Improving and Sustaining some Soil Properties and Productivity of Some Crops by combined effect of Vermicompost, phosphogypsum and Nitrogen Fertilizer Under Salt-Affected Soils

ABSTRACT

Two a field experiments were carried out at special farm, El Homel Distract . Kafr El-Sheikh Governorate , EGYPT during winter 2020/2021 and summer 2021 seasons to improving and sustaining some soil properties and productivity of wheat and rice by adding vermicompost and phosphogypsum as well as nitrogen fertilizer under salt-affected soils. The experimental designed were arranged in split plot design. The main plot, T_1: Check treatment,T_2: 100% from gypsum requirements as phosphogypsum (PG), T_3: 4ton /fed. from vermicompost (VC) and T_4: 100% GR (PG) +2ton VC. The sub plot were nitrogen fertilization N_1(50% from N-recommended).N_2 (75% from N-recommended) and N_3 (100% from N-recommended). After standardizing the inorganic nitrogen contents in the soil. The obtained results showed that Electrical conductivity (EC) in soil past extract , exchangeable sodium percentage (ESP), soil bulk density and soil penetration resistances were highly significant decreased ($P \leq 0.01$) by application of the soil amendments and recorded lowest values with PG+VC after harvesting of Wheat and Rice. Cation exchange capacity (CEC), soil porosity and soil basic infiltration rate (IR)were highly significant increased by individual application of vermin-compost, phosphogypsum and recorded highest values with PG+VC after harvesting of Rice and Wheat. 1000-grain weight, grain and straw yield of Wheat and Rice were highly significant increased by application both of PG, VC and recorded highest values due to the interaction between 100% from GR as PG + 2ton VC x N_{100}

Keywords :EC, ESP, IR, phosphogypsum, Rice, Soil properties ,Vermicompost and Wheat

1. INTRODUCTION

One of the major reasons for low productivity of crops grown on salt-affected soil is the salt toxicity and poor soil properties [1].Increasing the concentration of soluble salts in the soil by more than 4 dSm^{-1} influences plant growth and is certainly reflected in the quantity and quality of the crop in many areas around the world [2]. The increase of salts concentration in the root zoon especially the ions of Na^+, Cl^-, Mg^{2+}, $SO4_2^-$ or HCO_3^- causes toxicity to cross, moreover it affects the inhibition of biochemical and physiological processes as well as disrupting the metabolism and oxidation and reduction reactions inside the plant cell, thus disrupting water and nutrients uptake, the development of crop growth and the spread of the roots inside the soil[3].A need, therefore, exists for low-cost, efficient treatment strategies to reduce the salt toxicity of soils and to improve the soil properties as well as yield of wheat and rice crops .According to the Central Agency for Public Mobilization and Statistics (CAPMAS), Egypt is one of the largest importers of wheat in the world, and 80% of its supply is from Russia and Ukraine. Egypt consumes up to 21 million tons of wheat, around 13 million tons of which are imported. Rice (*Oryza sativa L.*) is a staple food of more than 50% of the world's population [4] and supplies 20% of total calories required by world and 31% required by the Egyptian population. Leaching of sodium from the root zone is one of the most common and effective methods for controlling sodium accumulation in salt affected soils [5]. The application of gypsum increases soluble Ca^{2+},thus helping to overcome the dispersion acts of Na^+ and to promote structure development in dispersed soils. Gypsum is typically used as a source of calcium to remove the exchangeable sodium. The application of calcium amendments can improve various soil properties and act as soil modifiers that prevent the development of sodicity which is directly related to plant growth and crop yields [6].Industrial byproduct such as phosphogypsum (96% $CaSO_4$_$2H_2O$ help in the reclamation of salt affected soils by providing Ca [7]. Nowadays scientific studies have mentioned the threat of using chemical fertilization and its harmful effects on the human health and environment ,Vermicompost is a potential input and nutritive organic fertilizer rich in humus, macro and micro nutrients, growth hormones (auxines, gibberlins and cytokinins) and beneficial for soil microbes. It is an excellent soil amendment and conditioner [8]. Vermicompost is considered an organic fertilizer as it is rich in nutrient and acting as a soil conditioner, it is concluded that indigenously prepared earthworm's vermicompost is still superior over conventionally prepared composts as it carries at least 4 times of nutrient comparing with conventional cattle dung compost [9].As a result, vermicompost is the best choice for organic manure management in crop processing, soil health improvement, efficiency and production enhancement, as well as microbial activity and soil properties [10].Such as soil organic carbon status, decreased bulk density, increased soil porosity and water holding capacity, increased dehydrogenase activity, and increased soil microbes [11].Worm casts have been found to contain four times more organic matter than surface soil, with average values of 48.2 and 11.9 g kg^{-1}soil, respectively [12] .With the continued application of vermicompost the ‘organic nitrogen’ and other nutrients tends to be released at a constant rate from the accumulated ‘humus’. The decaying organic matter increases soil CO_2 concentrations and releases H^+ when it dissolves in water. The released H^+ enhances $CaCO_3$ dissolution and liberates more calcium (Ca) for sodium (Na) exchange [5].The anaerobic conditions during rice growth with VC also provided higher CO_2, which could increase the amount of soluble $Ca^{2+}$for soil reclamation [6].Moreover, organic materials improve the soil physicochemical properties that accelerate exchange of cations on soil solids and leaching of salts from the root zone [13] , hence preventing root from salt injuries and roots can grow more smoothly. [14] Found a mixture of 75% chemical fertilizer and 25% vermicompost produced the largest tomato plant and fruit yield. The addition of organic materials in conjunction with gypsum hastens the reclamation process and also reduces the gypsum requirement [7].While it is generally believed that vermicompost only provides longterm benefits, there are many studies that show otherwise. Vermicompost increases the yield of grains such as wheat and maize [15] and legumes [16] and the growth and yield of fruits [17] and vegetables [18] .Vermicompost can increase soil total organic carbon (TOC) [19] , N and P [20]. A correlation between increased soil N from vermicompost and plant biomass has been demonstrated by [21] .The combined application of inorganic, for instance gypsum, and organic amendments, like farm manure and humic acid, improves their effectiveness for increasing soil properties [22]. Based on the above information, we planned a short term study to examine the effect of phosphogypsum (PG), vermicompost (VC) and PG+1/2VC application on amelioration of salt affected saline sodic soil and yield both of wheat (*Triticum asestivum* L.) and rice (*Oryza sativa L.*).

