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Effect of Different Sources of Nitrogen Application on Rice Yield and Soil Health in Saline Sodic Soil

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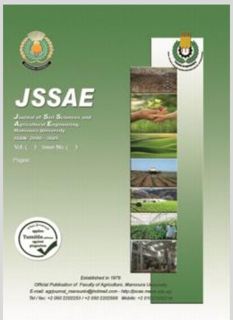

ABSTRACT

Afield experiments were carried out during 2021 and 2022 rice grown seasons. The site of experiment was located at El-Hamoal, Kafr El-Sheikh –Egypt. The goal of study to investigate the effect of different treatments application such as (urea, gypsum, compost and farmyard manure) as well as their duality treatments and water depths on saline soil properties and productivity of rice (*Oryza sativa*, cv Giza179). The main findings were displayed as following. All treatments reduced the bulk density (BD), electrical conductivity (EC), pH under saline soil condition except urea treatment. Compost + gypsum treatment under 10 cm water depth caused the lowest value of BD, EC, pH of surface soil in both seasons, Meanwhile hydraulic conductivity, total porosity, organic matter increased in two saline soil layers by applying different soil treatments and two water depths especially 10 cm except urea treatment at rice harvesting in the two study seasons. The lowest values of soil nitrogen, phosphorus, potassium contents were found in control plots. Meanwhile, the highest values of the increments were obtained by the duality treatment of the tested materials in soil layers of the two seasons. A significant and progressive increment in all different rice yield components with application of soil treatments and water depths especially at 10 cm. Additionally, the duality treatment of the tested materials seemed to be the most effective treatment in increasing measured yield components compared to other treatments.

Keywords: Salinity, Organic matter, leaching, rice.

INTRODUCTION

Recent and past data have shown that global agricultural production is continuously being impeded by salinity (Shahid *et al*., 2018). Soil salinity, which arises as a result of excessive accumulation of sodium chloride (NaCl), sodium sulfate (Na_2SO_4), sodium carbonate (Na_2CO_3), calcium chloride ($CaCl_2$), and magnesium chloride ($MgCl_2$), is a major environmental constrain hindering crop productivity and growth in the terrestrial ecosystem (Ahmad *et al*., 2018; Almeida *et al*., 2017). Salinity degrades physical, biological and chemical properties of the soil; thus, adversely reduce soils capability in meeting the needs of the required increase in global food security.

In this regard, gypsum has been reported several times to sustain optimal K^+/Na^+ and Ca^{2+}/Na^+ ratios, reduced pH as well as furnish crops with the required S nutrition in saline soils (Ahmed *et al*., 2016; Abdel-Fattah, 2015).

Organic materials such as mulch manures, plant residues, municipal solid wastes, and agricultural manures are currently used to ameliorate saline soil (Jones *et al*., 2012).

Compost has several beneficial effects as a nutrient source for plant production and does not have deleterious impacts on soil and plant (Scotti *et al*., 2016). Compost contains many enzymes and hormones that can promote plant growth (Liu *et al*., 2021). Nitrogen is an essential component of many vital compounds in plant, such as chlorophyll, nucleotides, proteins, alkaloids, enzymes, hormones, and vitamins; besides, N plays an important role in plant photosynthesis by improving leaf area index (Marschner, 1997). Application of 100% recommended dose of nitrogen from urea significantly influenced grain and straw yield of rice (Koushal *et al*., 2011).

Combined application of manure and chemical fertilizer (urea) to soil increases the available N, P, K status of soil and improves the organic carbon content of soil as well as increase crop yield (Nilotpal *et al*., 2018).

Rice (*Oryza sativa* L.) cultivation in many countries meets also water shortages and other environmental issues (He *et al*., 2016).

Rice is an important crop plant and feeds over 50% of the global population (Ahmad *et al*., 2018). It is not only a food crop, but also an important foundation for the economics of several developing countries (Van Dis *et al*., 2015). Rice is distinct from other crops as it is cultivated in flooded paddy soils over most growth stages.

In this regard, the current study aims to assess the effects of compost (organic fertilizer), farmyard manure, chemical fertilizer (urea) and gypsum with water management on the nutrient availability, growth and productivity of rice plant in saline sodic soil. Furthermore, to investigate the impact of such these treatments on some physical and chemical properties of this soil.

MATERIALS AND METHODS

A field experiment was conducted at El-Hamoal, Kafr El-Sheikh –Egypt (31°18'13"5 N and 31°03'30"8 E) during two growing seasons (2021 and 2022), to study the effect of different treatments application such as (urea, gypsum, compost and farmyard manure) as well as their duality treatments and water depths on saline soil properties and productivity of rice (*Oryza sativa*, cv Giza179). Rice grains were sown at a rate of 140 kg/ha on 15th April 2021, 2022. The experiment was laid out in a split

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plot design with four replications. The layout was made distributing two water depths to the main plots and fertilizer plus soil treatments to the sub plots.

Experiment treatments:

The experiment consists of 2 factors i.e., two water depths and soil treatments. Two water depths; $L_{1:}$(=5 cm water level), L_2 : (10 cm water level) and soil treatments: (1)-control(Ck), (2)-165 kg urea (N) ha^{-1} ,(3)-10 t farmyard (FYM) ha^{-1}, (4)-10 t compost (C) ha^{-1} (5)-5 t gypsum (G) ha^{-1}, (6)-165 kg N ha^{-1} + 10 t FYM ha^{-1}, (7)-165kg N ha^{-1} + 10 t compost ha^{-1} (8)-165kg N ha^{-1} + 5 t gypsum ha^{-1} (9)-10 t FYM ha^{-1}+10 t compost ha^{-1}(10)-10 t FYM ha^{-1}+5t gypsum ha^{-1} (11)-10t compost ha^{-1} +5 t gypsum ha^{-1}(12)-10tFYM ha^{-1}+ 10 t compost ha^{-1}+ 5 t gypsum ha^{-1} ,(13)-165 kg N ha^{-1}+10t FYMha^{-1}+10tcompost ha^{-1}+5t gypsum ha^{-1}.

Field experiment:

Before planting, Soil samples from the surface layer (0-30 cm) have been taken from the experiment site, air-dried, ground, sieved through a 2 mm sieve and analyzed for some physical and chemical properties as recorded in Table 1. The soil texture is clayey, characterized by high values of salinity. The chemical composition of compost and farmyard manure was in Table 2 a, b. Gypsum requirement for soil reclamation was obtained from the gypsum requirement (GR) determined by the saturated gypsum solution method (Bao, 2005).

Table 1. Physical and chemical properties of the studied soil before planting.

