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Influence of sowing date and organic fertilizers on productivity of *Moringa oleifera* plant under Aswan governorate conditions, Egypt

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Abstract

An experiment field were carried out in Aswan governorate, Egypt, during the two consecutive of seasons 20.17 and 2018 to evaluate the effect of organic fertilization and sowing date on: plant vegetation, yield and leaves chemical constituents of moringa plant. The organic fertilizers were farmyard manure (FYM), compost (COM) and poultry manure (PM). The results showed that, generally, organic fertilization improved growth characters, yield as well as N, P and K percentages in leaves. Whereas, the highest N, P and K contents leave were recorded when poultry manure added at 10 m^3 /feddan rate (feddan = 4200 m² = 0.420 hectares = 1.037 acres).

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Keywords: moringa, sowing date, organic fertilizers, farmyard manure, compost, poultry manure.

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1. Introduction

Moringa oleifera is a fast-growing tree which belongs to the moringaceae family. It is one of the most importance traditional multipurpose food plants that is produced and used in many African countries (Amaglo *et al.*, 2007). Moringa has a great potential to become one of the most economically important crops for the tropics and subtropics considering its use in many fields as a medicine (Peixoto *et al.*, 2011), food (Pontual *et al.*, 2012) and fodder plant. The demand for the plant products has been on ascendancy. However, not much work has been done on its cultivation especially in the various ecological zones. Organic fertilization deficiency limits the protections of many crops especially grain legumes in many soils. The application of farmyard manure to soil markedly increases plant growth availability of nutrients in soil and nutrients uptake by plants. Using the organic fertilizers to improved soil quality and fertility dates back to thousands of years ago. Greeks and Romans applied animal manure and human sewage to soil. At that time, they also knew that wheat took advantages if grown on fields previously cultivated with leguminous plants (Goss *et al.*, 2013). Different materials, such as seashells, vegetable waste, farmyard manure and other waste products were already utilized to enhance crop growth. Nowadays the most common soil organic fertilizers are compost and animal manure and plant residues (Scotti *et al.*, 2015). Both inorganic and organic substances can be added into the soil as soil amendments. Organic substances consist of material derived from living things (e.g. plants), whereas inorganic substances are mined or man-made (Bernal *et al.*, 2009). Moringa can grow well under tropical and subtropical areas; however, fertilization needs to be investigated under the Egyptian conditions. This work aimed to investigate the response of *Moringa oleifera* to sowing date and some source organic fertilization on growth, yield and chemical constituents under upper Egypt conditions.

2. Materials and methods

An experiment was carried out in a private farm in Aswan governorate, Egypt, during the two consecutive seasons (2017 and 2018) to study the influence of sowing date and source organic fertilizer on growth, yield parameters and chemical constituents of moringa plants under upper Egypt conditions. The organic fertilizers were Farmyard manure (FYM), compost (COM) and poultry manure (PM). The experimental plot was 2.0 × 3.0 m having 5 rows at 60 cm apart with 25 cm hills distances in the row (40 plants/ plot). The approximate plant population was 24000 plants per feddan (4200 m^2). The experiment was split plot design with three replicates. Moringa plants were sown three time on 1st April, 15th April and 1st May of the two seasons. Chemical and physical analyses of soil were carried out according to Page *et al.* (1982) and Klute (1986). Some physical and chemical properties of the field experiment are presented in Table (1).

Some chemical properties of used Farmyard manure and compost are shown in Table (2). Different levels of farmyard manure (15 (FYM_{15}) and 30 (FYM_{30}) m^3 /feddan) (feddan = 4200 m² = 0.420 hectares = 1.037 acres), compost (10 (COM_{10}) and 20 (COM_{20}) m^3 /feddan) and poultry manure (5 (PM_5) and 10 (PM_{10}) m^3/feddan) were mixed well with surface soil layes (25 cm) of the experimental farm. The following data were recorded at harvest stages for the three cuts. The first after two months of sowing date and next cut after first. Vegetative plant samples of moringa were randomly taken from each plot by cutting the plants 10-cm above the soil surface. The plant samples were freshly weighed and then air dried until constant dry weight. Some morphological parameters were measured (plant height, branches No./plant as well as fresh and dry leaves yield as kg per feddan. Half gram of leaves plant was digested in 10 ml of H_2SO_4 and 2 ml perchloric acid in a conical flask as described by Chapman and Pratt (1961). The digests samples were distilled using determined nitrogen (N), phosphorus (P) and potassium (K) percentages in the dry leaves were determined as follows: N was determined according to the modified micro Kjeldahel method as described by Wildy *et al.* (1985), P was estimated colorimetrically according to the method of Chapman and Pratt (1975) and K was determined by Flame-photometer according to Cottenie *et al.* (1982).