2. MATERIALS AND METHODS

Two field experiments were conducted at Hamoel, Kafr El Sheikh, Egypt during two growing season (winter 2020/2021 and summer of 2021) to study the improvement of some soil properties and productivity both of Wheat (*Triticum aestivum L.)* and Rice (*Oryza sativa L.*) by application of phosphogypsum (96% $CaSO_4$_$2H_2O$), vermicompost and nitrogen fertilization under salt-affected soils. The experimental designed were arranged in split plot design with three replications. The main plot (soil amendments), T1: Check treatment,T2: phosphor-gypsum (PG), T3: vermi-compost (VC, 4tonfed.$^{-1}$) and T4: PG+VC (2tonfed.$^{-1}$). The sub plot were nitrogen fertilization N_1(100% from N-recommended).N_2 (75% from N-recommended) and N_3 (50% from N-recommended).), where vermicompost was applied at 4tonfed.$^{-1}$.Therefore, of each the experiment units were 36 plots where the area of each plot was 42 m^2 (6X 7 m).Wheat Cv. Giza 171 was sowing in 20th Nov. winter season of 2020/2021 and Rice Cv. Giza 178 inthe 15june summer seasons of 2021. The Rice plants were harvested at 135 days after transplanting. And also harvest of wheat after 160 days from sowing. All the agronomic practices were applied as per recommendations. Nitrogen (N) fertilizer was applied as sulphate ammonium (33% N) at rate of 70kg fed^{-1} in two equal doses at 21 and 55 DAS, respectively for Rice.And75kg fed^{-1} as urea (46.5%N) for Wheat. The recommended dose of phosphorus as mono phosphate (15.5% P_2O_5) and potassium as potassium sulfate (48% K_2O), and fertilizers were applied to the Rice and Wheat plants before planting (at final tillage) at rates of 15 KgP_2O_5 fed^{-1} and 30K_2O fed^{-1}, respectively.1000- grain weight (g), Grain and straw yield of Rice and Wheat were determined at harvesting stage . Soil samples were collected at depths (0-20, 20- 40 and 40-60cm) before experiments and after harvesting of both crops for all treatments to carry out some physical and chemical analysis. Salinity was determined in saturated soil paste extract, cation exchange capacity (CEC) and exchangeable sodium percentage (ESP) according to [23]**.** Organic matter (OM) content was determined using the Walkley and Black method according to [24]**.** Soil bulk density and total porosity of different soil layers for all treatments were measured before experiments and after harvesting using the core sampling technique as described by **[25].** Particle size distribution of soil was measured using pipette method according to **[26]**. Infiltration rate was determined using double cylinder infiltrometer as described by [27]**.** Field capacity (FC) and permanent wilting point (PWP) were determined by using pressure membrane method at 0.33 and 15 bars **[28].**Gypsum ($CaSO_4.2H_2O$) requirements (GR) were determined according to **[29]** to reduce the initial ESP for the soil matrix to