Characteristic	Soil depths 0-25	25-50	50-75
Particle size distribution (%)			
Coarse Sand	5.3	6.2	9.6
Find sand	11.4	10.2	16.1
Silt	36.4	35.1	34.0
Clay	46.9	48.5	40.3
Texture class		Clay	
Chemical analysis			
PH (1:2.5 soil suspension)	7.81	7.83	7.77
OM (%)	1.32	1.23	1.20
EC, dS/m	5.5	6.0	6.2
Soluble cations (meq/L)			
Ca^{++}	8.0	9.6	10.4
Mg^{++}	4.3	5.5	5.6
Na^{+}	42.5	46.5	47.3
K^{+}	1.2	1.4	0.7
Soluble anions (meq/L)			
CO_3^{-}	-	-	-
HCO_3^{-}	0.6	0.5	0.4
Cl^{-}	47.9	53.2	58.0
SO_4^{--}	7.5	8.3	5.6
Available macro nutrients(mg\kg^{-1})			
N	25.5	26.8	24.0
P	6.5	7.1	8.1
K	181.6	209.5	211.4

EC: electrical conductivity (salinity); OM: organic matter.

Table 2 a. Some chemical analysis of compost (C) used in the experiment.

Analysis		N%	C:N	P%	K%
compost	2021	1.4	1.85	0.73	1.95
	2022	1.46	1.85	0.75	1.97

Table 2 b. Some chemical analysis of farmyard manure (FYM) used in the experiment.

Analysis		N%	C:N	P%	K%
Farmyard manure	2021	1.21	1.25	0.67	1.00
	2022	1.30	1.23	0.67	1.20

Treatments (gypsum, compost and farmyard manure) were applied before cultivation. The soil was ploughed followed by laser compromise before planting. Agricultural practices for rice plants were carried out as a recommendation.

Soil measurements

After harvest, soil samples have been collected from all plots at the first and second seasons, at two consecutive depths (0-25, 25-50cm). The soil samples were air-dried and analyzed for some chemical and physical properties, i.e., Soil pH according to (McLean, 1982). The total soluble salts (EC) were determined using electrical conductivity meter at 25C in soil paste extract as dS/m (Page *et al*., 1982). Soil available N was determined according to (Matsumoto *et al*., 2000), available P and K were determined according to (Tian *et al*., 2021). Organic matter content was determined according to (Bhattacharyya *et al*., 2015). Soil bulk density and total porosity were measured as described by (Campbell, 1994).

Crop Growth and Yield Measurements:

Five plants were chosen at random from each plot to measure the plant heights, number of tillers, and number of panicle\hill, panicle length, filled grains/ panicle and 1000 grain weight. The total yield of rice for each plot was harvested, weighed, and converted to tons ha^{-1} for each treatment.

Statistical Analysis:

Data obtained from the two seasons were statistically analyzed by the following analysis of variance (IRRISTAT) described by Gomez and Gomez, (1984). Differences among treatment means were compared by least significant difference were used at $P \leq 0.05$.

RESULTS AND DISCUSSION

Results

Soil physical properties:

Data presented in Table 3 showed the effect of different treatments (G, C, FYM and N) and water depths (L1and L2) on some soil physical properties including (bulk density (BD), hydraulic conductivity (HC) and total soil porosity (TSP)) in two soil layers (0- 25, 25- 50 cm) of the two-year experiment after rice harvesting.

Soil bulk density:

Data showed a progressive reduction in SBD of saline soil layers (0- 25, 25- 50 cm) with applied the different soil treatments added separately or together and two water depths in both seasons Table 3. All treatments reduced the BD under saline soil condition except N treatment. This reduction was more pronounced with increasing water depths. Additionally, it was in surface soil layer (0- 25 cm) more obvious than in subsurface soil layer (25- 50 cm). It was noticed that the highest bulk density value was obtained with the control treatment. Meanwhile, application of the compost + gypsum under 10 cm water depth had the lowest bulk density value in the two study seasons. Similar effects of these treatments upon on soil physical properties were reported by Nilotpal *et al*., 2018. In the first season, in 0- 25 cm saline soil layer, the decrement percentage in SBD was 9.77, 5.26, 3.76 and 11.28 % as result of application of G, C, FYM and their duality treatment at L2, respectively and was 6.77, 3.01, 2.26 and 8.27% as a result of applied the same tested materials under L1 in the same soil layer, respectively compared to Ck plots. Furthermore, in 25-50 cm saline soil layer, the application of G, C, FYM and their duality treatment at L2 recorded a reduction of SBD by 8.15, 3.70, 2.96 and 8.89%, respectively and by 5.19, 2.96, 2.22 and 5.93% decrement of the same materials at L1, respectively after rice harvesting relative to salinized untreated plots.

Table 3. Effect of different water depths and soil treatments on bulk density (BD), hydraulic conductivity (HC) and total porosity (TP) of the studied saline soil in both seasons.

Treatments	BD (g/cm³)				HC (cm/h)				TP (%)			
	Water depths											
	(5cm)		(10cm)		(5cm)		(10cm)		(5cm)		(10cm)	
	0-25	25-50	0-25	25-50	0-25	25-50	0-25	25-50	0-25	25-50	0-25	25-50
2021												
Ck	1.33	1.35	1.33	1.35	0.37	0.33	0.37	0.33	50.19	49.44	50.19	49.44
C	1.29	1.31	1.26	1.3	0.53	0.49	0.60	0.50	51.69	50.94	52.81	51.31
FYM	1.3	1.32	1.28	1.31	0.48	0.39	0.54	0.46	51.31	50.56	52.06	50.94
FYM + C	1.31	1.32	1.27	1.31	0.59	0.42	0.65	0.53	50.94	50.56	52.43	50.94
G	1.24	1.28	1.20	1.24	0.76	0.61	0.87	0.73	53.56	52.06	55.06	53.56
G + C	1.2	1.24	1.16	1.28	0.81	0.72	0.92	0.81	55.06	53.56	56.55	52.06
G + FYM	1.22	1.26	1.18	1.27	0.74	0.68	0.89	0.71	54.31	52.81	55.81	52.43
G + FYM + C	1.22	1.27	1.18	1.23	0.80	0.71	0.93	0.79	54.31	52.43	55.81	53.93
N	1.33	1.35	1.33	1.35	0.37	0.32	0.39	0.38	50.19	49.44	50.19	49.44
N + C	1.29	1.3	1.26	1.3	0.55	0.44	0.60	0.59	51.69	51.31	52.81	51.31
N + FYM	1.3	1.32	1.28	1.34	0.77	0.67	0.54	0.49	51.31	50.56	52.06	49.81
N + G	1.25	1.3	1.20	1.27	0.77	0.63	0.88	0.76	53.18	51.31	55.06	52.43
N + G + FYM + C	1.19	1.23	1.17	1.22	0.70	0.60	0.85	0.76	55.43	53.93	56.18	54.31
2022												
Ck	1.32	1.34	1.32	1.34	0.39	0.35	0.39	0.35	50.56	49.81	50.56	49.81
C	1.27	1.29	1.24	1.28	0.55	0.50	0.63	0.51	52.43	51.69	53.56	52.06
FYM	1.28	1.30	1.26	1.29	0.49	0.39	0.56	0.46	52.06	51.31	52.81	51.69
FYM + C	1.29	1.30	1.25	1.28	0.61	0.45	0.67	0.55	51.69	51.31	53.18	52.06
G	1.23	1.26	1.20	1.24	0.78	0.63	0.88	0.75	53.93	52.81	55.06	53.56
G + C	1.2	1.24	1.16	1.28	0.84	0.75	0.92	0.82	55.06	53.56	56.55	52.06
G + FYM	1.21	1.25	1.18	1.27	0.75	0.69	0.89	0.70	54.68	53.18	55.81	52.43
G + FYM + C	1.21	1.26	1.18	1.23	0.82	0.72	0.95	0.80	54.68	52.81	55.81	53.93
N	1.32	1.34	1.32	1.34	0.39	0.32	0.39	0.36	50.56	49.81	50.56	49.81
N + C	1.27	1.28	1.25	1.28	0.57	0.45	0.62	0.59	52.43	52.06	53.18	52.06
N + FYM	1.28	1.30	1.26	1.32	0.79	0.68	0.55	0.50	52.06	51.31	52.81	50.56
N + G	1.25	1.30	1.2	1.27	0.79	0.63	0.88	0.76	53.18	51.31	55.06	52.43
N + G + FYM + C	1.18	1.23	1.17	1.22	0.72	0.61	0.87	0.77	55.81	53.93	56.18	54.31

