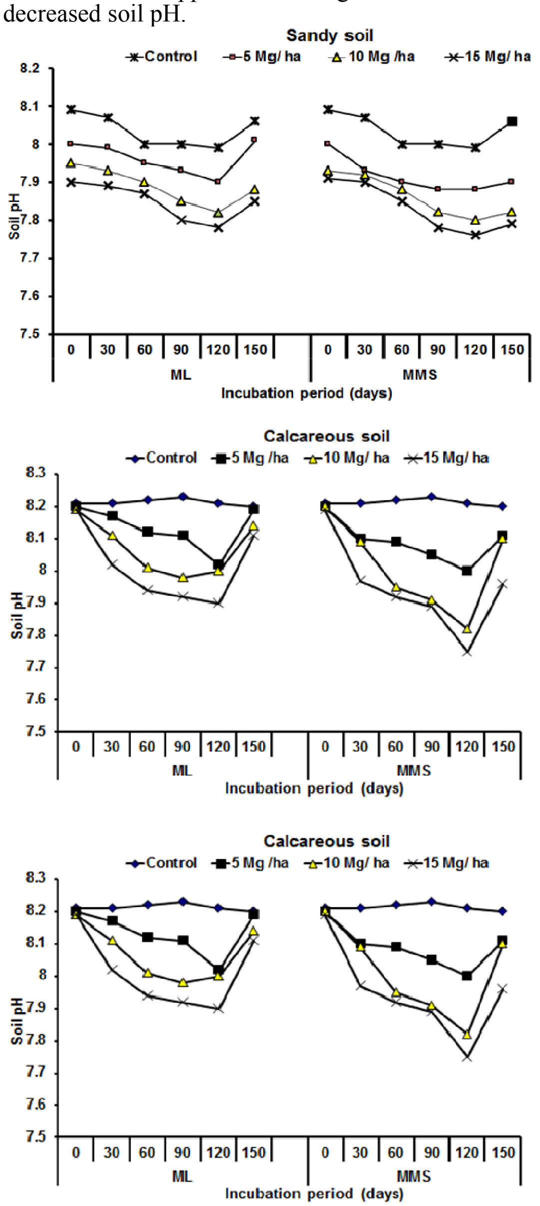

Fig.1. Soil pH as influenced by moringa residues during incubation periods in different soils.

As for incubation periods, data illustrated that soil pH values were decreased in the two soils under study for all treatments up to 120 days for incubation and then slightly increased. The ability of organic manure to decrease soil pH can be attributed to the enrichment of the soil through mineralization of cations particularly Ca and the buffering reserves of acidity in soils and nitrification of accumulated N as well as microbial processes of decarboxylation of organic acid during manure decomposition (Natschner and Schwartzman 1991, Naramibuye and Haynes 2006 and Wang *et al.,* 2017.).

Available nitrogen

Data revealed that highest values of available N in the treated sandy and calcareous soils with MOR (Fig. 2) were found with addition of 15 Mg ha^{-1} of MMS followed by 15 Mg ha^{-1} of ML after 90 days of incubation at sandy soil and 120 days at calcareous soil. While the lowest ones were obtained with untreated soils for the two types of MOR. The general average of available nitrogen in sandy soil with MMS at rates of 0,5,10 and 15 Mg ha^{-1}, over the different incubation periods ranged from (36.8 to 47.6), (38.5 to 53.2), (39.6 to 60.7), and (41.2 to 65.3) with an average of 42.7, 46.7,49.4 and 52.9 mg N kg^{-1}, respectively under the application of ML. The corresponding ranges under application of MMS ranged from (36.8 to 47.6), (39.6 to 60.2), (40.2 to 62.3), and (41.6 to 72.3) with an average of 43.5, 49.5, 51.7 and 55.3 mg N kg^{-1}, respectively. The corresponding ranges in a calcareous soil were (50.9 to 55.3), (52.6 to 66.3), (57.2 to 70.1) and (58.4 to 76.3) with an average 53.1, 60.3, 64.0, and 68.3 mg N kg^{-1}, respectively under application of ML. The corresponding ranges under application of MMS ranged from (50.9 to 55.3), (55.3 to 70.3), (60.2 to 74.0), and (60.29 to 82.1) with an average of 53.1, 62.5, 66.3 and 70.8 mg N kg^{-1}, respectively. Such results show that available nitrogen contents was greater in calcareous soil than in sandy soil. This result could be due to the great native content of available nitrogen in calcareous soil (Table 1).