10% in the surface layer (0-30 cm) according to the following equation: GR = (ESP_i – ESP_f) x CEC x 1.72× (100/purity) Where: GR: gypsum requirements (Mg ha^{-1}) for upper 30 cm soil, ESP_i: initial soil ESP, ESP_f: The desired soil ESP and CEC: cation exchange capacity (cmolc kg^{-1})and 1.72 is the amount (ton) of $CaSO_4{\cdot}2H_2O$ required to reduce Na^+ content of the soil by one unit (1 cmolc Na 100 g^{-1} soil).

Some physical and chemical properties of the experimental soil are shown in Tables (1).The meteorological data from Sakha Station during the growing seasons are presented in Table 2.

Table 1: *Some* physical and chemical properties *of the experimental soil.*

Soil depth(cm)	**Soil physical characteristics**								
	Soil moisture characteristics					**Particle size distribution** (%)			
	F.C (%)	**W.P. (%)**	**A.W. (%)**	**B.D. (kg m^{-3})**	**IR (cm/h)**	**Sand**	**Salt**	**Clay**	**Soil texture**
0-20	44.11	22.01	22.10	1.30		17.31	255.1	571.8	clay
20-40	40.52	20.28	20.24	1.32	0.55	18.85	247.6	563.9	clay
40-60	38.03	19.03	19.00	1.32		19.06	251.2	558.2	clay

Soil chemical properties						
Soil depth(cm)	**pH**	**EC (dSm^{-1})**	**ESP (%)**	**CEC (cmole kg^{-1})**	**OM (%)**	**$CaCO_3$ (%)**
0-20	8.31	11.12	15.89	31.19	1.78	1.98
20-40	8.39	13.79	17.96	30.95	1.64	2.09
40-60	8.46	14.52	19.42	30.65	1.42	2.16

F.C.: Field Capacity**; W.P.:** Wilting Point; **A.W**.: Available Water; **B.D**.: Bulk Density;**IR**: ;**pH**: was determined in soil water suspension (1:2.5);**EC**: was determined in saturated soil paste extract;**ESP:** Exchangeable Sodium Percent; **CEC:**Cation Exchange Capacity;**OM**: Organic Matter.

Table (2). Composition of the vermicompost

moisture	Organic carbon	Nitrogen	Phosphorous	Potassium	Sodium	Calcium	Magnesium	Copper	Iron	Zinc
%						meq/100g		mg kg-1		
25	12	1.11	0.16	0.45	0.08	14.1	8.15	2.1	1.35	9.48

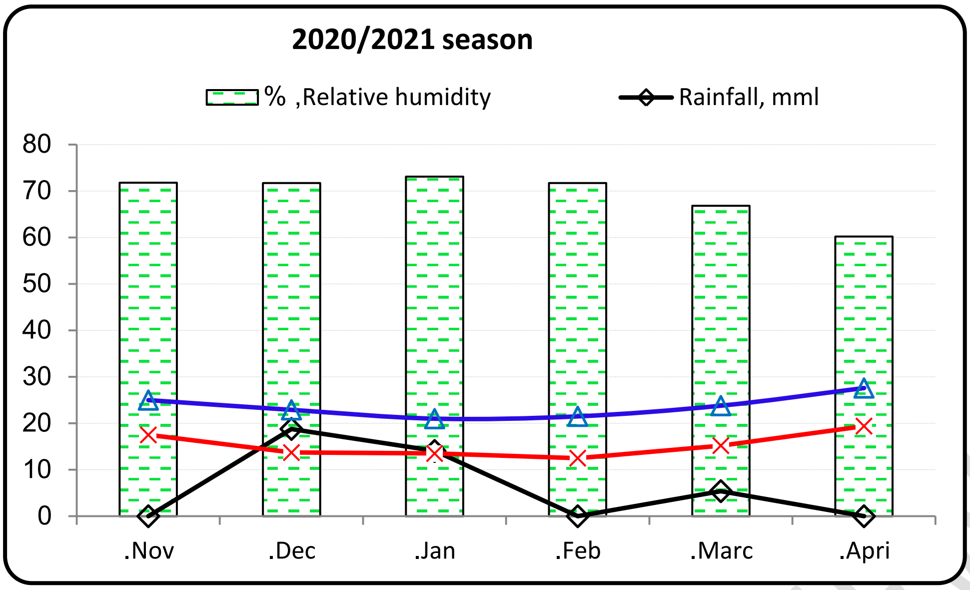

Fig.(1.a). Meteorological data of temperature (°C), rainfall (mm), and relative humidity (%) during 2020/2021 and 2021 growing seasons