Ck = control, FYM = farmyard manure, C = compost, G = gypsum, N= urea

Soil saturated hydraulic conductivity and total soil porosity:

The results in Table 3 revealed that SHC and TSP were increased in two saline soil layers (0- 25, 25- 50 cm) by applying different soil treatments as pretreated in soil either alone or together and two water depths except N treatment at rice harvesting in two seasons compared to Ck. This increment was more obvious when L2 was used. Also, this increment of SHC and TSP were higher in the surface soil layer (0- 25 cm) than subsurface soil layer (25- 50 cm) at L1and L2. For instance, in the first season at 0- 25 cm saline soil layer, the application of G, C, FYM and their duality treatment at L2 caused an increment in SHC represented by 135.14, 62.16, 45.95 and 151.35%, respectively. Moreover, the application of G, C, FYM and their duality treatment at L1 caused an increment in SHC by 105.41, 43.24, 29.73 and 116.22%, respectively. Also, the duality treatment of the C, G and FYM at L1 increased TSP represented by 8.21%, in 0- 25 cm soil layer and represented by 6.05%, in 25- 50 cm soil layer relative to salinized untreated plots. The above results demonstrated that the application of duality treatment of the C, G and FYM at L2 seemed to be the most effective treatment for increasing HC in two saline soil layers while, C + G treatment at L2 seemed to be the best one for improving TSP in surface soil layer in two seasons compared to other treatments at harvest time.

Soil chemical properties:

Soil salinity (EC):

Data recorded in Table 4 showed the effect of different soil treatments (G, C, FYM and N) as separately or alternatively and two water depths (L1and L2) on EC in two studied soil layers (0- 25 and 25- 50 cm) of both seasons at harvest time. Similar results on soil chemical properties agree well with previous data by Shahid *et al*., 2018. It could be observed that the application of these tested materials and L1, L2 decreased EC in the two studied saline soil depths except N treatment compared to Ck plots. This reduction was more obvious at L2 than L1. On the other hand, it could be noticed that, the values of EC in saline soil can be descended in order 25- 50 cm > 0- 25 cm soil layer in the two seasons. Meanwhile, the lowest value of reduction EC was obtained by C + G treatment of two soil layers in both seasons. For instance, in the first season, in 0- 25 cm soil layer, the decrement percentage of EC in studied soil and treated with C, G and FYM as well as their duality treatment at L2 were 17.31, 40.38, 7.69 and 34.62%, respectively and at L1 were 11.11, 33.33, 5.56 and 27.78%, respectively compared to corresponding salinized Ck plots. Interestingly, in 25- 50 cm soil layer, the decrement of soil EC in the studied soil and treated with C, G and FYM as well as their duality at L2 were 16.67, 37.04, 5.56 and 37.04%, respectively compared to salinized untreated plots. Similar trend was detected for plots under the same soil layer and treated with the same tested materials at L1 after rice harvesting.

Soil pH:

Table 4 revealed that soil pH values in two saline soil layers were decreased by applying different soil treatments either alone or alternatively and water depths (L1 and L2) except N treatment in the two study seasons compared to Ck at harvest time. This reduction was more obvious at L2. The lowest values of soil pH were found with G treatment in 0- 25 cm at L2. Meanwhile, the highest values of this character were scored from Ck treatments.

Soil organic matter:

The effect of both different two water depths and soil treatments applied separately or alternatively caused a pronounced increment in the SOM except G treatment of two soil layers compared to corresponding control values Table 4. Concerning the values of N+G treatment were in the second season < the values of the first season at L1and L2. It could be observed that the duality treatment as pretreated in soil at L1 and L2 seemed to be the best one for improving OM in two soil layers of both seasons.

Table 4. Effect of different water depths and soil treatments on electrical conductivity (EC, salinity) dS/m, soil pH values and organic matter (%) of the studied saline soil in both seasons.