As for application rates of moringa, results show that the average values of available nitrogen increased with the increasing application rates of MOR at different periods in sandy and calcareous soils .These results could be attributed due to the higher content of total nitrogen in high rate (15 Mg ha^{-1}) of residues. Moringa has been reported to possess wide adaptations and high nutrients composition in its biomass (Bosch, 2004 ; Merwad, 2015b , Merwad, 2017 Rady *et al.,* 2015 ; Adekiya *et al.* , 2017 ; Desoky *et al.,* 2017 ; Wang *et al.*, 2017 and Oladeji *et al.,* 2017.

As for incubation periods, results reveal that available nitrogen increased up to 90 days from incubation and then decreased in sandy soil, while in calcareous soil, the values were decreased at 90 days and then increased again up to 120 days from incubation . This trend was found true for MMS and ML residues. This may be due to the mineralization of organic residues and solubilizing action of certain organic acids produced during manure decomposition. This result is in a good agreement with those obtained by Merwad (2009); Azeez and Van Averbeke (2012) and Kolawole *et al.* (2013).

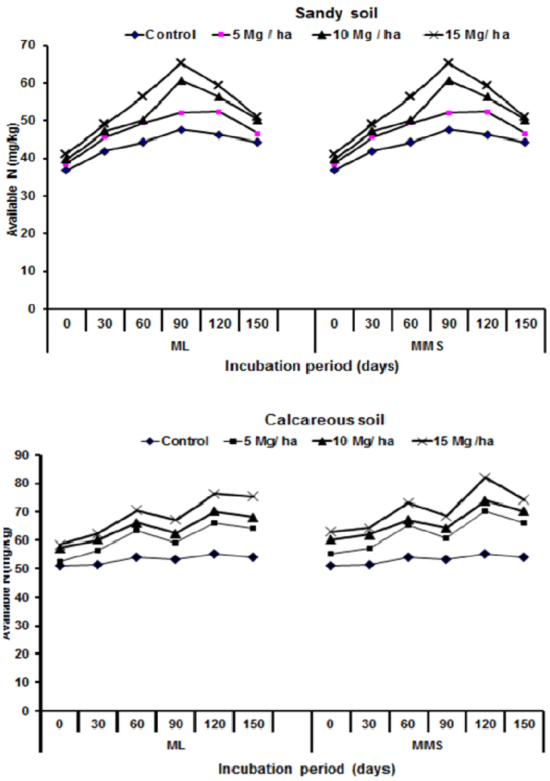

Fig. 2. Available nitrogen (mg kg^{-1}) in different soils as influenced by moringa residues during incubation periods.

In general, the values of available nitrogen in the studied soils were higher with MMS treatments than with ML .These results may be due to one or all the four of the following possibilities: a) The release of amino acids and other organic acids in MMS treatments. This finding is in agreement with that obtained by Kolawole *et al.,* (2013) and Sodamade *et al.,* (2017). b) The decomposition rate of MMS was faster than that of ML due to C/N ratio in MMS was lower than that in ML (Table 2) as reported by Roy and Abul Kashem (2014) and Sodamade *et al.,* (2017). c) The total nitrogen content in MMS residuse was greater than in ML (Table 2). This result is in agreement with that obtained by Basyouny (2001). d) The accumulated carbon dioxide values from MMS than ML as reported by Salem *et al.,* (2004) as well as the solubilizing action of certain organic acids produce during manure decomposition. This finding agreed with that obtained by Vel Murugan and Swarnam, (2013) ; Rady *et al.,* (2015) ; Rady *et al.,* (2016) and Adekiya *et al.,* (2017).