Statistical analysis

The data were analyzed statistically by analysis of variance (ANOVA) using Cohort computer program according to [30]. Mean separation procedure was performed using LSD, S test at a 0.05 and 0.01 level of significance.

3. RESULTS AND DISCUSSION

3.1 Soil chemical properties

The effect of phosphogypsum (PG), vermicompost (VC) and its combination on some soil chemical properties are presented in (Table 3 and Fig.2).

The results revealed that the Electrical Conductivity (EC), Exchangeable Sodium Percentage (ESP) and Cation Exchange Capacity (CEC) were highly significant ($P \leq 0.01$) influenced by individually application of soil amendments. The same data showed that soil salinity (EC_e) was recorded lowest values (9.37 and 8.44dSm^{-1}) for 1st season and 2nd season with combined application of phosphogypsum and vermicompost (PG +VC). Fig.(1.a) showed that EC was decreased by about 32.59% by application of PG+VC after harvesting of Wheat and Rice .

Also ESP took the same trend and recorded lowest values (10.26 and 9.21%) for 1st season and 2nd season by application of phosphogypsum and vermicompost (PG +VC). ESP was decreased by about (42.52% and 47.88%) after harvesting of wheat and Rice (Fig.2.a)

These results may be due to the role of phosphogypsum as industrial byproducts help in the reclamation of saline sodic soils by providing Ca these treatments on improving chemical of soil properties. These results are supported by [6 and7]

Table (3) pointed out that the application of soil amendments have positive effect on increasingof CEC significantly ($P \leq 0.01$) with application of PG, VC, and their combination (PG + VC).The application of VC was the most effective treatment via recording the highest values(41.47 and 42.28cmolekg^{-1}) after harvesting of wheat and rice

Fig.(2.b) Showed that CEC was increased by about (35.57% and 36.87%) with application of VC after harvesting of Wheat and Rice. The effect of treatments can be arranged in descending order: V > PG + VC > PG > control.

This result was probably due to the effect of VC on increasing the specific surface and thus increasing soil exchangeable capacity soil as reported by[13,5]

EC and ESP were non- significant affected with application of Nitrogen fertilizer as compared without application during two growing seasons as show Table (3).The same data pointed out that EC was significantly decreased and recorded lowest values (9.35 and 8.42dSm^{-1}) for 1stseason and 2nd season due to the interaction between PG+2ton VC x N_{50}.

On the other hand ESP was insignificant affect due to the interaction between A x B during two growing season, and recorded lowest values (10.22 and 9.18) for 1st and 2ndseason due toPG+2ton VC x N_{50} as compared to the other treatments .

With regarded to CEC was highly significant increased ($P \leq 0.01$) and recorded highest values (41.55 and 42.55 cmolekg^{-1})for 1st season and 2nd season due to the interaction between PG + VC x N_{100}

Table 3.Mean values of EC (dsm^{-1}), exchangeable sodium percentage (ESP %) and cation exchange capacity ($cmolekg^{-1}$) as affected by the soil amendments, nitrogen fertilizer and its interaction after harvesting of winter wheat 2020/21 and rice in summer of 2021 seasons.

Treatment	After wheat (1st season)			After Rice (2nd season)		
	EC (dSm^{-1})	**ESP** (%)	**CEC** ($cmolekg^{-1}$)	**EC** (dSm^{-1})	**ESP** (%)	**CEC** ($cmolekg^{-1}$)
Soil amendments (A)						
Control	13.90a	17.85a	30.59d	12.52a	17.67a	30.89d
PG	10.76c	11.52c	30.80c	9.70c	11.21c	31.09c
VC	13.43b	16.61b	41.47a	12.10b	16.07b	42.28a
PG+VC	9.37d	10.26d	40.84b	8.44d	9.21d	41.18b
F_{test}	**	**	**	**	**	**
$LSD_{0.05}$	0.038	0.064	0.067	0.034	0.147	0.025
$LSD_{0.01}$	0.058	0.098	0.102	0.052	0.223	0.039
N-Fert. (B)						
50%N	11.89	14.05	35.93	10.71	13.59	36.30
75%N	11.84	14.06	35.89	10.66	13.53	36.34
100%N	11.87	14.08	35.96	10.69	13.52	36.44
F_{test}	ns	ns	ns	ns	ns	ns
Interaction						
A x B	**	ns	*	**	ns	*