Treatments	2021											
	EC (dS/m)				pH (1:2.5)				OM (%)			
	Water depths											
	(5cm)		(10cm)		(5cm)		(10cm)		(5cm)		(10cm)	
	0-25	25-50	0-25	25-50	0-25	25-50	0-25	25-50	0-25	25-50	0-25	25-50
Ck	5.4	5.9	5.2	5.4	7.81	7.83	7.81	7.83	1.32	1.23	1.32	1.23
C	4.8	5.0	4.3	4.5	7.78	7.8	7.74	7.76	1.51	1.40	1.55	1.41
FYM	5.1	5.3	4.8	5.1	7.81	7.83	7.79	7.81	1.48	1.37	1.51	1.39
FYM + C	4.9	5.2	4.5	4.8	7.77	7.79	7.75	7.76	1.55	1.41	1.57	1.42
G	3.6	4.0	3.1	3.4	7.75	7.78	7.70	7.75	1.32	1.23	1.33	1.23
G + C	3.5	4.0	2.9	3.1	7.75	7.75	7.71	7.73	1.49	1.34	1.50	1.40
G + FYM	3.8	4.3	3.4	3.9	7.76	7.77	7.75	7.77	1.42	1.35	1.46	1.38
G + FYM + C	3.9	4.2	3.4	3.4	7.74	7.8	7.73	7.78	1.50	1.41	1.54	1.40
N	5.4	5.7	5.3	5.5	7.81	7.83	7.81	7.83	1.33	1.25	1.34	1.26
N + C	4.9	5.2	4.6	5.0	7.82	7.83	7.77	7.82	1.48	1.39	1.51	1.39
N + FYM	5.0	5.3	5.0	5.2	7.81	7.83	7.79	7.82	1.46	1.38	1.50	1.38
N + G	4.1	4.9	3.8	4.4	7.79	7.81	7.75	7.79	1.33	1.25	1.34	1.25
N + G + FYM + C	4.2	4.6	3.7	4.1	7.76	7.79	7.75	7.8	1.56	1.44	1.60	1.45
	2022											
Ck	5.2	5.8	5.0	5.2	7.81	7.83	7.81	7.83	1.32	1.22	1.32	1.23
C	4.6	4.8	4.1	4.4	7.78	7.8	7.74	7.76	1.52	1.40	1.56	1.42
FYM	4.8	5.0	4.6	4.9	7.80	7.82	7.78	7.81	1.49	1.38	1.53	1.40
FYM + C	4.7	4.9	4.3	4.6	7.77	7.79	7.74	7.76	1.57	1.42	1.59	1.42
G	3.4	4.0	3.1	3.4	7.74	7.78	7.70	7.75	1.32	1.22	1.32	1.23
G + C	3.4	4.0	2.9	3.1	7.74	7.75	7.72	7.73	1.50	1.34	1.52	1.41
G + FYM	3.7	4.2	3.4	3.9	7.75	7.77	7.74	7.77	1.44	1.36	1.50	1.39
G + FYM + C	3.8	4.2	3.4	3.5	7.73	7.8	7.73	7.78	1.51	1.42	1.56	1.41
N	5.2	5.8	5.0	5.2	7.81	7.83	7.81	7.83	1.33	1.22	1.32	1.23
N + C	4.7	5.0	4.5	4.9	7.82	7.83	7.77	7.82	1.49	1.40	1.53	1.40
N + FYM	4.9	5.2	4.8	5.0	7.81	7.83	7.79	7.82	1.46	1.38	1.50	1.38
N + G	4.1	4.9	3.6	4.4	7.79	7.81	7.75	7.79	1.32	1.23	1.32	1.23
N + G + FYM + C	4.2	4.6	3.5	4.1	7.76	7.79	7.75	7.8	1.59	1.45	1.61	1.46

Ck = control, FYM = farmyard manure, C = compost, G = gypsum, N= urea

Available nutrients content:

Data in Table 5 illustrated that nitrogen content in soil layers was increased as a result of (C, G, FYM and N) treatments applied either alone or together and (L1, L2) in both seasons compared to untreated plots. These increments were more pronounced with increasing water depths. Moreover, it had greater values in 25- 50 cm than 0- 25 cm soil layer. The lowest values of soil nitrogen content were found in Ck plots.

Table 5. Effect of different water depths and soil treatments on available nutrients content (mg kg^{-1} soil) of the studied saline soil in both seasons.

Treatments	2021											
	N (mg kg^{-1} soil)				P (mg kg^{-1} soil)				K (mg kg^{-1} soil)			
	Water depths											
	(5cm)		(10cm)		(5cm)		(10cm)		(5cm)		(10cm)	
	0-25	25-50	0-25	25-50	0-25	25-50	0-25	25-50	0-25	25-50	0-25	25-50
Ck	25.5	26.8	26.5	27.8	6.5	7.1	6.7	7.4	219.6	226.4	229.5	235.2
C	30.1	31.8	31.4	33.4	8.1	8.5	8.6	8.8	265.5	281.4	301.3	317.6
FYM	31.7	33.1	33.4	35.2	7.1	8.4	7.6	8.7	295.4	313.6	336.8	349.7
FYM + C	33.4	34.5	36.1	36.4	8.5	8.7	8.8	9.0	285.6	291.2	320.4	325.6
G	28.5	29.4	30.1	31.4	7.4	8.0	8.1	8.6	255.9	265.2	279.4	292.3
G + C	30.4	31.8	32.1	33.5	8.4	8.6	8.7	8.8	263.4	270.0	315.6	322.8
G + FYM	31.8	33.4	34.1	36.1	7.6	8.4	8.3	8.7	335.2	350.1	375.9	390.2
G + FYM + C	32.1	33.8	34.2	35.5	8.5	8.6	8.7	8.9	356.1	370.0	398.6	400.8
N	31.8	34.5	35.2	39.2	6.6	7.2	7.8	7.5	231.5	290.1	235.6	236.5
N + C	33.1	33.4	36.4	37.1	8.3	8.7	8.8	9.0	256.1	288.6	300.6	320.3
N + FYM	33.7	31.9	36.1	37.2	7.8	8.6	7.9	8.7	306.2	315.1	340.3	355.2
N + G	34.7	36.7	36.4	39.4	7.6	8.2	8.4	8.6	311.3	330.5	342.1	360.1
N + G + FYM + C	36.7	38.5	39.8	41.1	8.6	8.9	8.9	9.1	360.5	371.3	400.3	408.7
	2022											
Ck	27.4	28.7	28.8	29.7	7.0	7.4	7.2	7.6	220.0	227.0	230.1	235.2
C	30.4	32.0	31.9	33.5	8.4	8.8	8.7	9.0	266.5	282.0	303.2	318.1
FYM	32.7	34.4	33.7	35.5	8.2	8.5	8.6	8.9	297.1	315.2	339.2	350.3
FYM + C	33.5	34.6	36.5	37.1	8.7	9.0	8.9	9.1	286.3	293.4	322.2	326.4
G	29.5	29.9	30.2	31.8	8.1	8.5	8.4	8.6	255.9	265.2	279.4	292.3
G + C	30.4	32.8	32.8	33.9	8.6	8.9	9.0	9.1	265.5	272.0	318.1	323.3
G + FYM	32.8	34.9	34.4	35.6	8.5	8.6	8.6	8.9	337.0	352.2	376.3	391.1
G + FYM + C	32.9	34.6	34.7	36.1	8.6	9.0	9.1	9.2	359.3	370.0	399.7	401.2
N	32.9	35.0	35.5	40.2	8.0	8.5	8.2	8.6	233.6	293.7	236.8	237.2
N + C	33.6	34.4	35.9	38.2	8.6	9.0	9.1	9.2	258.2	290.1	302.9	322.0
N + FYM	33.8	34.4	36.9	39.2	8.3	8.8	8.7	9.0	309.4	318.1	344.2	355.2
N + G	34.8	36.9	36.9	40.3	8.1	8.5	8.7	8.8	312.0	331.2	345.3	360.1
N + G + FYM + C	37.2	39.1	40.9	42.1	8.9	9.2	9.2	9.5	363.4	371.3	402.3	408.7

Ck = control, FYM = farmyard manure, C = compost, G = gypsum, N= urea

Meanwhile, the highest values of the increments of the same character were obtained by the duality treatment of the tested materials in soil layers of the two seasons compared to other treatments. In 0- 25 cm saline soil layer of the first season, the increment of soil nitrogen content at L2 and pretreated soil with C, G, FYM, N and their duality treatments were 23.43, 18.06, 31.15, 38.09 and 56.15%, respectively. Additionally, the increments at L1 were 22.89, 16.49, 29.70, 29.83 and 49.86%, respectively.

