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Improvement of loamy sand soil and potato plant productivity under integrated organic and inorganic nitrogen fertilizers

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Abstract

Two experiments were conducted at EL Khattatba region – Egypt during two winter seasons to evaluate the effect of single or combined application of organic nitrogen fertilizer farmyard manure, chicken manure and compost with inorganic nitrogen fertilizer (ammonium nitrate 33.5%) on soil properties and identify the best rates on potato tuber yield and quality. Five ratio of nitrogen fertilizers were 100% nitrogen mineral fertilizer, 75% nitrogen mineral+25% nitrogen organic fertilizer, 50% nitrogen mineral +50% nitrogen organic fertilizer, 25%nitrogen mineral + 75% nitrogen organic fertilizer and 100% nitrogen organic fertilizer. Organic carbon content was increased significantly with applied organic fertilizers compared to mineral fertilizer. Soil total nitrogen ascertained highest values by applying mineral N fertilizer than organic fertilizer treatments. C: N ratio of soil significantly increased with organic fertilizers and 100%N organic fertilizer treatment was superiority for raising C:N ratio of soil. 100% N mineral fertilizer treatment had depressive effects on C: N which were lower than tested soil. Both pH and bulk density were significantly decreased by applying organic fertilizers. 100% N chicken manure treatment was recorded maximum decreasing. Each of E.C, K_h and available water were influenced by applying organic fertilizers types. 100%N organic fertilizers were ascertained the significant effect for each EC, K_h and available water compared to other rates or 100%N mineral fertilizer. The highest tuber yield was ascertained by applying the treatment 25%N organic fertilizer with 75% N mineral for each season. Carbohydrate% was decreased with raising the rates of organic fertilizers and the maximum values were recorded at 100%N mineral. There was irregular trend for tuber specific gravity with organic fertilizers or their rates for both seasons. The relation between NO3-N ion, N% content in tuber and Total N% in soil indicated that increasing ratio of organic fertilizers decreased the NO3-N ion in tuber.

Keywords: loamy sand soil, organic fertilizer, mineral fertilizers, potatoes, carbohydrate, nitrate ion.

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1. Introduction

Soil in Egypt are very poor in their organic matter content which fluctuates between 0.1 – 2.5. Organic and mineral fertilization improves light-textured soils, physical properties, available water and warmth regime. Systematic fertilization not only increases crop yield but also alters its quality, sustain soil health and its fertility (Shaker Nesreen *et al.,* 2015). The current global scenario firmly emphasizes the need to adopt eco-friendly agricultural practices for sustainable agricultural production **(**Ashraful Islam *et al.,* 2017). The cost of inorganic fertilizers is increasing enormously, to the extent that they are out of reach for small and marginal farmers. The effect of organic manure on plant behavior is not just a matter of nutrients supply and organic materials influence physio, chemical and biological characteristics of soil which in turn influence development of plants. Integrated use of chemical fertilizers and organic fertilizers may be an approach for sustainable production of crops. Application of farmyard manure improved the productivity of potato plants and it was increased with increasing of farmyard manure levels up to 20 m3/fed (1 feddan = 4200 square metres (m^2) = 0.42 hectares = 1.038 acres) (Ahmed *et al.,* 2015). This may improve the efficiency of chemical fertilizers and thus reduce their use (Baniuniene and Zekaite, 2008). The potato is the world's most important root and tuber crop worldwide. It is grown in more than 125 countries and consumed almost daily by more than a billion people. Hundreds of millions of people in developing countries depend on potatoes for their survival. Potato cultivation is expanding strongly in the developing country, where the potato's ease of cultivation and nutritive content has made it a valuable food security and cash crop for millions of farmers. Developing countries are now the world's biggest producers, importers of potatoes or potato products (Girma *et al.,* 2017). The objectives of present study were to evaluate effect of single or combined application of farmyard manure, chicken manure (CH) or compost (CO) with inorganic nitrogen fertilizer (ammonium nitrate 33.5%) on some soil properties and identify the best levels in yield production and use efficiency in response to different rate of the applied organic and inorganic nitrogen fertilizer.

2. Materials and methods

Two field experiments were conducted at newly reclaimed loamy sand soil in El-Khatataba region, El-Monofia governorate, Egypt, during two successive winter seasons of 2013/14 and 2014/15. Some initial physical and chemical properties of tested soil are showing in Table (1) according to (Black, 1983).

2.1 Nitrogen fertilizer sources

Different nitrogen fertilizer sources were used as follows:

Organic fertilisers (OF)

- Farmyard manure (FYM).
- Chicken manure (CH).
- Compost fertiliser (CO).

Mineral nitrogen fertiliser (Min)

- Ammonium nitrate (33.5%)

The chemical characteristics of organic fertilizers were determined according to Black (1965) are presented in Table (2) was average two seasons.