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

Soil parameter	Unit	Values	Soil parameter	Unit	Values
Sand	(g/kg)	536.1	O.M	(g/kg)	15.1
Silt	(g/kg)	221.9	Total-N	(g/kg)	0. 9
Clay	(g/kg)	242.0	Total-P	(g/kg)	0.8
Texture grade	----	Sandy Clay Loam	Total-K	(g/kg)	0.1
pH (1:2.5)	-----	7.81	Ava-P	(mg/kg)	13.50
EC (1:2.5)	(dS/m)	1.321	Ava-K	(mg/kg)	129.51

Table (2): Some chemical characteristics of the studied organic fertilization.

Property	Unit	Farmyard manure	Compost	Poultry Manure
pH (1: 2.5)	---	6.92	7.85	6.78
EC (1:2.5)	(dS/m)	1.69	2.88	2.96
OM	(%)	35.80	37.95	55.51
N	(%)	2. 27	2.22	2.88
P	(%)	1.29	1.33	1.65
K	(%)	0.95	1.83	3.80

3. Results

3.1 Effect of sowing date and some source organic fertilizers on vegetative growth moringa

Data presented in Figure (1) and Table (3) show that plant height and number of branches /plant were significantly increased in both seasons due to sowing date and some source organic fertilizers on vegetative growth. It is clear that the use of organic fertilizers at all levels led to a significant increment in plant height among all cuts at the two seasons as compared to control in most cases. Sowing date at 1st April, compared with organic fertilizers treatment FYM_{15}, FYM_{30}, COM_{10}, COM_{20}, PM_5 and PM_{10} increased plant height by 7.0, 12.6, 12.3,18.6, 17.5 and 26.7% in the first cut, by 3.6, 9.6, 8.3,13.5, 15.5 and 24.1% in the second cut and by 3.5, 8.0, 9.3, 13.5,17.3 and 26.9% in the third cut over untreated ones in first season, respectively.

Table (3): The influence of sowing date and some source organic fertilization on number of branches of morinaga plants during the seasons of 2017and 2018.

Fertilizer (B)	Sowing date (A)							
	1st time 1/4	2nd time 15/4	3th time 1/5	Mean	1st time 1/4	2nd time 15/4	3th time 1/5	Mean
	First cut							
	First season				Second season			
Control	4.3	4.7	4.0	4.3	4.7	4.8	5.0	4.8
Farmyard manure 15 m^3 /feddan	5.0	5.0	4.7	4.9	5.0	5.2	5.0	5.1
Farmyard manure 30 m^3 /feddan	6.3	6.7	6.3	6.4	6.3	8.0	7.3	7.2
Compost 10 m^3 /feddan	5.0	5.0	4.7	4.9	5.0	5.3	5.0	5.1
Compost 20 m^3 /feddan	5.7	6.3	6.0	6.0	6.3	7.3	6.3	6.6
poultry manure 5 m^3 /feddan	5.0	5.7	5.7	5.5	6.3	6.3	6.7	6.4
poultry manure 10 m^3 /feddan	7.0	5.7	6.3	6.3	7.7	6.3	8.3	7.4
Mean	5.5	5.6	5.4	5.5	5.9	6.2	6.2	6.1
L.S.D. for 5%	A: NS B: 0.762 A*B: NS				A:0.507 B: 0.775 A*B:NS			
	Second cut							
Control	5.8	6.0	5.0	5.6	5.7	6.0	5.8	5.8
Farmyard manure 15 m^3 /feddan	6.2	6.7	6.0	6.3	5.7	6.7	6.2	6.2
Farmyard manure 30 m^3 /feddan	8.3	9.3	9.0	8.9	8.7	10.0	9.0	9.2
Compost 10 m^3 /feddan	6.0	6.0	5.7	5.9	6.7	6.0	6.0	6.2
Compost 20 m^3 /feddan	8.0	8.3	7.7	8.0	8.3	9.0	8.7	8.7
poultry manure 5 m^3 /feddan	6.7	7.7	7.7	7.4	8.0	8.0	8.7	8.2
poultry manure 10 m^3 /feddan	11.0	7.3	11.0	9.8	11.0	7.7	11.7	10.1
Mean	7.4	7.3	7.4	7.4	7.7	7.6	8.0	7.8
L.S.D. for 5%	1. A: 0.575 B: 0.878 A*B:NS				2. A:0.528 B: 0.806 A*B:NS			
	Third cut							
Control	7.0	7.0	6.0	6.7	7.2	7.3	7.2	7.2
Farmyard manure 15 m^3 /feddan	7.3	7.7	7.3	7.4	7.5	7.5	7.6	7.5
Farmyard manure 30 m^3 /feddan	9.0	10.0	10.0	9.7	9.3	11.3	10.3	10.3
Compost 10 m^3 /feddan	7.3	7.7	7.0	7.3	7.3	7.0	7.0	7.1
Compost 20 m^3 /feddan	8.7	9.7	8.3	8.9	9.3	10.0	9.3	9.5
poultry manure 5 m^3 /feddan	7.7	8.3	8.3	8.1	8.7	9.3	9.7	9.2
poultry manure 10 m^3 /feddan	12.3	8.3	12.3	11.0	11.7	8.7	12.0	10.8
Mean	8.5	8.4	8.5	8.4	8.7	8.7	9.0	8.8
L.S.D. for 5%	A:0.519 B: 0.793 A*B:NS				A:0.403 B:0.616 A*B:1.067			