Available phosphorus

Data illustrated in Fig. 3 demonstrate the effect of applied various MOR on available P in the tested soils during incubation periods. The highest values of available phosphorus were found in the two soils when treated with 15 Mg ha^{-1} of MMS followed by 15 Mg ha^{-1} of ML up to 120 days and then followed by 10 Mg ha^{-1}. The lowest values were obtained in different untreated soils with MOR. These results could be attributed due to the higher content of total phosphorus in high rate (15 Mg ha^{-1}) of MOR. The favourabe effect of organic materials (MMS and ML) may be to the positive effect of these materials on soil reaction and increasing the available moisture content and hence increasing the availability of P in the soil solution and it increases microbial population and P immobilization. This finding agreed with those obtained by Rady *et al.* (2015) ; Sinegani and Mahohi (2009) ; Adekiya *et al.* (2017) and Merwad, (2017).

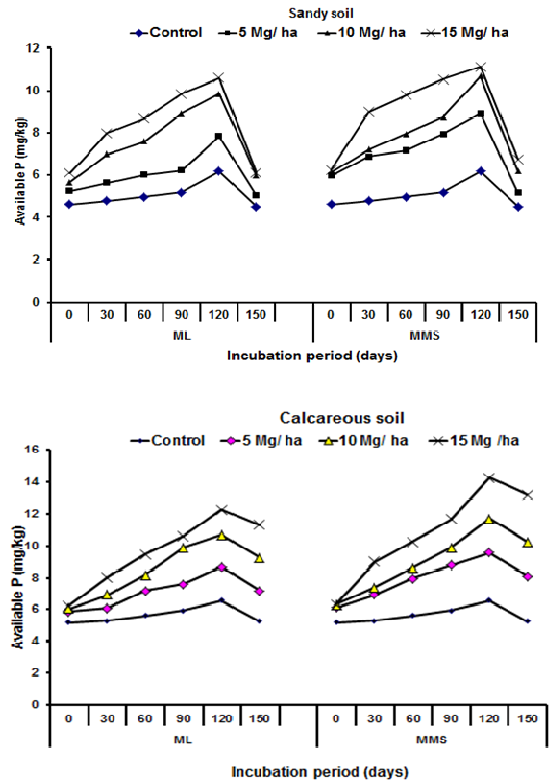

Fig.3. Available phosphorus (mg kg^{-1}) in different soils as influenced by moringa residues during incubation periods.

The MSM was superior to ML. As for incubation periods, data reveal that available P values were increased gradually up to 120 days of incubation and then decreased for the two soils under study and the increasing values were greater with MMS than ML residues. The increase in available P content after 90 and 120 days in the tested soils may be due the microbial activity which has ability to affect soil pH in the soil microenvironment leading to solubilizing mineral P. This finding is in agreement with that obtained by Merwad *et al.* (2013). The decrease in available P level after 150 days in tested soils may be attributed to assimilation by microorganisms. This finding agreed with those obtained by Sinegani and Mahohi, (2009) who reported that the addition of sewage sludge increased available P in calcareous soil after 60 and 90 days of incubation.

Comparing the values of available P in sandy and calcareous soils, data presented in Fig. 4 show that the available P were higher in the calcareous soil than in sandy soil, in all periods. These results may be attributed to the rate of organic breakdown as well as the effect of soil pH as reported by Roy and Abul Kashem, (2014) ; Kolawole *et al.,* (2013); Kekong *et al.,* (2016) and Adekiya, (2017).