2.2 The experimental design and treatments

Split plot design was used with three replicates. Nitrogen fertilizer types either organic or mineral fertilizers were devoted to the main plots, while the fertilizers rates were assigned to sub–plots. To achieve the purpose of present study potatoes (Diamount *cv.*) was chosen from local source in Egypt. Five nitrogen fertilizer sources were applied on the base of nitrogen recommended doses for potatoes plant (150 kg N fed $^{-1}$) (1 feddan = 4200 square metres (m²) = 0.42 hectares = 1.038 acres) as following: 100% recommended N in mineral fertilizer (min) form, 75% N min. plus 25% N OF, 50%N min plus 50% N.OF, 25% N min plus75% NOF and 100% N OF. The organic nitrogen fertilizers were added at preparation of soil. The plot area was 30m2 with 12 lines in each plot. Calcium super phosphate (15.5% P_2O_5) at a recommended dose of 400 kg/ fed was applied before soil tillage. Mineral nitrogen fertilizer was applied through drip irrigation system (fertigation). Also, potassium sulphate (48% K_2O) at 200 kg/ fed level was applied through drip irrigation Potato tuber pieces were planted at 25 cm distance in 10 cm of furrow depth at the rate of 1300 kg fed-1 on 20th November in both seasons.

Table (1): Some physical and chemical properties of initial soil for two winter seasons 2013/14 and 2014/15.

Year	Depth	Physical soil character								
		Particle size distribution%			Texture class	B.D gcm^3	F.C %	W.P	A.W	$K_{h\ cmh}^{-1}$
		Sa	Silt	Cla						
2013/2014	0-30	81	13	6.23	Loamy sand	1.71	10.34	3.9	6.44	9.3
2014/2015	0-30	80	12	7.23	Loamy sand	1.67	11.3	4.3	7.00	9.6

		Chemical soil character								
		EC dSm^{-1}	pH	Total N%	OC%	Available K $mgkg^{-1}$	Available P $mgkg^{-1}$	DTPA (mg/kg)		
								Zn	Fe	Mn
2013/2014	0-30	1.3	7.8	0.04	0.18	88.5	4.5	0.98	3.1	2.1
2014/2015	0-30	1.6	7.8	0.05	0.27	89	4.9	1.10	4.2	2.3

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

Organic fertilizers	pH 1:10	EC dSm^{-1}	OC %	Total N %	Total K%	Available P (ppm)	C/N ratio	Fe (ppm)	Zn (ppm)	Mn (ppm)
FYM	6.5	9.9	36.03	2.55	2.26	180.7	14:1	42.95	30.55	46.3
CH	7.14	3.7	36.06	3.14	2.65	342.3	11.5:1	27.80	55.90	63.15
Comp	7.54	2.5	34.49	2.16	1.17	187.3	16:1	31.2	19.7	53.5

2.3 Soil analysis before planting and after harvest

Mechanical analysis was determined according to Piper (1950). Soil pH and electrical conductivity (EC) and available water % were determined as described by Richards (1954). Organic carbon (OC %) was determined according to Walkley and Black method as described by Hesse (1971). Soil bulk density and hydraulic conductivity were determined according to Black (1983). Total soil nitrogen was determined according to Bremner *et al.* (1982). The C/N ratio was calculated as

$$\text{C/N ratio} = \text{O.C\% of soil} \ / \ \text{Total N \% of soil.}$$

2.4 Chemical analysis of plant

Samples of tubers from three potato plants were chosen randomly in both two seasons after 110 days (harvest stage). Samples were oven dried at 70°C till constant weight then were ground to a fine powder to determine:

- The percentages of total nitrogen by Kjeldahl method as Hesse (1971).
- Tuber Quality Parameters at harvest stage
- Total Nitrate.
- The NO_3-N concentration was determined according to Ulrich *et al.* (1959).
- Carbohydrate content (%) according to Herbert (1971)
- Specific gravity: it was determined according to the methods of Smith (1975).

The tuber were weighted in air and then in water.

$$\text{Specific gravity (S.g.)} = \frac{\text{Weight in air}}{\text{Weight in air - Weight in water}}$$

2.5 Statistical analysis

Obtained data was statistically analyzed using MSTAT program (1990).

3. Results and Discussion

3.1 Organic carbon percent (OC %)

The effect of applied different nitrogen fertilizer sources on soil OC% is presented in Table (3). Date revealed that, applying CH, FYM or CO were associated with an increase of soil OC % than the initial data one in both seasons. The highest mean values of soil OC%

(2.1 and 2.18 %) were recorded in chicken manure treatment. The difference among the mean values of soil OC content due to applying different nitrogen fertilizer sources were significantly. Similar results were obtained by Ahmed Azza *et al.* (2012) reported that the inclusion of manure in the fertilization schedule improved the organic carbon status and available N,P,K and S in soils so sustaining soil health. Data in Table (3) revealed that soil OC % increased by increasing the rates of organic fertilization till the highest (100% OF + Zero MIN). Also, it was noticed, that soil OC% due to applying 100 % mineral nitrogen fertilizer decreased compared to initial OC% which cause soil deterioration. These findings were in harmony by Ahmed Azza *et al.* (2011) and Sadaf Khan (2011).

Table (3): Effect treatments on organic carbon percent OC% and Total nitrogen N% after two winter of 2013/14 and 2014/15.