While, organic fertilizers treatment FYM_{15}, FYM_{30}, COM_{10}, CO_{20}, PM_5 and PM_{10} increased plant height by 6.9, 10.4, 10.8,14.9, 17.4 and 27.1% in the first cut, by 4.3, 9.5, 8.9,12.5, 13.5 and 24.3% in the second cut and by 5.9, 11.1, 9.8, 14.0,18.9 and 26.1% in the third cut over untreated ones in second season.

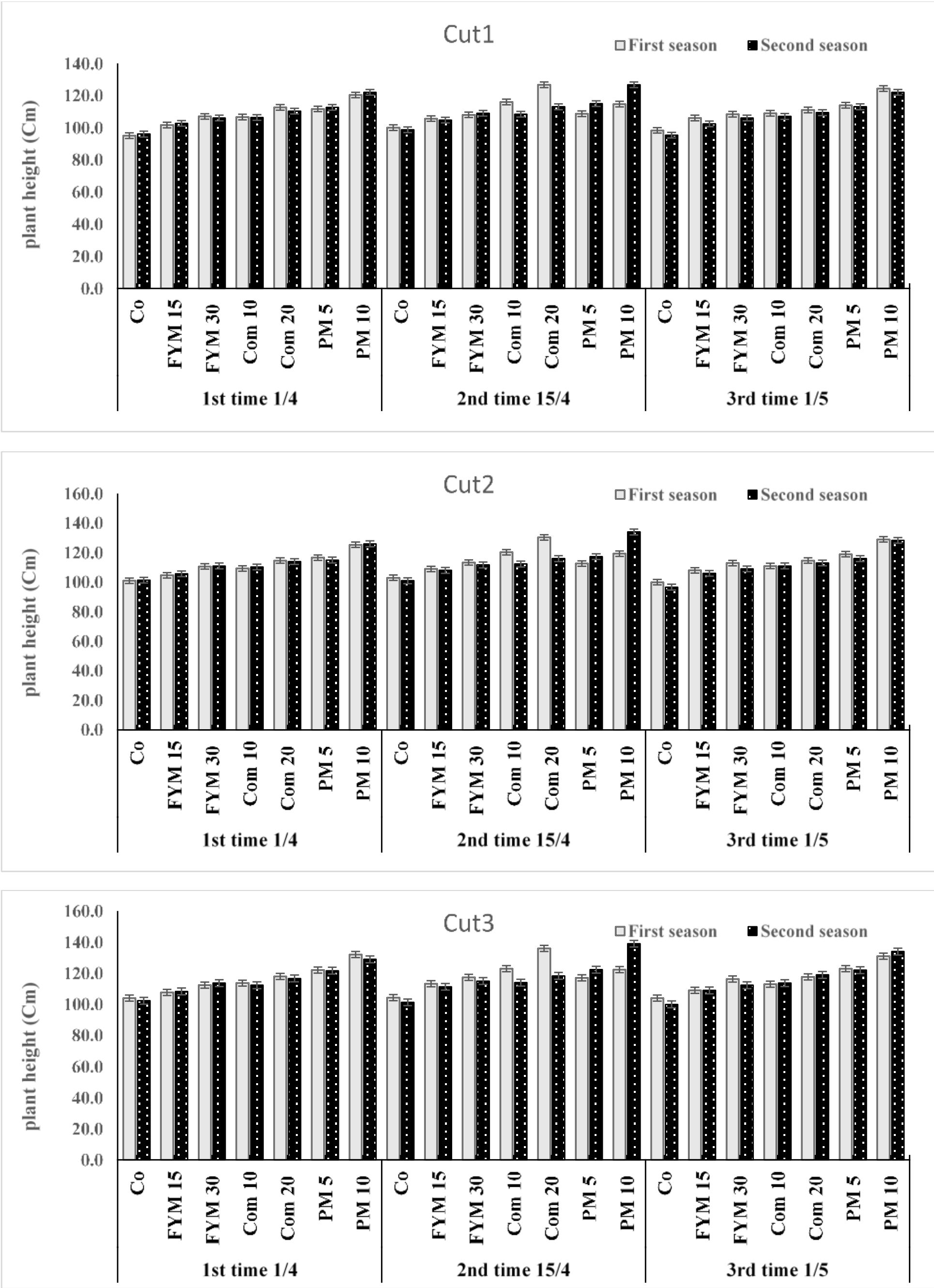

Figure (1): The influence of sowing date and some source organic fertilization on plant height (cm) of morinaga plants during the seasons of 2017and 2018.

It is clear that the sowing date led to a significant increment in plant height among all cuts at the two seasons as compared to control. In most cases, the highest value of the plant height was observed of after the harvest of plants with applying PM_{10} (139.0 cm) for third cut and 1st May in second season, and Com_{20} (136.0 cm) for third cut and 15th April in first season. On the other hand, the lowest value of plant height was observed of after the harvest of plants with applying Co (95.0 cm) for first cut and 1st April in first seasons, and Co (96.0 cm) for first cut and 1st April in second season. Data listed in Table (3) reveal that the main effect of sowing date and some source organic fertilizers treatments on branch number of Moringa plants was statistically significant at the three cuts for the second seasons. All organic fertilizers treatments led to a significant increase in branch number among all cuts compared to unfertilized control in the two seasons in most cases.

3.2 Effect of sowing date and some source organic fertilizers on moringa yield

The obtained data pointed out that fresh and dry weight (kg /feddan) of moringa was significantly affected by supplying the plants with sowing date and some source organic fertilizers at the three cuts for the two seasons (Table 4 and Figure 2).

Table (4): The influence of sowing date and some source organic fertilization on yield fresh leaves (kg /feddan) of Morinaga plants during the seasons of 2017and 2018.