Means of each factor followed by the same letter are not significantly different at 5 % level according to Duncan's multiple range test.*indicate significant $p < 0.05$,** indicate significant $p < 0.01$ and ns indicate not significant. The values mean over soil depths of (0-20, 20- 40 and 40-60cm)

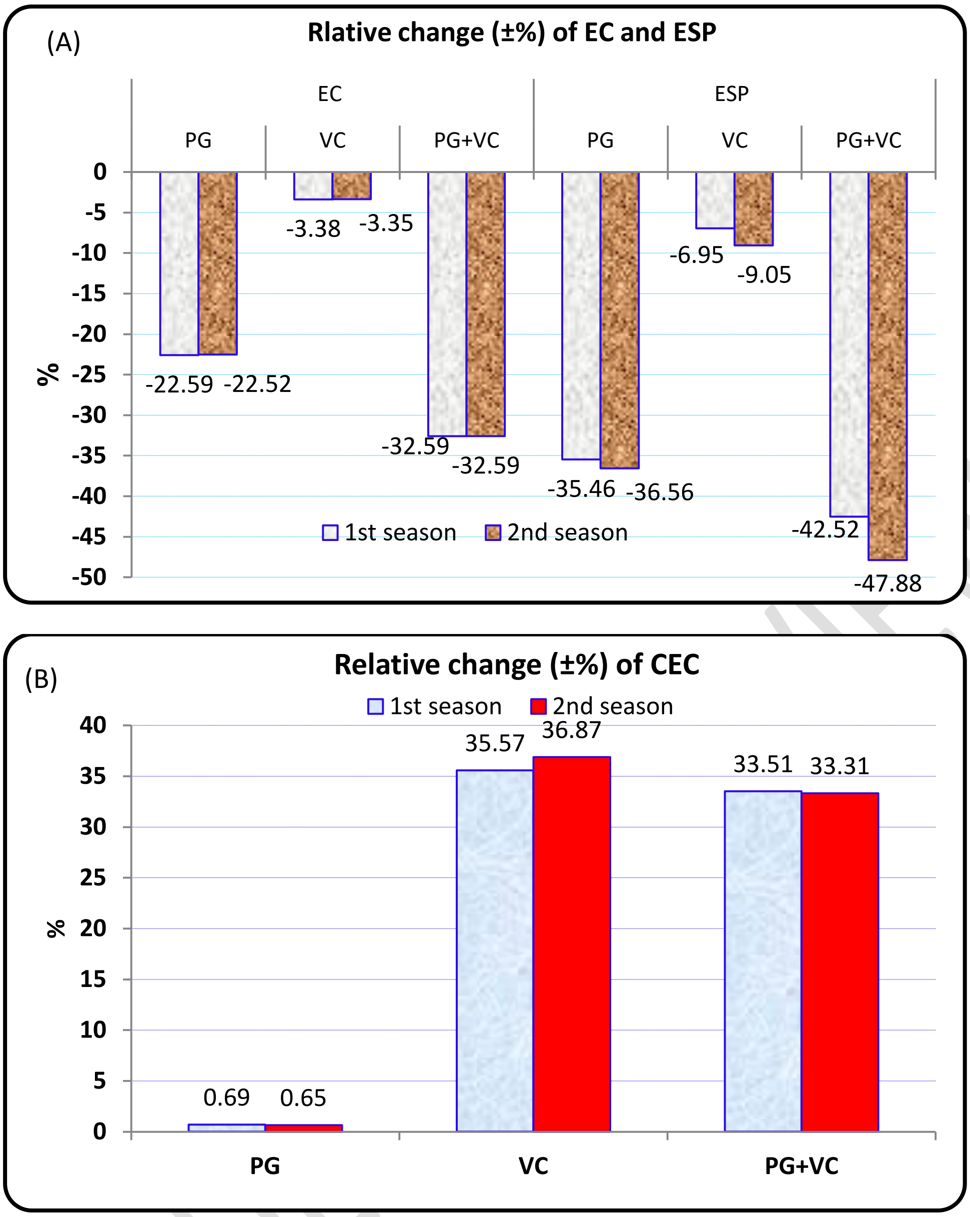

Fig.(2): Relative change (± %) mean values of EC (dsm^{-1}), Exchangeable sodium percentage (ESP %) and cation Exchange capacity (cmolekg^{-1}) as affected by the soil amendments, in 2020 and 2021 seasons.