OF(N%)	min (N%)	O.C% 2013/14			mean rate	O.C% 2014/15.			mean rate
		FYM	CH	CO		FYM	CH	CO	
Zero	100	0.17^{f}	0.17^{f}	0.17^{f}	0.17^{E}	0.19^{i}	0.19^{i}	0.19^{i}	0.19^{E}
25	75	1.03^{d}	1.20^{cd}	0.46^{e}	0.90^{D}	1.62^{e}	1.65^{e}	0.51^{h}	1.26^{D}
50	50	1.17^{cd}	1.32^{c}	0.58^{e}	1.02^{C}	1.75^{c-e}	1.69^{de}	0.93^{g}	1.46^{C}
75	25	1.76^{b}	1.85^{b}	1.06^{d}	1.56^{B}	1.88^{b-d}	2.06^{ab}	1.27^{f}	1.74^{B}
100	Zero	1.90^{b}	2.10^{a}	1.28^{c}	1.76^{A}	1.98^{a-c}	2.18^{a}	1.63^{e}	1.93^{A}
Mean (OF)		1.21^{B}	1.33^{A}	0.71^{C}		1.48^{A}	1.55^{A}	0.91^{B}	
OF(N%)	min (N%)	N%				N%			
Zero	100	0.33^{a}	0.33^{a}	0.33^{a}	0.33^{A}	0.39^{a}	0.39^{a}	0.39^{a}	0.39^{A}
25	75	0.12^{de}	$0.12d^{e}$	0.09^{e}	0.11^{C}	0.13^{b-d}	0.13^{b-d}	0.10^{d}	0.12^{B}
50	50	0.10^{de}	0.14^{b-e}	0.09^{e}	0.11^{C}	0.13^{b-d}	0.14^{bc}	0.11^{cd}	0.13^{B}
75	25	0.13^{c-e}	0.16^{b-d}	0.11^{de}	0.13^{B}	0.14^{bc}	0.14^{bc}	0.12^{b-d}	0.13^{B}
100	Zero	0.13^{c-e}	0.18^{bc}	0.12^{de}	0.14^{B}	0.14^{bc}	0.15^{b}	0.13^{b-d}	0.14^{B}
Mean (OF)		0.16^{B}	0.19^{A}	0.15^{B}		0.19^{A}	0.19^{A}	0.17^{B}	

OF= organic fertilizer, min = mineral fertilizer, FYM= farmyard manure, CH= chicken manure, CO= compost.

3.2 Total nitrogen percent

Data present in Table (3) showed the application of different type of nitrogen fertilizers were significant increased the total N% compared the initial one. The mineral nitrogen fertilizer (min) was ascertained the maximum mean values of total N% (0.33 and 0.39% N after 1st and 2nd season, respectively. Data in Table (3) revealed that treatment of 100% N of all organic nitrogen fertilizers recorded the highest mean values of total N% in soil.

3.3 Organic carbon to nitrogen ratio (C: N ratio)

Data in Figure (1a&b) showed that the value of C/N ratio of untreated soil equal to 4.5 and 5.4. Application of mineral nitrogen fertilizer caused a significant

decrease in C: N ratio that became 0.51 and 0.48 for the corresponding season. On the other hand, adding different organic nitrogen fertilizers increased significantly the mean values of C: N ratio in the descending order as FYM (9.3)> CH (8.7)> CO (6.49). Mineral fertilization had depressive effect on C: N ratio. The dose 100% organic fertilizers for all types were ascertained the highest mean values of C:N which were 12.36 and 13.68 for 1st and 2nd seasons, respectively. Also, it was noticed that, the treatment of chicken manure induce an initial increase at dose 25% organic fertilizer which was equal to10.0 and 12.41 for1st and 2nd seasons, respectively. Instead the dose 50% caused a reduction in C:N ratio fall to 9.4 and 12.07. Moreover, the mean values of C:N ratio at dose 75% N and 100% N of CH manure treatments were almost 11.56 and 11.79 also 14.3 and 14.43 in 1st and 2nd seasons, respectively, indicating of the organic fertilizer.

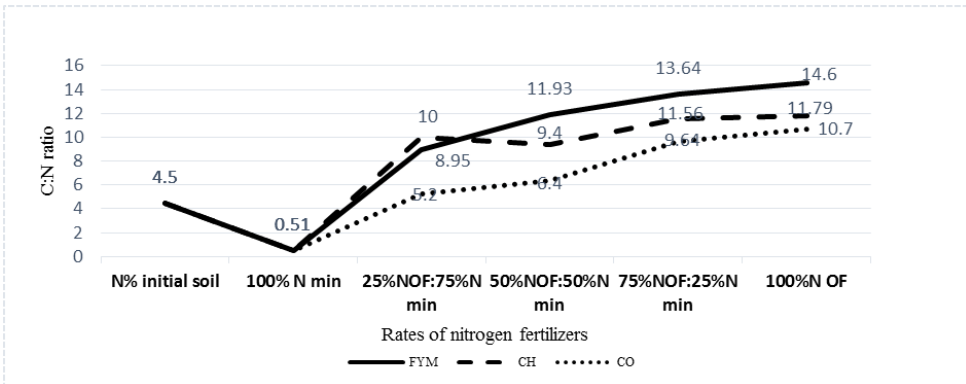

Figure (1-a): Effect of treatments on C:N ratio of soil after winter 2013/14.