Fertilizer (B)	Sowing date (A)							
	1st time 1/4	2nd time 15/4	3th time 1/5	Mean	1st time 1/4	2nd time 15/4	3th time 1/5	Mean
	First cut							
	First season				Second season			
Control	280.0	304.0	328.0	304.0	368.0	360.0	360.0	362.7
Farmyard manure 15 m^3 /feddan	320.0	368.0	400.0	362.7	408.0	432.0	408.0	416.0
Farmyard manure 30 m^3 /feddan	560.0	648.0	616.0	608.0	624.0	680.0	584.0	629.3
Compost 10 m^3 /feddan	360.0	400.0	384.0	381.3	400.0	424.0	408.0	410.7
Compost 20 m^3 /feddan	584.0	624.0	616.0	608.0	576.0	592.0	576.0	581.3
poultry manure 5 m^3 /feddan	568.0	656.0	600.0	608.0	504.0	576.0	552.0	544.0
poultry manure 10 m^3 /feddan	784.0	520.0	688.0	664.0	784.0	520.0	744.0	682.7
Mean	493.7	502.9	518.9	505.1	523.4	512.0	518.9	518.1
L.S.D. for 5%	A: 7.591 B:11.595 A*B:20.083				A:17.797 B:27.185 A*B:47.086			
	Second cut							
Control	408.0	456.0	424.0	429.3	504.0	512.0	496.0	504.0
Farmyard manure 15 m^3 /feddan	496.0	528.0	552.0	525.3	560.0	600.0	544.0	568.0
Farmyard manure 30 m^3 /feddan	752.0	824.0	768.0	781.3	816.0	864.0	752.0	810.7
Compost 10 m^3 /feddan	544.0	552.0	544.0	546.7	552.0	576.0	528.0	552.0
Compost 20 m^3 /feddan	752.0	792.0	784.0	776.0	744.0	744.0	720.0	736.0
poultry manure 5 m^3 /feddan	784.0	816.0	768.0	789.3	664.0	744.0	736.0	714.7
poultry manure 10 m^3 /feddan	912.0	680.0	904.0	832.0	936.0	672.0	928.0	845.3
Mean	664.0	664.0	677.7	668.6	682.3	673.1	672.0	675.8
L.S.D. for 5%	A:9.316 B:14.230 A*B:24.647				A:18.492 B:28.248 A*B:48.927			
	Third cut							
Control	448.0	512.0	480.0	480.0	536.0	552.0	544.0	544.0
Farmyard manure 15 m^3 /feddan	520.0	584.0	584.0	562.7	600.0	632.0	584.0	605.3
Farmyard manure 30 m^3 /feddan	792.0	840.0	808.0	813.3	848.0	896.0	792.0	845.3
Compost 10 m^3 /feddan	608.0	600.0	576.0	594.7	592.0	608.0	576.0	592.0
Compost 20 m^3 /feddan	784.0	808.0	824.0	805.3	792.0	784.0	760.0	778.7
poultry manure 5 m^3 /feddan	832.0	848.0	792.0	824.0	704.0	784.0	776.0	754.7
poultry manure 10 m^3 /feddan	960.0	712.0	952.0	874.7	960.0	712.0	984.0	885.3
Mean	706.3	700.6	716.6	707.8	718.9	709.7	716.6	715.0
L.S.D. for 5%	A:9.258 B:14.142 A*B:24.495				A:17.902 B:27.345 A*B:47.363			