Available potassium

Data presented in Fig. 4 show the available K released in the tested soils after incubation period of 150 days. After all periods, available K values were the highest with 15 Mg ha^{-1} of MMS followed by 15 Mg ha^{-1} of ML except, after 30 and 60 days of incubation in sandy soil. While the lowest one were obtained with untreated soils followed by 5 Mg ha^{-1}ML. The average values of available K increased with increasing application rates of MOR at different periods in the tested soils. These results could be attributed due to the higher content of total K in high rate (15Mg ha^{-1}) of MOR. This finding is in agreement with that obtained by (Rady *et al.,* 2015 ; Merwad (2017) ; Merwad (2018) ; Kekong *et al.* (2016); Rady *et al.,* (2016) ; Adekiya *et al.* (2017) ; Sodamade *et al.* (2017) and Oladeji *et al.* (2017). Emmanuel *et al.,* (2011) showed that MMS increased the mineral content *i.e.,* N, P, K, Ca, Mg, Fe, Mn, Cu and Zn of the soil.

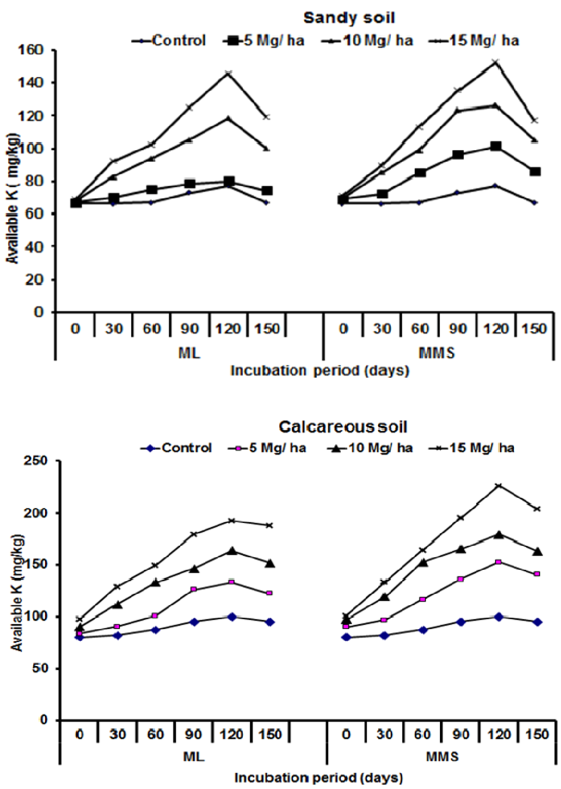

Fig.4. Available potassium (mg kg^{-1}) in different soils as influenced by moringa residues during incubation periods.

As for incubation periods, data show that available-K was increased gradually up to 120 days and then decreased for the tested soils and two types of residues. Nwoko and Ogunyemi (2009) found that available N, P and K significantly increased in palm oil mill effluent amended soil, especially at 40 and 60 days incubation periods.

Comparing the values of available K in sandy and calcareous soils, data presented in Fig. 4 show that the available K were higher in the calcareous soil than in sandy soil, in all periods. This finding agreed with those obtained by Najafi-Ghiri (2014).

Relationship between soil pH and available N, P and K

Data illustrated in Fig. 5 show the relation between soil pH and available N, P and K (mg kg^{-1}) in the tested soils during incubation periods. Available N, P and K values in tested soils increased with the decreasing soil pH. Overall, there was a positive relationship between pH and available N, P and K (mg kg^{-1}) in different soils. The correlation coefficient (r) values between pH and available N, P and K were 0.61, 0.67 and 0.79 in sandy soil and 0.76, 0.76 and 0.74 in calcareous soil, respectively Merwad (2017). Roy and Abul Kashem (2014) reported that the values of NH_4^+-N in tested soils increased with the decreasing soil pH. Merwad, (2017) found that the application of humic and fluvic acids to saline soils decreased soil pH and increased available N, P and K.