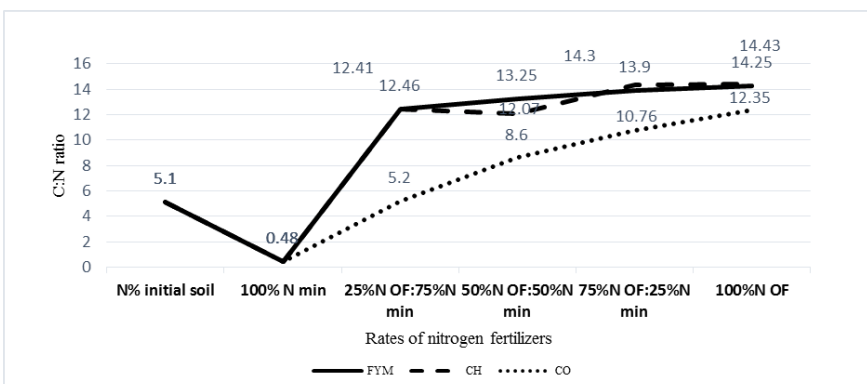

Figure (1-b): Effect of treatments on C:N ratio of soil after winter 2014/15.

3.4 Soil pH

Table (4) revealed that the effect of different organic nitrogen fertilizers sources on soil pH was insignificant in both seasons. While the mean values of soil pH were decreased significantly by applying different organic nitrogen fertilizers sources compared to the initial one in both seasons. The values of pH decreased from 7.8 to 7.20, 7.10 and 7.2 by applying FYM, CH and Comp, respectively in the 1st season while they were 7.8 to 7.63, 7.52, 7.64 in the 2nd one for the corresponding treatments This result reported by Ahmed Azza (2013). From above mentioned date, adding organic fertilizers (OF) caused a reduction in soil pH. The highest rates of organic fertilization, the lowest soil pH values. The lowest values of soil pH were 7.027 and 7.33 in 1st and 2nd seasons respectively in the treatment 100% OF+ Zero MIN. The minimum soil pH values of 7.01 and 7.12 were recorded in the treatment of CH manure at 100% OF in 1st and 2nd seasons, respectively.

3.5 Soil salinity (EC)

Table (5) showed the effect of different nitrogen fertilizers after two winter sseasons on soil salinity. EC value was increased by adding different organic fertilizers from 1.3 dSm^{-1} **(**initial soil) to1.44, 26, 2.63 and 2.17 in 1styear and to 1.49 2.71, 2.61 and 2.02 in 2nd year in mineral nitrogen fertilizers, FYM, CH and Comp, respectively. It is obvious that EC values were rather higher with FYM than CH and Comp in both seasons. The increasing rates of organic fertilizers (OF) increase the means values of EC significantly in both seasons. The highest value of EC was recorded with 100% of each type of organic nitrogen fertilizers in both seasons.

Table (4): Effect of treatments on soil pH after two winter of 2013/14 and 2014/15.

Treatments		pH 2013/14			mean	pH 2014/15			mean
OF (N%)	min (N%)	FYM	CH	CO	(rate)	FYM	CH	CO	(rate)
Zero	100	7.90^{a}	7.90^{a}	7.90^{a}	7.90^{A}	7.95^{a}	7.95^{a}	7.95^{a}	7.95^{A}
25	75	7.45^{b}	7.25^{c}	7.43^{b}	7.38^{B}	7.78^{bc}	7.76^{c}	7.78^{bc}	7.77^{B}
50	50	7.15^{cd}	7.12^{c}	7.12^{c}	7.13^{C}	7.70^{cd}	7.66^{cd}	7.70^{cd}	7.69^{BC}
75	25	7.14^{cd}	7.02^{de}	7.08^{d}	7.08^{C}	7.62^{cd}	7.53^{de}	7.64^{cd}	7.60^{C}
100	Zero	7.05^{de}	7.01^{de}	7.02^{de}	7.03^{C}	7.45^{e}	7.12^{f}	7.43^{e}	7.33^{D}
Mean (OF)		7.34^{A}	7.26^{B}	7.31^{A}		7.70^{A}	7.60^{B}	7.70^{A}	

OF= organic fertilizer, min= mineral fertilizer, FYM= farmyard manure, CH= chicken manure, CO= compost.

3.6 Bulk density (gcm-3)

Data presented in Table (6) showed that the application of comp as organic nitrogen fertilizers decreases the mean values of bulk density significantly compared to FYM and CH treatments in both seasons.This data was harmony with that reported by El-Fayomy and Hammed (2001) and Hati *et al*. (2006). The

minimum bulk density values of 1.52 and 1.40 g/ cm3 were recorded at 100% organic fertilizer in 1st and 2nd season, respectively. This data was harmony with that reported by Sadaf and Khan (2011) and Ahmed Azza (2013).

Table (5): Effect of treatment on EC of soil after two winter seasons 2013/2014 and 2014/2015.