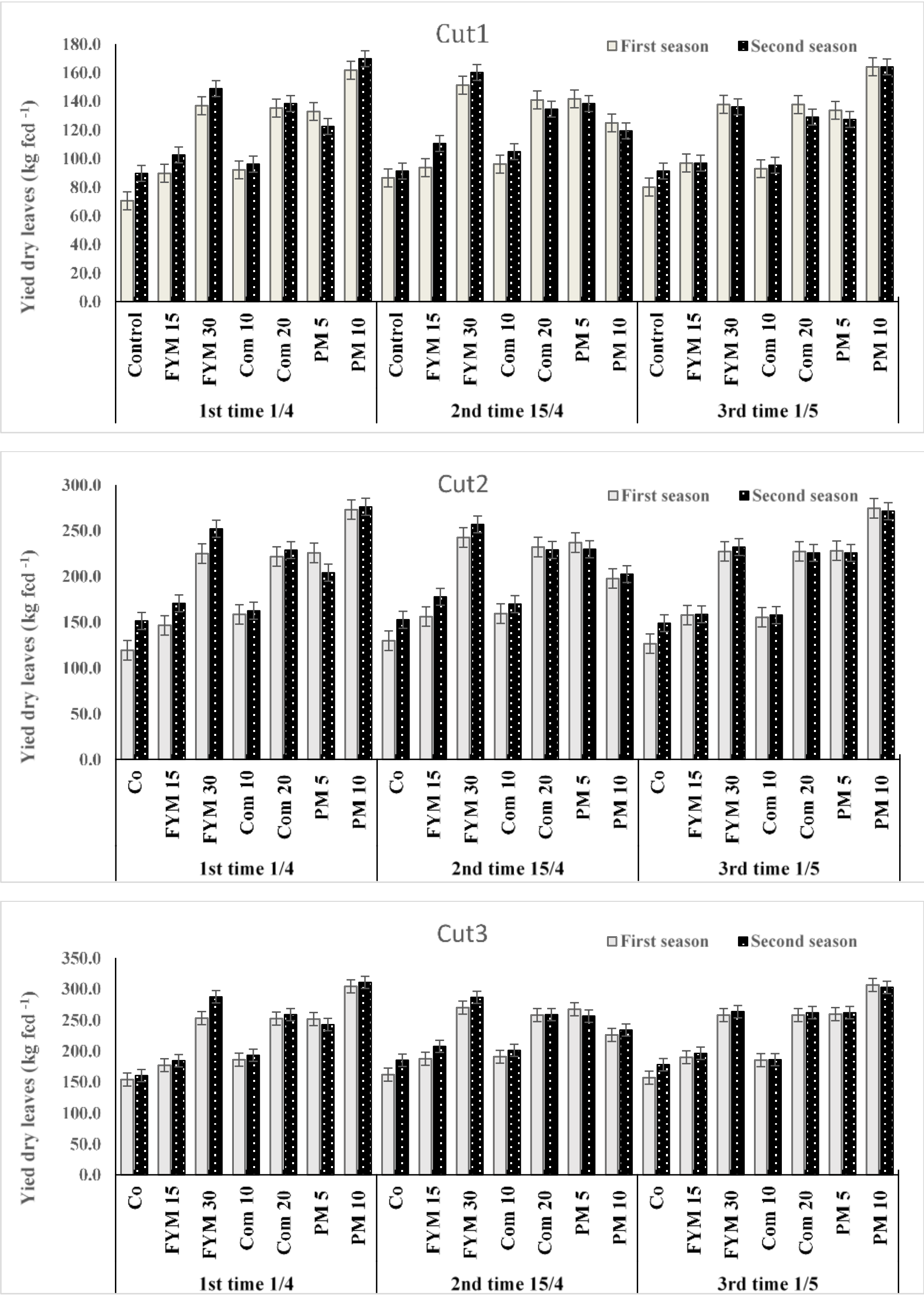

Figure (2): The influence of sowing date and some source organic fertilization on yield dry leaves (kg /feddan) of moringa plants during the seasons of 2017and 2018.

Sowing date 1 Apirl, organic fertilizers treatment FYM_{15}, FYM_{30}, COM_{10}, COM_{20}, PM_5 and PM_{10} increased yield dry leaves by 27.3, 94.3, 30.7,92.0, 88.6 and 129.5% in the first cut, by 22.8, 88.6, 32.9,85.9, 89.3 and 128.9% in the second cut and by 15.1, 64.6, 20.8, 64.1,63.5 and 97.9% in the third cut over untreated ones in first season, respectively. While organic fertilizers treatment FYM_{15}, FYM_{30}, COM_{10}, COM_{20}, PM_5 and PM_{10} increased yield dry leaves by 14.3, 66.1, 7.1,54.5, 36.6 and 89.3% in the first cut, by 12.7, 66.7, 7.4,51.3, 34.9 and 82.5% in the second cut and by 15.0, 79.5, 20.5, 61.5, 51.5 and 94.0% in the third cut over untreated ones in second season.

3.3 Effect of sowing date and some source organic fertilizers on moringa chemical constituents

It was noticed that, N, P and K percentage gradually increased, while a significant in both experimental seasons with increasing organic fertilizers level (Table 5). The highest N (4.73 %), P (0.20 %) and K (1.67 %) percentage were recorded when poultry manure 10 m^3 /feddan.

Table (5): The influence of sowing date and some source organic fertilization on nitrogen (N), phosphorus (P) and potassium (K) (%) of morinaga plants during the seasons of 2017and 2018.