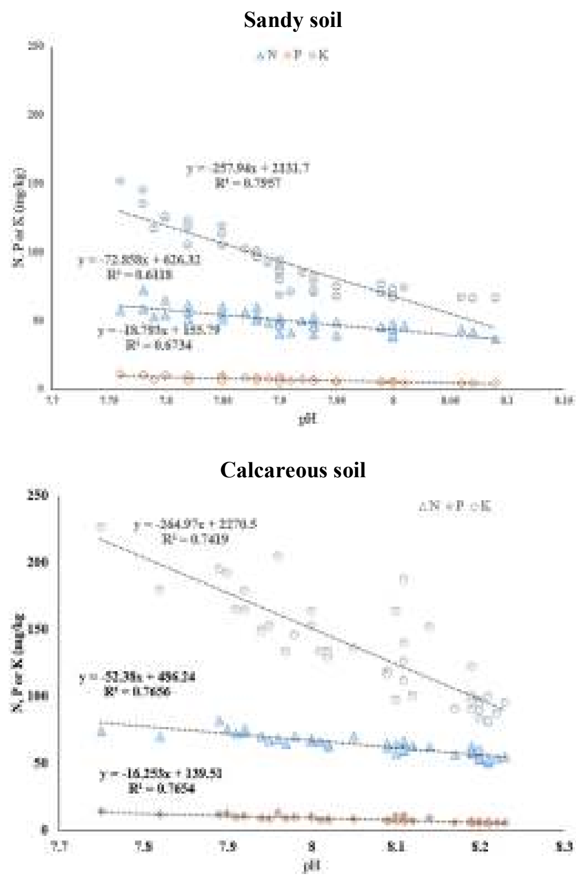

Fig. 5. Relationship between pH and available N, P and K in sandy and calcareous soils as influenced by moringa residues during incubation periods.

Yield and protein content of wheat as affected by moringa residues in sandy and calcareous soils.

Data in Table 3 show that there were significant differences between treatments in increasing values of straw, grain yield, biological yield, weight of 1000 grain and protein content of wheat plants in both soils. Highest values of the all aforesaid parameters were obtained with 15 Mg ha^{-1} of MMS application under sandy and calcareous soils. They surpassed those of the corresponding untreated controls by 61.3, 72.5, 65.8, 36.4 and 61.2%, respectively for sandy soil and 60.6, 73.3, 65.9, 32.9 and 62.2%, respectively for calcareous soil. Comparing the values of straw and grain yield as well as protein content in sandy and calcareous soils, data presented in Table 3 show that these parameters were higher in the calcareous soil than in sandy one. This finding agreed with those obtained by Rady *et al.* (2015); Adekiya *et al.* (2017); Desoky *et al.* (2017); Ejaz *et al.* (2017) and Oladeji *et al.* (2017). Undie *et al.,*(2013) found that application of ML at 20 Mg ha^{-1} produced highest amount of plant dry matter, number of fruits per plant and fruit yield of garden egg plants.

Table 3. Yield and protein content of wheat as affected by moringa residues in sandy and calcareous soils.