Regarding to soil phosphorus content, the effect of (C, G, FYM and N) treatments applied alone or as alternatively and (L1, L2) on P content in soil layers were illustrated in Table 5. A marked increment was detected due to treatments. The results obtained agree well with previous data by Tian *et al*., 2021. The application of different sources of soil treatments ameliorated the harmful effect of salinity on P content especially at 25- 50 cm saline soil layer in both seasons. This increment was more pronounced with increasing water depths. In 0- 25 cm soil layer, in the first season, the application of G treatment caused an increment of soil P content represented by 14.66%, this may be due to presence of sulfate (SO_4^{-}) which push phosphate (HPO_4^{-}) from adsorption sites to soil solution. Hence increase available-P.

Table 5 showed the effect of applied (C, G, FYM and N) and their duality treatment as well as (L1, L2) on K content in the studied soil. The results indicated that all the tested treatments increased soil K content in the two seasons. The increments in the soil K content were directly proportional with increasing water depths. In 0- 25 cm soil layer of the first season, the increment percentage in soil K content was 20.90, 16.53, 34.52, 5.42 and 64.16% as a result of L1 and application of C, G, FYM, N and their duality treatment, respectively and was 31.29, 21.74, 46.75, 2.66 and 74.42%increment as a result of applied the same materials and L2 in the same soil layer, respectively.

Yield components:

Results presented in Table 6 cleared the effect of different soil treatments (C, G, FYM and N) applied either alone or duality treatment and (L1, L2) on different yield components including (plant height, number of tillers, number of panicles and panicle length) of rice plants at harvest time under saline soil condition. Data showed a significant and progressive increment in all different yield components with application of water depths especially at L2. Also, different soil treatments caused a pronounced increment in all studied parameters of rice plants compared to Ck in both seasons. Similar effects of all treatments applied upon yield components were reported by Hidetoshi *et al*. (2021) on rice plants. Gogoi *et al*. (2010) found significantly higher effective tillers/ m^2, panicle length, filled grain/ panicle, test weight and grain yield of rice with the substitution of 50% N with farmyard manure over control and recommended dose fertilizer (RDF). The interactive effect between different water depths and soil treatments had significantly differences except the plant height and No. of tillers had non-significant.

Table 6. Effect of different water depths and soil treatments on different yield components of rice plants under saline soil in the two seasons.

parameters	Plant height (cm)		Number of tillers		Number of panicle\hill		Panicle length(cm)	
	2021	2022	2021	2022	2021	2022	2021	2022
Water depth (10cm)	99.21a	98.11a	20.45a	21.65a	15.28a	16.28a	14.28a	15.38a
Water depth (5cm)	92.097b	91.097b	16.56b	17.66b	13.60b	14.60b	12.60b	13.62b
Soil treatments								
Ck	90.98 l	89.78 l	15.68g	16.88g	11.55g	12.55g	18.1j	19.11j
C	92.01k	91.01k	16.65f	17.85f	12.65f	13.65f	19.1i	20.11i
FYM	93.4j	92.2j	17.10f	18.15f	13.15e	15.15e	19.5h	20.51h
FYM + C	93.6i	92.4i	17.75e	18.85e	13.38e	14.38e	20.6g	21.63g
G	93.9h	92.7h	17.75e	18.85e	13.9d	14.9d	20.6g	21.36g
G + C	95.1g	94.1g	18.45d	19.55d	14.4c	15.4c	21.2f	22.21f
G + FYM	95.4f	94.3f	18.75c	19.95c	14.66c	14.66c	21.4d	22.42d
G + FYM + C	95.58 e	94.48 e	18.75c	19.95c	14.65c	15.65c	21.35e	22.33e
N	95.71e	94.51e	19.03c	20.05c	14.65c	15.65c	21.35e	22.33e
N + C	97.01d	96.01d	19.12c	20.15c	14.75c	14.75c	21.4d	22.42d
N + FYM	97.96 c	96.95c	19.65b	20.75b	15.86b	16.86b	21.6c	22.61c
N + G	100.13b	99.11b	21.12a	22.15a	17.00a	18.00a	21.8b	22.81b
N + G + FYM + C	102.7a	102.7a	21.35a	22.45a	17.2a	18.2a	22.1a	23.11a
Interaction	Ns	Ns	Ns	Ns	***	***	***	***

Ck = control, C = compost, FYM = farmyard manure, G = gypsum, N = urea

The interactive effect among (L1, L2) and (N, FYM, C and G) treatments separately or alternatively as applied in saline soil on No. of panicle/hill and panicle length of rice plants were recorded in Table 7. All treatments markedly improved these parameters in the two seasons. The application of these tested materials, especially the duality treatment ameliorated the harmful effect of salinity on measured yield components.

The effect of both water depths and soil treatments applied separately or together caused a pronounced increment in the studied yield components involved (filled grain/ panicle, 1000 grain, grain yield and straw yield) at harvest time compared to control values Table 8. The increments in the studied yield components were directly proportional with increasing water depths. Additionally, the duality treatment of the tested materials seemed to be the most effective treatment compared to other treatments in increasing the different yield components. The results obtained in the present investigation concerning the effect of tested materials on yield components agree well with previous data by Laila *et al*. (2021) and Hidetoshi *et al*. (2021) on rice plants. Ranjitha *et al*. (2013) indicated that application of 50% recommended dose of nitrogen through urea + 50% recommended dose of nitrogen through vermicompost recorded the significantly maximum grain and straw yield of rice. It could be noticed that the interactive effect between water depths and different soil amendments as well as their duality treatment were non-significant differences to the grain and straw yield.

Concerning filled grain/ panicle and 1000 grain, the application of (N, FYM, C and G) as pretreated in saline soil separately or alternatively and (L1, L2) significantly increased the studied parameters in both seasons Table 9. It was noticed that the lowest percentage of the tested characters were achieved from Ck plots. Meanwhile, the highest values of the increment of the same characters were obtained by duality treatment of the different soil treatments at L2, the N + C treatment in filled grain/ panicle was lower than the control at L1 in both seasons. For instance, the increment percentage of filled grain/ panicle and 1000 grain were 24.08 and 11.49 % as a result of application of duality treatment of different soil treatments at L2, respectively relative to Ck plots of the first season.