Fertilizer (B)	Sowing date (A)							
	1st time 1/4	2nd time 15/4	3th time 1/5	Mean	1st time 1/4	2nd time 15/4	3th time 1/5	Mean
	Nitrogen (N)							
	First season				Second season			
Control	1.15	1.86	1.47	1.49	1.20	1.90	1.52	1.54
Farmyard manure 15 m^3 /feddan	3.63	3.70	3.33	3.56	3.50	3.83	4.00	3.78
Farmyard manure 30 m^3 /feddan	4.23	4.05	4.00	4.09	4.53	4.20	4.20	4.31
Compost 10 m^3 /feddan	2.67	2.87	2.77	2.77	3.80	3.27	4.07	3.71
Compost 20 m^3 /feddan	3.93	3.63	4.00	3.86	4.33	3.70	4.17	4.07
poultry manure 5 m^3 /feddan	3.60	4.23	4.07	3.97	3.53	4.50	4.10	4.04
poultry manure 10 m^3 /feddan	4.73	3.06	5.00	4.26	6.00	3.10	5.33	4.81
Mean	3.42	3.34	3.52	3.43	3.84	3.50	3.91	3.75
L.S.D. for 5%	A: 0.118 B:0.181 A*B:0.313				A:NS B:0.230 A*B:0.398			
	Phosphorus (P)							
Control	0.07	0.09	0.03	0.05	0.10	0.06	0.04	0.10
Farmyard manure 15 m^3 /feddan	0.10	0.05	0.05	0.07	0.13	0.07	0.07	0.09
Farmyard manure 30 m^3 /feddan	0.13	0.09	0.10	0.10	0.16	0.12	0.10	0.13
Compost 10 m^3 /feddan	0.11	0.05	0.08	0.08	0.12	0.09	0.10	0.10
Compost 20 m^3 /feddan	0.20	0.14	0.09	0.14	0.21	0.15	0.12	0.16
poultry manure 5 m^3 /feddan	0.14	0.09	0.09	0.11	0.16	0.10	0.10	0.12
poultry manure 10 m^3 /feddan	0.20	0.12	0.18	0.16	0.21	0.14	0.13	0.16
Mean	0.13	0.09	0.09	0.10	0.16	0.10	0.09	0.12
L.S.D. for 5%	A:0.010 B:0.015 A*B:0.026				A:0.009 B:0.014 A*B:0.024			
	Potassium (K)							
Control	1.16	1.04	1.09	1.10	1.22	1.07	1.08	1.12
Farmyard manure 15 m^3 /feddan	1.18	1.15	1.09	1.14	1.20	1.15	1.12	1.16
Farmyard manure 30 m^3 /feddan	1.38	1.31	1.32	1.33	1.40	1.32	1.35	1.36
Compost 10 m^3 /feddan	1.17	1.15	1.09	1.14	1.20	1.19	1.10	1.16
Compost 20 m^3 /feddan	1.51	1.54	1.42	1.49	1.53	1.58	1.43	1.51
poultry manure 5 m^3 /feddan	1.21	1.24	1.19	1.22	1.23	1.28	1.20	1.24
poultry manure 10 m^3 /feddan	1.64	1.38	1.64	1.55	1.68	1.41	1.89	1.66
Mean	1.32	1.26	1.26	1.28	1.35	1.29	1.31	1.32
L.S.D. for 5%	A:0.015 B:0.024 A*B:0.041				A:0.013 B:0.020 A*B:0.035			

4. Discussion

The increase was gradual by the gradual increase in organic fertilizer levels. Organic fertilizers increased soil organic matter, improving physical, chemical and biological functions of the soil (Babalola *et al.*, 2012). As it plays a crucial role in maintaining soil functions and is a parameter for soil fertility and resistance to erosion. Physical functions increasing SOM will enhance aggregation and stability and thereby improving soil structure and soil porosity. Stability of aggregates prevents surface sealing and soil erosion, improves water infiltration, and enhances water holding capacity (Martínez-Blanco *et al.*, 2013). However, SOM improves the retention of plant nutrients and increases the soil biodiversity (Vanlauwe *et al.*, 2015). As a chemical function it considered a source of plant nutrients, especially in the direct supply of N, P, S and K, enhance CEC particularly in soils. Similar results were found by Imoro *et al.* (2012), Pahla *et al.* (2013) and Umar (2014) on moringa. The micro-organisms require N for their growth, so they break down the organic materials and release nutrients. This process involves immobilization of N from the soil by the micro-organisms (Das and Deka, 2021). However, Geng *et al.* (2019) found that application of different composted organic residues significantly increased the N, P and K uptake by corn plants over control and the increase was proportional to the increase in the composted organic residues rates. The uptake of macro and micronutrients were increased after application of bio-compost and application of different rates of farmyard manure are significantly effective in increasing most of absorbed macro and micronutrients by different parts of plant (Bayu *et al.*, 2006). Rekaby *et al.* (2020) found that the uptake of N, P, and K nutrients in barley plants increased with applying of organic absorbents. Applying organic fertilizer to the soil can either increase metal availability, solubility, and plant uptake (Rekaby *et al.*, 2020). Insoluble OM usually forms insoluble organ metal complexes, making them less available for plant uptake or leaching (Lal and Francaviglia, 2019). However, many organic fertilizers have a soluble C component or produce soluble decomposition products, which can increase metal solubility by forming soluble organ metal complexes. Micronutrients are also released through the biodegradation of OM by microorganisms (Kalantary *et al.*, 2014).

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