Treatments		E.C dSm^{-1} 2013/14			mean rate	E.C dSm^{-1} 2014/15			mean rate
OF (N%)	min (N%)	FYM	CH	CO		FYM	CH	CO	
Zero	100	1.44^{f}	1.44^{f}	1.44^{f}	1.44^{E}	1.90^{e}	1.90^{e}	1.90^{e}	1.90^{D}
25	75	1.53^{f}	2.01^{e}	1.54^{f}	1.69^{D}	2.50^{d}	1.91^{e}	1.28^{f}	1.90^{D}
50	50	2.02^{e}	2.95^{d}	1.54^{f}	2.17^{C}	2.94^{bc}	2.61^{cd}	1.64^{e}	2.40^{C}
75	25	3.30^{c}	3.38^{c}	2.14^{e}	2.94^{B}	3.33^{b}	2.98^{bc}	2.55^{d}	2.95^{B}
100	Zero	4.80^{a}	3.35^{c}	4.19^{b}	4.11^{A}	3.29^{b}	4.05^{a}	3.16^{b}	3.50^{A}
Mean (OF)		2.62^{A}	2.63^{A}	2.17^{B}		2.79^{A}	2.69^{A}	2.11^{B}	

OF= organic fertilizer, min= mineral fertilizer, FYM= farmyard manure, CH= chicken manure, CO= compost.

Table (6): Effect of treatments on B.Dg cm^{-3} after two winter seasons 2013/14 and 2014 and 15.

Treatments		Bulk density g cm^{-3} 2013/14			mean rate	Bulk density g cm^{-3} 2014and 15			mean rate
OF(N%)	min (N%)	FYM	CH	CO		FYM	CH	CO	
Zero	100	1.70^{a}	1.70^{a}	1.70^{a}	1.70^{A}	1.69^{a}	1.69^{a}	1.69^{a}	1.69^{A}
25	75	1.52^{b}	1.69^{a}	1.50^{b}	1.57^{B}	1.52^{c}	1.67^{a}	1.39^{de}	1.53^{B}
50	50	1.50^{b}	1.66^{a}	1.48^{b}	1.55^{B}	1.46^{c}	1.61^{b}	1.37^{de}	1.48^{C}
75	25	1.48^{b}	1.64^{a}	1.48^{b}	1.53^{B}	1.43^{cd}	1.60^{b}	1.28^{fg}	1.44^{D}
100	Zero	1.46^{b}	1.52^{b}	1.46^{b}	1.48^{C}	1.33^{ef}	1.55^{b}	1.26^{g}	1.38^{E}
Mean (OF)		1.53^{B}	1.64^{A}	1.52^{B}		1.49^{B}	1.62^{A}	1.40^{C}	

OF= organic fertilizer, min= mineral fertilizer, FYM= farmyard manure, CH= chicken manure, CO= compost.

3.7 Hydraulic conductivity and available water

Results in Figure (2a, b and c) showed that application of organic nitrogen fertilizers induced significant decreases in soil hydraulic conductivity (K_h) and in the same time, progressive increases of the available water (AW %). Considering the organic nitrogen types the following mean values of hydraulic conductivity could be arranged in the descending order FYM> Comp> CH. On the contrary, the available water increased in the following order CH> Comp> FYM, while increasing of hydraulic conductivity values decrease in available water values with mineral nitrogen fertilization compared to the initial stat. Ddecreasing in K_h and increase in AW may be due to redistribution pore size (El-Fayoumy *et al*., 2001). The treatment of 100% N of CH manure was ascertained the maximum decreasing of K_h (3.53 cm/ h) and increasing AW (20.97%) than other tested treatments.

3.8 Tuber yield

Table (7) showed the effect of nitrogen sources on tuber yield in both seasons.

The differences among means values of dry tuber yield were significant in both seasons. The CH treatment increased the mean values of tuber yield by 10.26% &8.77% in 1st year and 9.7% & 8.31 in2nd year than the treatments of FYM and Comp. On the other hand, the superiority mean values of tuber yield were recorded in Chicken manure treatment which was 13.76 and 14.60 ton fed^{-1}in both 1st and 2nd seasons. Mean values of tuber yield at the rate 25% OF +75% MIN, increased by 2.72, 8.7, and 3.4% in treatments of FYM, CH and comp. Consequently, the chicken manure treatment with rate of 25% OF+75% MIN is the best treatment on tuber yield at 1st and 2nd seasons.These results in agreement by Abay and Tesfaye (2011), Balemi (2012) and Shiferaw (2014).

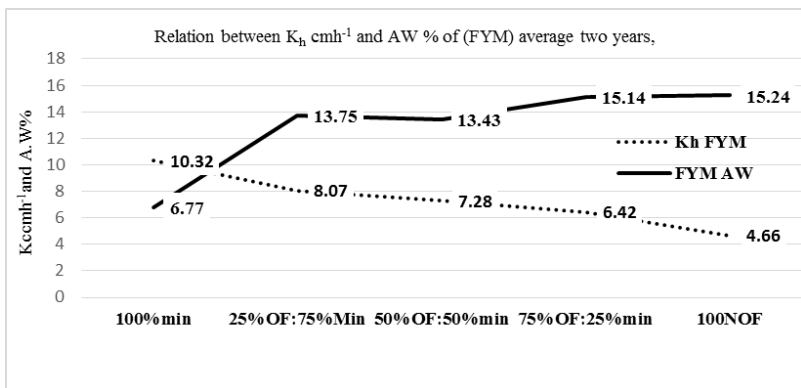

Figure (2-a): Effect of Farmyard manure (FYM) and its rates on hydraulic conductivity K_h cm h^{-1}and available water AW % average two years. OF= organic fertilizer, min = mineral fertilizer.