Table 7. Effect of interaction between water depths and soil treatments on number of panicle\hill and panicle length (cm) of rice plants under saline soil in the two seasons.

parameters	number of panicle/hill				Panicle length /cm			
	2021		2022		2021		2022	
	Water depth				Water depth			
Treatments	(5cm)	(10cm)	(5cm)	(10cm)	(5cm)	(10cm)	(5cm)	(10cm)
Ck	11.7j	13.13ghij	12.7j	15.13ghij	18.6j	21.1fg	17.6j	20.1fg
C	12.7hij	14.73cdefg	13.7hij	15.73cdefg	20.5gh	23bcde	19.5gh	22bcde
FYM	14efghi	14.767cdefg	15efghi	15.767cdefg	21.13fg	23.5abcd	20.13fg	22.5abcd
FYM + C	14.8cdefg	16.56b	15.8cdefg	17.56b	21.23fg	23.86abc	20.23fg	22.86abc
G	13.1ghij	14.53cdefgh	14.1ghij	15.53cdefgh	19.33ij	22.667ef	18.33ij	21.667ef
G + C	12.63hij	14.43cdefgh	13.63hij	15.43cdefgh	19.73hi	22.73cde	18.73hi	22.73cde
G + FYM	13.86efghi	15.3bcdef	14.86efghi	16.3bcdef	20.93gh	23.7abc	19.93gh	22.7abc
G + FYM + C	14.06defghi	16.267bc	15.06defghi	17.267bc	20.83gh	24.06ab	20.83gh	23.06ab
N	14.53cdefgh	15.96bcd	15.53cdefgh	16.96bcd	20.1ghi	23.26bcde	19.1ghi	22.26bcde
N + C	12.3ij	14.06defghi	13.3ij	15.06defghi	19.2ij	22.36de	18.2ij	21.36de
N + FYM	13.5fghi	15.4bcdef	14.5fghi	16.4bcdef	20.26ghi	23.96abc	20.26ghi	22.96abc
N + G	14efghi	15.7bcde	15efghi	16.7bcde	20.6gh	24.23ab	19.6gh	23.23ab
N + G + FYM + C	15.667bcde	17.9a	16.667bcde	18.9a	21.13fg	24.63a	20.13fg	23.63a

Ck = control, C = compost, FYM = farmyard manure, G = gypsum, N = urea

Table 8. Effect of different water depths and soil treatments on different yield components of rice plants under saline soil in the two seasons.

Parameters	Filled grain/ pan		1000grain weight(gm)		Grain yield		Straw yield	
	2021	2022	2021	2022	2021	2022	2021	2022
Water depth (10cm)	141.45a	143.45a	25.28a	26.28a	6.90 a	7.90 a	8.65a	9.65a
Water depth (5cm)	134.87b	136.87b	23.00 b	24.00 b	6.45 b	7.45 b	7.71b	8.71b
Soil treatments								
Ck	120.75m	122.75m	21.7i	22.7i	4.94h	5.94h	5.82 m	6.82 m
C	121.25l	123.25l	22.2h	23.2h	5.94 g	6.94 g	6.82 l	7.82 l
FYM	125.85k	127.85k	23.2g	24.2g	6.016g	7.016g	6.96 k	7.96 k
FYM + C	126.45j	128.45j	24.3f	25.3f	6.34 f	7.34 f	7.29 j	8.29 j
G	130.55i	132.55i	24.3f	25.3f	6.44 ef	7.44 ef	7.626 i	8.626 i
G + C	132.35h	134.35h	24.3f	25.3f	6.47 ef	7.47 ef	8.06 h	9.06 h
G + FYM	138.35g	140.35g	24.4e	25.4e	6.51e	7.51e	8.56 g	9.56 g
G + FYM + C	142.55f	144.55f	24.4e	25.4e	6.71d	7.71d	8.72 f	9.72 f
N	146.95e	148.95e	24.5d	25.5d	6.74 d	7.74 d	8.82 e	9.82 e
N + C	147.85d	149.85d	24.5d	25.5d	6.81d	7.81d	8.86 d	9.86 d
N + FYM	152.45c	154.45c	26.1c	26.1c	7.11c	8.11c	9.14 c	10.14 c
N + G	152.75b	154.75b	26.4b	26.4b	7.59 b	8.59 b	9.74 b	10.74 b
N + G + FYM + C	158.05a	160.05a	26.6a	26.6a	9.12a	10.12a	9.89 a	10.89 a
Interaction	***	***	***	***	Ns	Ns	Ns	Ns

Ck = control, C = compost, FYM = farmyard manure, G = gypsum, N = urea

Table 9. Effect of different water depths and soil treatments on filled grain/ panicle and 1000 grain weight of rice plants under saline soil in the two seasons.

Parameters	Filled grains /panicle				1000grain weight(g)			
	2021		2022		2021		2022	
	Water depth				Water depth			
Treatments	(5cm)	(10cm)	(5cm)	(10cm)	(5cm)	(10cm)	(5cm)	(10cm)
Ck	131.2jk	135.53ijk	131.2jk	135.53ijk	21.1h	23.63de	22.1h	24.63de
C	138.53hij	142.53fghi	138.53hij	142.53fghi	23.2def	25.4abc	24.2def	26.4abc
FYM	151.36cde	155.36bcd	151.36cde	155.36bcd	23.33de	25.53abc	24.33de	26.53abc
FYM + C	159.767b	163.76ab	159.767b	163.76ab	23.9de	26.1ab	24.9de	27.1ab
G	140.6ghi	146.6efgh	140.6ghi	146.6efgh	22.03g	24.5cd	23.03g	25.5cd
G + C	134.36ijk	140.86ghi	134.36ijk	140.86ghi	23ef	25.13bc	24ef	26.13bc
G + FYM	144.5efgh	151cde	144.5efgh	151cde	23.43de	25.56abc	24.43de	26.56abc
G + FYM + C	155.83bc	162.33ab	155.83bc	162.33ab	24de	25.9ab	25de	26.9ab
N	149.76cdef	157.43bc	149.76cdef	157.43bc	23.23def	25.56abc	24.23def	26.56abc
N + C	129.26k	138.26hij	129.26k	138.26hij	22.13fg	24.33cde	23.13fg	25.33cde
N + FYM	138.5hij	147.5defg	138.5hij	147.5defg	23.23def	25.43abc	24.23def	26.43abc
N + G	150.53cde	159.53b	150.53cde	159.53b	23.36de	25.56abc	24.36de	26.56abc
N + G + FYM + C	159.16b	168.16a	159.16b	168.16a	24.26cde	26.46a	25.26cde	27.46a

Ck = control, C = compost, FYM = farmyard manure, G = gypsum, N = urea

Discussion

Soil physical properties affected by different soil treatments and water depths:

Bulk density, hydraulic conductivity and total soil porosity:

Data in Table 3 showed that the bulk density in top soil layer was decreased by applying different soil treatments with water depths as salt leaching. Beneficial effects of gypsum reclamation process have been reported by (Laila *et al.*, 2021) on rice plant. Gypsum receiving treatments may be explained by ameliorating effects of gypsum a site supplies the Ca^{2+}, which replaces the adsorbed Na^{+} from exchangeable site and this excessive toxic Na^{+} is accumulated in subsurface drain and leaching water removed it from the root zone (Mohamed *et al.*, 2012) and lead to significant decrease in soil pH (Abdel-Fattah, 2012). Consequently, this decrease in pH value, results a decline in other salinity indices, i.e. EC (Qadir and Oster, 2002) and lastly, decrease soil bulk density. Concerning the soil HC and TP were increased by applying G treatment and (L1, L2) compared with Ck Table 3 in two studied saline soil layers of both seasons. The increment of SHC was 135.14% as a result of applying this tested material at L2 in 0- 25 cm soil layer of the first season. This result was in agreement with