3.2 Soil physical properties:

3.2a. Soil bulk density:

Fig.(3.a) showed that soil bulk density was decreased due to individual application of phspho-gypsum, vermin-compost and recorded lowest values (1.29 and 1.28Mg/m^3) for 1st season and 2nd season with treatment of PG+VC as compared to without application .

The same data showed that decreased as equation Y= -0.027x +1.398 (R^2= 0.94) for 1st season and Y= -0.028x +1.393 (R^2= 0.99) for 2nd season.

3.2.b. Soil porosity

With regarded to the soil porosity was increased with application of the soil amendments and recorded highest values (51.32 and 51.70%) for 1st season and 2nd season with treatment of PG+VC as compared to without application as shown (Fig.3.b).

The same data showed that decreased as equation Y= 1.018x +47.23 (R^2 = 0.997) for 1st season and Y=1.081x +47.42 (R^2= 0.99) for 2nd season. The effect of soil amendments can be arranged in descending order: PG+VC > VC >PG>control.Thesis results may be due to the application of phosphor-gypsum increases soluble $Ca^{2+,}$ thus helping to overcome the dispersion acts of Na^+ and to promote structure development in dispersed soils and the role of vermicompost on improved both soil bulk density and its porosity. These results are supported by [10].

3.2.c. Soil penetration resistances

Fig.(3.c) pointed out that Soil Penetration Resistances (SPRa) was decreased by application of soil amendments and recorded lowest values (1.09 and 0.89Mpa) for 1stand 2nd seasons with application of PG+VC as compared to the other treatments. The same data showed that decreased as equation Y= -0.073x +1.415 (R^2 = 0.894) for 1st season and Y= -0.136x +1.508 (R^2 = 0.819) for 2nd season

3.1.d. Soil basic infiltration rate (IR) :

Data in Fig.(4) Cleared that soil basic infiltration rate (IR) was increased by individual application of PG , VC and recorded highest values (1.3 and 1.38 cm/h)for 1st season and for 2nd season by application of PG + VC as compared the other treatments. The effect of soil amendments can be arranged in descending order: PG + VC > VC > PG >control. Thesis results may be due to the beneficial effect of vermicompost on improve the soil porosity, aeration, soil structure hence soil basic infiltration. This finding is supported by [13 and 9].