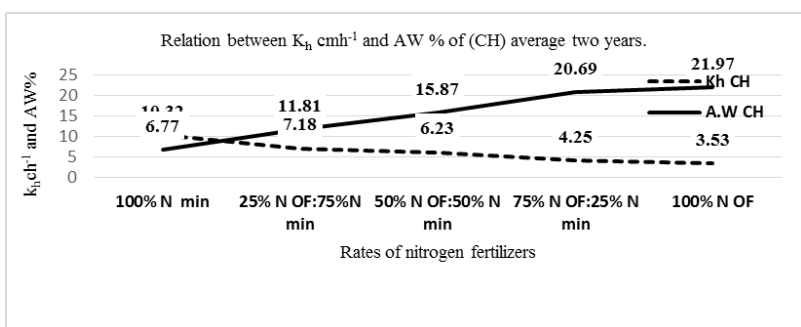

Figure (2-b): Effect of chicken manure (CH) and its rates on hydraulic conductivity $k_h$cmh^{-1} and available water A.W% average two years. OF= organic fertilizer, min = mineral fertilizer.

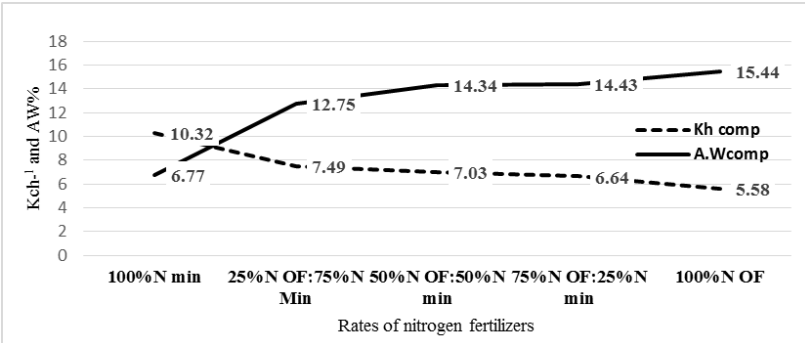

Figure (2-c): Effect of compost (CO) and its rates on Hydraulic conductivity Kcmh^{-1} and available water AW% average two years. OF= organic fertilizer, min = mineral fertilizer.

Table (7): Effect of treatments on Potato yield during two winter of 2013/14 and 2014/15.

Treatments	2013/14 Organic N %: mineral N %					mean
	0:100	25:75	50:50	75:25	100:0	(OF)
FYM	14.70^{b}	15.10b	13.00c	12.11d	7.50	12.48B
CH	14.70^{b}	15.98a	14.60b	13.14c	10.40	13.76A
CO	14.70^{b}	15.20b	13.10c	12.40c	7.85	12.65B
mean rate	14.70^{B}	15.43A	13.57C	12.55D	8.58E	
	2014/15					
FYM	15.60^{b}	14.94c	13.73de	12.10f	10.18	13.31B
Chicken manure	15.60b	16.80a	15.50bc	14.10d	11.02	14.60A
Compost	15.60b	15.20bc	13.50de	12.50ef	10.60	13.48B
mean rate	15.60A	15.65A	14.24B	12.90C	10.60D	

OF= organic fertilizer, min= mineral fertilizer, FYM= farmyard manure, CH= chicken manure, CO= compost.

3.9 Carbohydrate % in tuber potato plant

Table (8) showed that, different organic nitrogen fertilizer sources have significant influence on carbohydrate content in tubers in both seasons. Whereas, the mean values of carbohydrate content increased with applying chicken manure CH treatment by 1.7% and 1% and by3.09% and 2.09% compared to the treatments of FYM and Comp in 1st and 2nd seasons, respectively. Also, mineral nitrogen fertilizer increased Carbohydrate % in tubers compared to FYM and comp fertilization. It is clearly that, applied FYM or Compost reduced carbohydrate content compared to chicken manure (CH) and mineral fertilizers. The obtained results are also in harmony with reported by (Ahmed *et al*., 2015).

3.10 Specific gravity of tuber potatoes

As shown in Table (9) the difference effects of organic nitrogen fertilizers on tuber specific gravity is significantly in both seasons. The specific gravity decreased from 1.066 by applied chicken manure (CH) to 1.064 and 1.036 g/cm^3 by applied both of (FYM) and (Comp) in 1st season, respectively. While in 2nd season

the different among mean values of tuber specific gravity for all realized irregular trend by increasing organic fertilizers ratio up to 100% mineral nitrogen fertilizers in 1st and 2nd seasons. The superiority mean value was recorded for 100%N mineral this data are in harmony with Shaheen *et al.* (2014).

Table (8): Effect of treatment on carbohydrate % of potato tuber during two winter of 2013/14 and 2014/15.