(Bayoumy *et al*., 2019). Thus, the beneficial effects of G treatment on soil HC primarily due to the fact that gypsum can improve soil structural stability through enhancing ionic strength effects and removing exchangeable sodium from the soil colloid (Rasouli *et al*., 2013). Hussain *et al*. (2001) stated that, physical properties like porosity, water permeability and hydraulic conductivity were significantly improved when FYM (10 ton ha^{-1}) was applied in combination with chemical amendments, resulting in enhanced rice and wheat yields in sodic soil. Similarly, the application of gypsum and farmyard manure have been reported to have improved soil properties, including pH, bulk density, EC, organic matter, hydraulic conductivity, after 3 years of application on a saline-sodic soil field condition (Ahmed *et al*., 2015). Compost application generally influences soil structure in a beneficial may be lowering soil density due to admixture of low density organic matter into the mineral soil fractions. The positive effect has been detected in most cases and it is typically associated with an increase in porosity because of the interactions between organic and inorganic fractions (Amlinger *et al*., 2007). The soil HC of the subsurface layer (25- 50 cm) in both seasons was lower than that of the surface soil layer Table 3. Hence, the efficiency of gypsum and different soil treatments on the salt leaching is likely to be astricted by the low HC of subsurface layer. This is indicated that a certain amount of replaced Na^+ retained in the soil profile (Rasouli *et al*., 2013).

Soil chemical properties affected by different soil treatments and water depths:

Soil salinity (EC):

Salt stress as manifested in saline soils is an important limitation to agricultural productivity for it reduces water potential and causes ion imbalance or disturbance in ion homeostasis and toxicity. The gypsum incorporation at 0- 25 cm soil layer with (L1, L2) as salt leaching decreased the soil salinity (EC) in both seasons Table 4. In (0- 25, 25- 50 cm) soil layer of the first season, the decrement in salinity by adding G treatment and L2 was 40.39 and 37.04%, respectively. Similar results had been reported by (Gonçalo Filho *et al*., 2019). This could be attributed to its provision of Ca^{2+}. In saline soil, a substantial percentage of the exchangeable Na^+ accomplished using $CaSO_4.2H_2O$. This exchangeable of Ca^{2+} for Na^+ in the soil colloids improves soil stabilization and permeability. The use of $CaSO_4.2H_2O$ reduces Na^+ from the cations exchange sites, thereby reducing its uptake by plants (Gonçalo Filho *et al*., 2019). Additionally, the application of soil amendments (C, FYM) as pretreated soil and (L1, L2) as salt leaching on such salt affected soil helps in diminishing salinity and improving soil characteristics Table 4. These finding are in agreement with those obtained by (Ding *et al*., 2021b). In a saline soil (10.6 dS m^{-1}) irrigated with a slightly saline water (4.28 dS m^{-1}), organic amendments, including vermicompost and cow dung, were found to improve the soil EC (3.37 dS m^{-1}) and pH, thus increasing maize growth compared to untreated control (Khatun *et al*., 2019). Our results could be explained as a reflection of the activity of microorganisms in reducing salinity and simultaneously improving soil structure, increasing drainable pores, total porosity, aggregate stability, and consequently enhanced leaching process through irrigation fractions (Shaban *et al*., 2012).

Soil pH:

The soil pH value was increased in Ck plots due to salinity. In saline soil, there is excessive Na^+ and certain amount of HCO_3 in the soil solution which accelerate the soil alkalization (Guo *et al*., 2006). Application of G treatment and (L1, L2) as salt leaching maintained lower soil pH values than Ck plots in both season Table 4. The decline of soil pH value from adding G to saline soil has been reported by (Bayoumy *et al*., 2019). This could be attributed to the formation of precipitates such as $CaCO_3$ and $Ca(HCO_3)_2$ (Qadir *et al*., 2001). The application of $CaSO_4.2H_2O$ reduced the soil pH from 8.1 to 7.64, soil EC from 6.21 to 2.39 dS/m (Lastiri-Hernández *et al*., 2019). Gypsum application, along with humic acid and organic manure, in a saline-sodic soil has been demonstrated to improve soil pH, EC (2.65 dS m^{-1} from 6.35 dS m^{-1}) and, consequently, the root growth and yield of rice (Shaaban *et al*., 2013). Also, the soil pH values were decreased due to the application of different soil amendments (C, FYM) with (L1, L2) as salt leaching especially at L2 in both seasons Table 4. Similar results have been obtained by Rebeka (2006) who found that compost fertilizer lowed pH, salinity (EC, for lower dilutions). The slight decrease of soil pH values may reflect the activity of microorganisms in decomposing organic matter and releasing organic acids. These results were in harmony with these obtained by Shaban and Omar, (2006).

Soil organic matter:

Data in Table 4 indicated that OM was increased against salinity compared with Ck in the two seasons. This increment due to the application of different sources of soil treatments with water depths as salt leaching. Soil salinity reduces the soil organic matter content, soil-water holding capacity, water infiltration, weakness the soil structure and disrupts the soil aggregate stability (Gonçalo Filho *et al*., 2019). Organic matter acts as chelates for basic cations, such as Ca^{2+} and Mg^{2+}, in the soil solution and thus promotes their uptake compared to Na^+.

Concerning available nutrients content, Soil available (N, P and K) was decreased in Ck plots due to salinity. While, they increased by applying (N, C, FYM and G) treatments and (L1, L2) in the two study seasons. Without proper monitoring, irrigation water often concentrations a high concentration of salts, which increases the susceptibility of soils and crops to salinity stress (Tanji and Kielen, 2002). The excessive uptake of these salts leads to toxicity, which has negative impacts on growth and productivity by reducing the availability and uptake of water and essential nutrients, such as nitrogen (N) and phosphorus (P) (Khan *et al*., 2019). Gypsum application increases the availability of several nutrients, such as P, and promotes a balanced concentration of electrolytes in the soil solution (Alcívar *et al*., 2018). Provision of Ca through gypsum application can also help with reversing the negative impact of salinity on P uptake (Cuevas *et al*., 2019). The application of FYM at rate 3 ton increased the P and K applied to the soil by 11 and 55 kg/ha per year (Cathy *et al*., 2019). In addition, the combined use of organic materials (e.g., compost and straw) as bioorganic amendments with gypsum has a great potential in ameliorating saline soils. This combination could improve the soil structure, increase the soil organic carbon, humus and nutrient contents, which are the most growth-constraining factors in saline soils.