Treatment		Sandy soil					Calcareous soil				
		Mg ha^{-1}			Weight of 1000 grain (g)	Protein (g kg^{-1})	Mg ha^{-1}			Weight of 1000 grain (g)	Protein (g kg^{-1})
		Straw	Grains	Biological yield			Straw	Grains	Biological yield		
Control		6.12	4.15	10.27	38.21	82.5	6.35	4.53	10.88	39.87	91.25
Sources of residues effect [a]											
ML		8.18b	6.12b	14.30b	47.37b	111b	8.61b	6.39b	14.99b	48.41b	115b
MMS		8.66a	6.46a	15.12a	48.47a	119a	9.30a	6.84a	16.14a	49.47a	124a
Rate of moringa residues effect [b]											
5		7.31c	5.43c	12.74c	44.76c	106c	7.74c	5.68c	13.42c	45.52c	105c
10		8.31b	6.35b	14.66b	47.84b	113b	9.14b	6.48b	15.61b	48.90b	117b
15		9.65a	7.09a	16.74a	51.17a	126a	9.98a	7.70a	17.68a	52.41a	137a
Interaction effect [a*b]											
	5	6.98c	5.20cd	12.18c	44.35d	103d	7.25d	5.52d	12.77d	45.14d	104d
ML	10	8.15ab	6.13b	14.28b	47.52c	111c	8.81c	6.10c	14.91cd	48.23b	116cd
	15	9.42a	7.02ab	16.44ab	50.23b	118ab	9.76b	7.54b	17.3b	51.87ab	126b
	5	7.64c	5.65c	13.29c	45.16d	109cd	8.23d	5.83d	14.06d	45.89c	106d
MMS	10	8.46b	6.57b	15.03b	48.15bc	114b	9.46bc	6.85bc	16.31c	49.56b	118c
	15	9.87a	7.16a	17.03a	52.10a	133a	10.2a	7.85a	18.05a	52.95a	147a

Note: [a] Sources of residues effect, [b] Rate of moringa residues effect, ML: Moringa leaves, MMS: Moringa meal seed.

Response of straw and grain nutrients uptake of wheat to moringa residues under sandy and calcareous soils

Data in Table 4 exhibit that there were significant differences between treatments in increasing values of straw and grains nutrient uptake (*i.e.,* N, P and K) in both soils. Highest values of NPK uptake were obtained when plants treated with 15 Mg ha^{-1} of MMS application for straw and grain and was found true for the two soil under study. They exceeded the corresponding untreated controls by 169, 290 and 143%, respectively for straw and 177, 360 and 137%, respectively for grains. As for calcareous soil, the increases over the control treatment were 164, 277 and 143%, respectively for straw and 178, 267 and 144%, respectively for grains. This finding agreed with those obtained by Rady *et al.* (2015); Kekong *et al.* (2016); Adekiya *et al.* (2017); Desoky *et al.* (2017) ; Ejaz *et al.,* (2017); Merwad, (2017) and Sodamade *et al.* (2017). Values of yield, N,P and K uptake in the studied soils were higher with MMS treatments than with ML**.** Using domestic wastes from agricultural has been found to improve available nutrients in the soil, increase crop yields and activities of soil microorganisms due to amelioration of soil pH (Kolawole *et al.,* 2013 and Rady *et al.,* 2016). Moringa has been reported to possess wide adaptations and high nutrients composition in its biomass (Bosch, 2004). Adekiya *et al.,* 2017 stated that applied of MOR increased yield and nutrient accumulation *i.e.,* N,P, K, Ca, and Mg uptake of okra compared to untreated soils.

Table 4. Straw and grain N, P and K-uptake (kg ha^{-1}) of wheat as affected by moringa residues in sandy and calcareous soils

Factor of study		Sandy soil						Calcareous soil					
		Straw			Grain			Straw			Grain		
		N	P	K	N	P	K	N	P	K	N	P	K
Control		74.05	11.63	75.28	54.78	8.72	57.69	84.46	12.70	79.38	66.14	11.33	63.42
Sources of residues effect [a]													
ML		142	32.21b	133b	109b	25.94b	103b	158b	35.41b	150b	119b	29.23b	113b
MMS		159a	36.14a	146a	124a	30.16a	114a	180a	39.77a	167a	137a	33.58a	126a
Rate of moringa residues effect [b]													
5		117c	24.57c	107c	92.34c	19.57c	85.05c	131c	27.45c	127c	96.20c	24.16c	96.2c
10		146b	34.07b	135b	114b	27.33b	109b	166b	38.90b	162b	121b	30.77b	115b
15		188a	43.89a	176a	142a	37.25a	132a	208a	46.42a	187a	168a	39.28a	147a
Interaction effect [a*b]													
	5	109cd	21.64d	99.12d	85.80d	17.68de	79.04d	122de	26.10de	116d	93.29de	22.08d	93.29de
ML	10	140bc	32.60b	130c	109c	25.75cd	103cd	158cd	35.24cd	154bc	113cd	28.67bc	107c
	15	178a	42.39a	169b	133b	34.40b	127ab	193b	44.90b	181a	152b	36.95a	140b
	5	126c	27.50c	115d	98.88cd	21.47d	90.97c	141d	28.81d	138c	99.11d	26.24c	99.11d
MMS	10	153b	35.53b	140bc	120bc	28.91c	115b	175bc	42.57bc	170b	129c	32.88b	123bc
	15	199a	45.40a	183a	152a	40.10a	137a	223a	47.94a	193a	184a	41.61a	155a