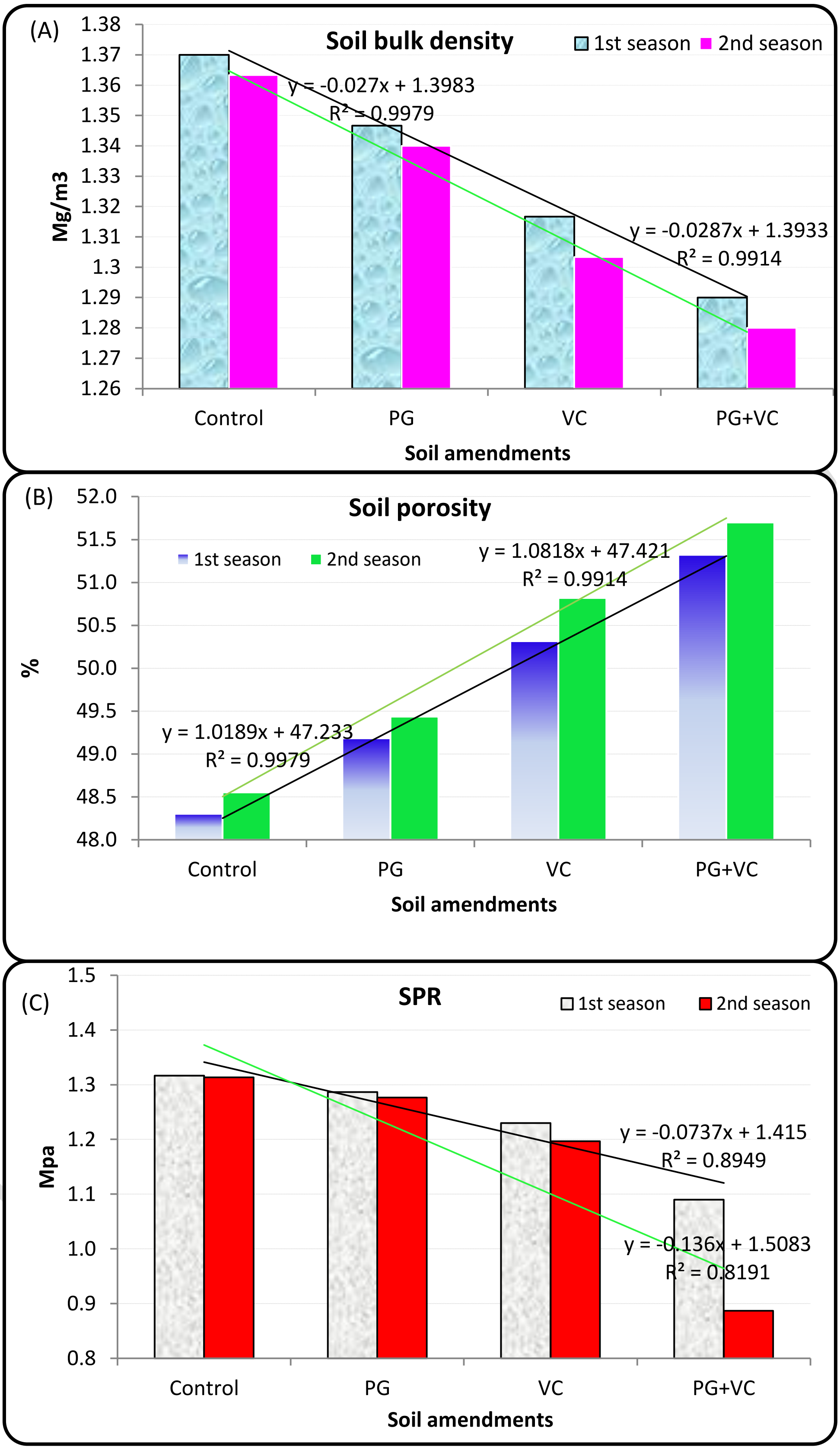

Fig.(3) Soil bulk density, soil porosity and SPRa as affected by the soil amendments in 2020 and 2021 seasons (The values mean over soil depths of (0-20, 20-40 and 40-60cm)