Rice yield affected by different soil treatments and water depths:

The total rice yield (grain + straw) were negatively affected by saline soil and resulted in a marked reduction in control plots. This could be explained to salinity results in a toxic accumulation of Na^+ which creates osmotic stress in plants eventually leading to cell death due to low water uptake (Ahanger *et al*., 2018). This excessive accumulation of Na^+ thereby leads to plant wilting even under adequate soil moisture (Abdelhamid *et al*., 2013). Therefore, agricultural productivity under salt stress was significantly declined by reduction in plant vigor, growth, development and yield (Cheeseman, 2015). Gypsum application is foremost among the widely known methods of reclaiming salt-affected soils (Lastiri-Hernández *et al*., 2019). The gypsum increased the total yield (grain, straw) by 30.36 and 30.93 %, respectively in the first season compared to un-amended plots. Soil solutions in gypsum treated plots had better Ca^{2+}/Na^+ ratio that have been categorized as a reliable indicator of salt stress in the rooting medium of salt-affected soils (Munnus and termaat, 1986). Our results clearly demonstrated that the use of FYM, urea and compost treatments separately is a practical alternative to mineral fertilizers. Ranjitha *et al.* (2013) indicated that application of 50% recommended dose of nitrogen through urea + 50% recommended dose of nitrogen through vermicompost recorded the significantly maximum grain and straw yield of rice. The addition of these organic materials to saline soil may improve soil quality and health for increased rice production compared to control plots under different water depths as salt leaching especially at high levels to reduce the salts in soil solution. These results were consistent the previous reported by (Hidetoshi *et al*., 2021). The application of organic materials in the topsoil of saline soils help in reducing soil evaporation, salt water movement and salt accumulation by regulating the distribution of salt in the rhizosphere (Cuevas *et al*., 2019). The duality treatment of different soil amendments and the two water depths as salt leaching had the best effectiveness for improving our studied total yield of rice compared to control one Table 8. This can be primarily due to the lower EC in duality treatment of soil amendments. Furthermore, the application of these tested materials also enhanced the salt tolerance and improved the rice growth.

Yield components affected by different soil treatments and water depths:

The pattern changes in different yield components of rice plants including; plant height, number of tillers, number of panicles and panicle length, filled grain/ panicle, 1000 grain, grain yield and straw yield were significantly suppressed in response to saline soil in control plots of two growing seasons. Both of soil treatments and water depths treatments significantly increased the yield components Table 6 and 8. On uptake at moderate levels, Ca^{2+} supplementation promotes crops tolerance to salinity stress by increasing the hydraulic conductivity and leaf surface area (Cramer, 1992). Apart from the improvement of nutrients uptake, the increase of 1000-seed weight by applying gypsum can also be achieved by extending the days to maturity and filling period (Rasouli *et al*., 2013). Concerning the FYM, urea and compost treatments as pretreated soil and water depths as salt leaching Table 6 and 8. These tested materials also increased the yield components compared to un-amended plots in both seasons. Gogoi *et al*. (2010) found significantly higher effective tillers/ m^2, panicle length, filled grain/ panicle, test weight and grain yield of rice with the substitution of 50% N with farmyard manure over control and recommended dose fertilizer (RDF) (60: 20: 40 kg N, P, K per ha).

Additionally, the duality treatment of soil amendments had higher effective on rice yield component than untreated plots at two water depths in the two seasons Table 7 and 9. The duality treatment of these tested materials increased the yield components. This could be due to the improvement of plant growth conditions and nutritional balance by applying the tested soil amendments (Qadir *et al*., 2001). Generally, the rice plants which growing in saline soil nutritional deficiency had caused by insufficient supply of nutrients and toxicity of Na^+ (Tejada *et al*., 2006).

CONCLUSION

Under saline sodic soil condition, the results showed that continual use of water levels in irrigation improves the available nutrients content, HC, TP, OM in the studied saline soil as well as the yield components of rice plants in the two growing seasons but the same time, decreased EC, pH and BD. Application of (G, C, FYM and N) treatments and (L1, L2) improved the physical and chemical properties of the studied saline soil layers. The application of these tested materials separately and (L1, L2) decreased soil pH value, soil salinity (EC) and BD in surface saline soil layer. Meanwhile, increased the soil HC, TSP, OM as well as available nutrients content except N treatment had no differences effect on BD, TSP, pH value. However, lower HC in the subsurface layer likely restricted salt leaching and resulted in the retention of replaced Na^+ in the soil layer. The improvement in surface soil conditions under (G, FYM, C and N) and (L1, L2) favorably affected rice yield and its components which was reflected in increased plant height, number of tillers, number of panicles and panicle length, filled grain/ panicle, 1000 grain, grain yield and straw yield.

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تأثير مصادر مختلفة من النتروجين على محصول الأرز وصحة التربة في الاراضي الملحية الصودية

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الملخص

أقيمت تجربة حقلية فى منطقة الحامول- كفرالشيخ خلال الموسمين الزراعيين 2021- 2022 بهدف استجابة نباتات الأرز للرى بمستويين ماء مختلفين (5, 10 سم) وكذلك دراسة تطبيق(الكمبوست بمعدل 10طن/هكتار - السماد البلدي بمعدل 10طن/هكتار - الجبس بمعدل 5طن/هكتار - اليوريا بمعدل 165 كيلوجرام/هكتار) كمعاملات أرضية للتربة قبل الزراعة بغرض التغلب على التأثير الضار للملوحة وقد طبقت هذة المواد فى صورة منفردة أو معاً كما تم دراسة بعض الخواص الفيزيائية والكيميائية للتربة. وفى النهاية تم أخذ المحصول لدراسة طول النبات- طول السنبلة- عدد الفروع/ للجورة- عدد السنابل\للجورة - وزن 1000 حبة- الوزن الكلى للحبوب والقش\طن\للهتكار. ويمكن تلخيص أهم النتائج فيما يلى: أشارت النتائج إلى حدوث نقص فى قيم كل من الكثافة الظاهرية, حموضة التربةومحتوى الأملاح للتربة خصوصاً عند10سم ماء رى مع تطبيق كل المعاملات المضافة للتربة ما عدا اليوريا كانت غير مؤثرة وكانت معاملة الكمبوست+الجبس أكثر المعاملات فاعلية مع مستوى الري المرتفع فى كلا الموسمين. أدت إضافة المعاملات إلى زيادة ملحوظة لبعض خواص التربة السطحية عن الطبقة تحت السطحية مثل التوصيل الهيدروليكى, المادة العضوية والمسامية الكلية للتربة خاصة عند مستوى الري الأعلى ما عدا اليوريا كانت غير مؤثرة كما حدث تفوق واضح لمستوى النتروجين والفسفور والبوتاسيوم فى التربة نتيجة كل المعاملات وكانت المعاملة المشتركة أكثر المعاملات فاعلية خاصة عند مستوى الري الأعلى فى كلا الموسمين. أظهرت نتائج التفاعل المشترك وجود زيادة معنوية واضحة فى قياسات المحصول مقارنة بالنباتات الغير معاملة (الكنترول) وسجلت المعاملةالمشتركة خاصة عند مستوى الري (10سم) أعلى القيم للمحصول ومكوناتة فى كلا الموسمين.