Treatments	2013/14 Organic N %: mineral N %					Mean (OF)
	0:100	25:75	50:50	75:25	100:0	
FYM	20.10^{bc}	20.32^{a-c}	20.22^{bc}	19.95^{c}	19.00^{e}	19.92^{B}
CH	20.10^{bc}	20.57^{a}	20.20^{bc}	20.07^{bc}	19.48^{d}	20.08^{A}
CO	20.10^{bc}	20.44^{ab}	20.22^{bc}	19.97^{c}	19.13^{e}	19.97^{AB}
mean rate	20.10^{BC}	20.44^{A}	20.21^{B}	20.00^{C}	19.20^{D}	
2014/15						
FYM	20.07b-d	19.81de	19.71ef	19.45f	19.04g	19.62C
CH	20.07b-d	20.84a	20.30b	20.27b	19.91c-e	20.28A
CO	20.07b-d	20.27b	20.17bc	19.51f	19.44f	19.89B
Mean (rate)	20.07B	20.31A	20.06B	19.74C	19.46D	

OF=organic fertilizer, FYM= farmyard manure, CH= chicken manure, CO= compost.

Table (9): Effect of treatments on specific gravity of Potato plant after two winter of 2013/14and 2014 /15.

Treatments	2013/14 Organic N %: mineral N %					Mean (OF)
	0:100	25:75	50:50	75:25	100:0	
FYM	1.050^{b}	1.080ab	1.080^{ab}	1.080^{ab}	1.03^{b}	1.064^{A}
CH	1.050^{b}	1.070ab	1.060^{b}	1.030^{b}	1.12^{a}	1.066^{A}
CO	1.050b	1.020b	1060^{b}	1.030^{b}	1.02^{b}	1.036^{B}
mean (rate)	1.050^{A}	1.057^{A}	1.067^{A}	1.047^{A}	1.057^{A}	
2014 /15						
FYM	1.040^{b}	1.040^{b}	0.990^{c}	1.040^{b}	1.040^{b}	1.030^{A}
CH	1.500^{a}	1.020^{bc}	1.030^{bc}	1.010^{bc}	1.040^{b}	1.120^{A}
CO	1.020^{bc}	1.010^{bc}	1.040^{b}	0.990^{c}	1.040^{b}	1.020^{B}
Mean (rate)	1.187^{A}	1.023^{BC}	1.020^{BC}	1.013^{C}	1.040^{B}	

OF=organic fertilizer, FYM= farmyard manure, CH= chicken manure, CO= compost.

3.11 The relationship between NO3-N ppm in potato tubers, total nitrogen in tuber and total N % in soil

Data presented in Figure (3a, b and c) show that the different types of organic nitrogen fertilizers sources realized regular trend on N% in tubers in both seasons. However, the difference between FYM and CH and Comp was almost insignificant in both seasons. The maximum mean of N% in tuber was 1.51% and 1.42% with chicken manure as organic nitrogen fertilizers in 1st and 2nd seasons, respectively. The equal mean values of N concentration for different organic nitrogen fertilizers sources may

be due to almost equal quantities of nitrogen added during the experiments period. This data is that obtained by Ewulo *et al*. (2008). The opposite effect of increasing OF rates on N % in tuber caused the positive effect of NO_3-N ion concentration in tuber of potato. Data present in the Figure 3 showed that the increasing total N% in both tuber and soil leads to increasing NO_3-N ion in tuber potato up to the harmful concentration. Difference among organic nitrogen fertilizer sources addition on nitrate ion in tuber potato was high significantly in both seasons. Generally, the means values of nitrate ion decreased by applied Comp fertilizer by 20.16% and 13.7% compared to CH manure and FYM, respectively in 1st season. Similar trend was observed in the 2nd season since nitrate ion decreased by applied Comp fertilizer by 40.1% and 22.2% compared to CH manure and FYM, respectively. The NO3-N ion concentration was directly proportional to the total N in the tubers and in soil. This data was harmony with that reported by Abbas *et al.* (2011) and Worthington (2001).