See footnote Table 3

CONCLUSION

Organic farming based on using *Moringa oleifera* residues as fertilizer on crops farm achieved significant improvement on available nutrients in soil and increased the yield of crops. The highest values of available N, P and K were found in the tested soils when treated with 15 Mg ha^{-1} of MMS followed by 15 Mg ha^{-1} of ML at different periods. The highest values of yield, biological yield, 1000-grain weight, protein content, straw and grain yields as well as N, P and K uptake of wheat were found in the tested soils owing to treated with15 Mg ha^{-1} of MML followed by 15 Mg ha^{-1} of ML.

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تأثير مخلفات المورينجا على تيسر العناصرالغذائية وانتاجية القمح فى الأراضى الرملية والجيرية

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إن استخدام المواد العضوية مثل بقايا المورينجا أوليفيرا كمحسنات للتربة هى استراتيجية إدارة مهمة يمكن أن تحسن من خصائص وجودة التربة وينعكس ذلك على دورة العناصر الغذائية من خلال عمليتى المعدنة والتقيد. وقد أجريت تجربتان لدراسة تأثير مخلفات المورينجا أوليفيرا مثل أوراق وتفلة بذور المورينجا بمعدل 5، 10، 15 طن /هكتار على درجة حموضة التربة ، ومحتوى التربة من النتيروجين والفوسفور والبوتاسيوم الميسر خلال فترات تحضين مختلفة وكذلك محصول القمح وامتصاص العناصر الغذائية فى الأراضى الرملية والجيرية. انخفضت قيم الرقم الهيدروجيني للتربة مع زيادة معدلات مخلفات المورينجا خلال فترات التحضين المختلفة فى الاراضى تحت الدراسة. أدت إضافة تفلة بذور المورينجا لإنخفاض قيم الرقم الهيدروجيني للتربة مقارنة باضافة أوراق المورينجا. وجدت أعلى قيم للنيتروجين والفوسفور والبوتاسيوم الميسر فى الاراضى تحت الدراسة عند إضافة 15 طن/هكتار تفلة بذور مورينجا يليها 15 طن/هكتار أوراق مورينجا خلال فترات التحضين المختلفة ، فى حين وجدت أقل القيم فى الأراضى غير المعاملة ويليها عند اضافة 5 طن/هكتار اوراق مورينجا. زاد النيتروجين الميسر بعد 90 يوم من التحضين فى الأرض الرملية وبعد 120 يوم من التحضين فى الأرض الجيرية عند إضافة مخلفات المورينجا. لوحظ زيادة فى الفوسفور والبوتاسيوم الميسر تدريجيا حتى 120 يوم ثم انخفضت فى كلا الأرضين. وجدت أعلى قيم لمحصول القش والحبوب والمحصول البيولوجى ووزن 1000 حبة ونسبة البروتين والنيتروجين والفوسفور والبوتاسيوم الممتص بواسطة القمح عند إضافة 15 طن/هكتار تفلة بذور المورينجا يليها 15 طن/هكتار أوراق مورينجا فى كلا الأرضين تحت الدراسة.