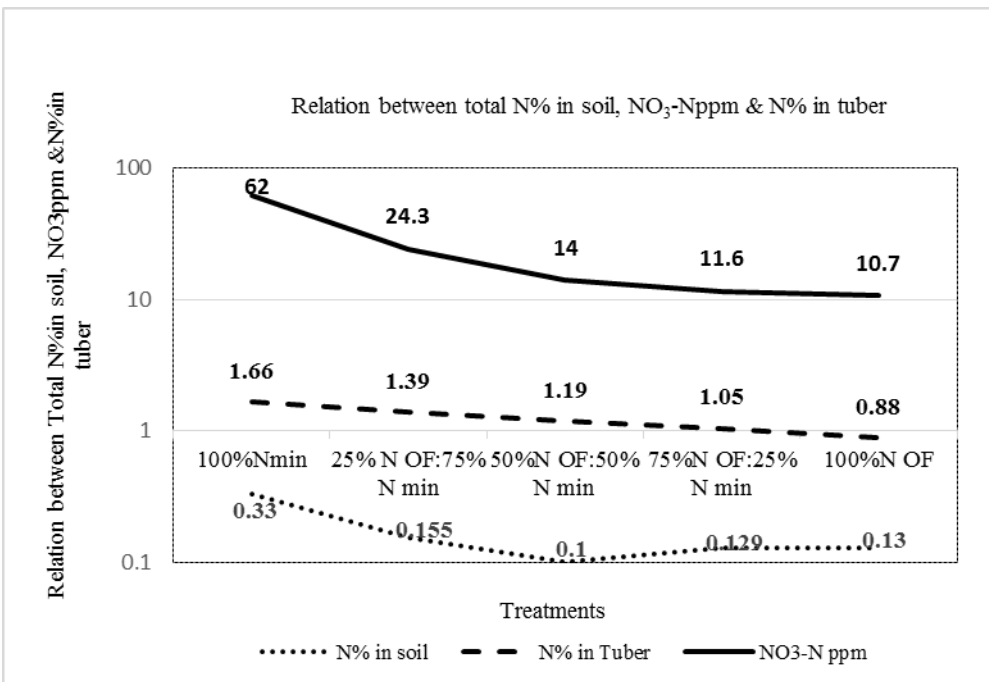

Figure (3-a): Relation between total N% in soil and NO3-N ion and N% in potato tuber by applying farmyard manure fertilizer. OF= organic fertilizer, min = mineral fertilizer.

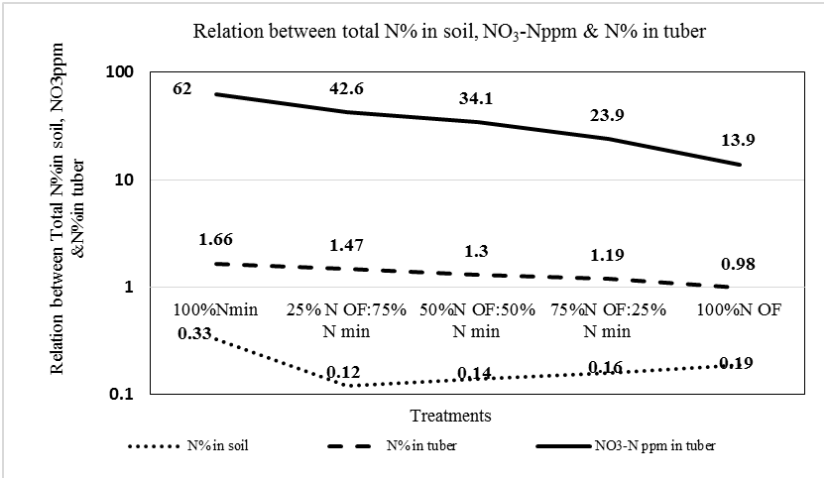

Figure (3-b): Relation between total N% in soil and NO_3-N ion and N% in tuber by applying chicken manure fertilizer. OF= organic fertilizer, min = mineral fertilizer.

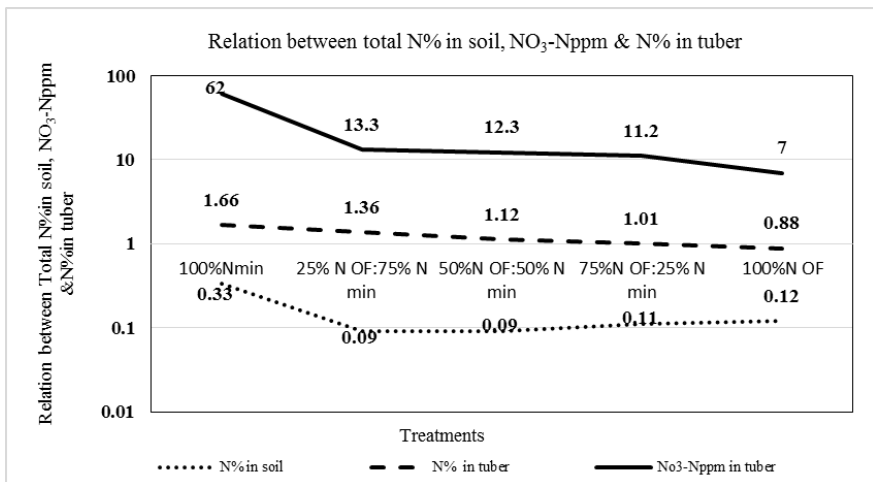

Figure (3-c): Relation between Total N% in soil and NO_3-N ion and N% in tuber by applying Compost fertilizer. OF= organic fertilizer, min = mineral fertilizer.

4. Conclusions

It could be concluded that the integrated of organic and mineral nitrogen fertilizers are more important in potato fields. Since integrated OF with mineral fertilizer at level 25 OF: 75 min, 50 OF: 50 min and 75 OF:25 min gave the moderated values of tuber yield and maintained soil health. While using 100% of mineral nitrogen gave the highest tuber yield production, at the same time, using 100% OF produce

high quality tuber yield. Therefore, integrated organic and mineral nitrogen fertilizers contribute significantly towards maintaining and improving not only the potato productivity crop also improving chemical, physical properties of soil. In addition, they reduced the harmful effects of using nitrogen chemical fertilizers on tuber quality and soil. So, the application of organic and inorganic nitrogen fertilizers are considered the best option for sustaining soil fertility statues and leads to rationalize use of N-mineral fertilizer for growing crop.

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