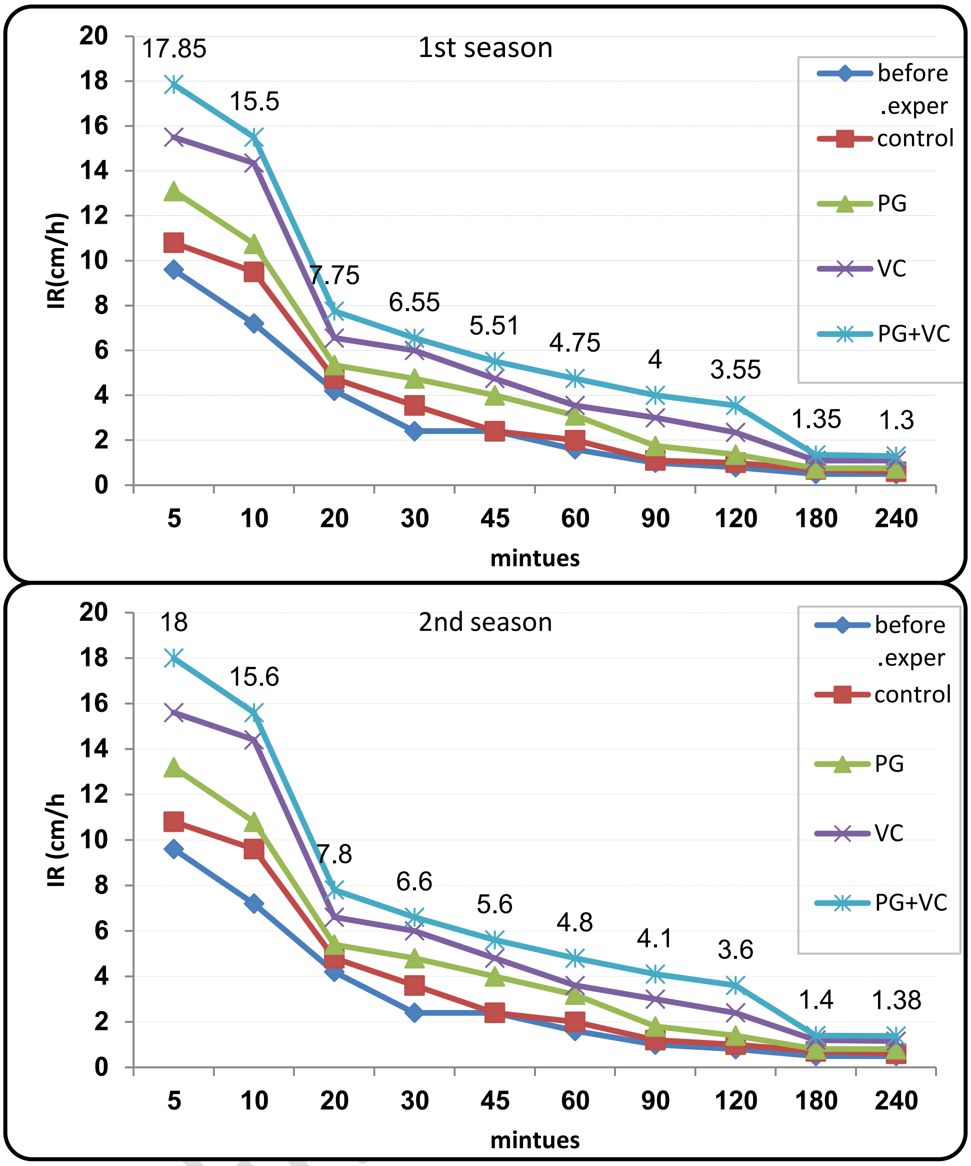

Fig.(4): Mean values of soil infiltration (IR) as affected by the soil amendments after two growing winter 2020/2021and summer 2021 seasons.

3.3. A.Yield of wheat:

Data in Table (4) showed that mean values of 1000-grain weight, grain and straw yield of wheat were highly significant increased by application of the soil amendments PG,VC and recorded highest values (40.72,1.842and 1.943) with application of PG+VC. Also the same data pointed that mean values of 1000-grain weight, grain and straw yield of wheat were highly significant increased due to application of N-treatment and recorded highest values(40.21,2.108 and 2.148) with application of 100% from N recommended. Table (4) cleared that mean values of 1000-grain weight, grain and straw yield of wheat were highly significant increased due to the interaction between PG x VC x N and recorded highest values (41.75g., 2.108ton and 2.148ton) with PG +2ton from VC xN_{100}

3.3. B.Yield of Rice

The presented data in Table (4) noticed that mean values of 1000-grain weight, grain and straw yield of Rice were highly significant increased by application of the soil amendments PG,VC and recorded highest values (21.21g., 2.587ton and 2.646ton) with combined application of PG+VC

Also the same data pointed that mean values of 1000-grain weight, grain and straw yield of Rice were highly significant increased due to application of N-treatment and recorded highest values(21.06g., 2.248ton and 2.368 ton with application of 100% from N recommended

Table (4) pointed out that mean values of 1000-grain weight, grain and straw yield of Rice were highly significant increased due to the interaction between PG + VC xN and recorded highest values (21.55g.,2.755 ton and 2.807 ton with PG + VC x N_{100}

Thesis results may be due to the availability of macronutrients and micronutrients is generally higher in vermicompost than in the other treatments, indicating that vermicompost is a better supplement to improve both of physical and chemical properties of the soilas well as stimulate plant growth. Thus vermicompost has a huge potential for use on agricultural crops. Thesis results supported by **[10, 21].** Vermicompost as an organic amendment has ability to produce some essential nutrients for supporting plant growth compared with chemical fertilizers. Use of the right amounts of vermicompost as an important source of nitrogen and its replacement for N-recommended will guaranty soil quality and health for the future generations

Application of VC and PG with more pronounced the treatment this may be due to the role of PG used as a source of calcium to remove the exchangeable sodium and improve chemical soil properties and act as soil modifiers that prevent the development of sodicity which is directly related to plant growth and both of Rice and wheat yields. Thesis results supported by [6].

Table 4.Mean values of 1000-GW(g) and both of grain and straw yield of Wheat and Rice (t/Fed.[1]) as affected by the soil amendments, nitrogen fertilizer and its interaction in 2020/21 and 2021 seasons.

Treatment		Wheat			Rice		
		Grain	Straw	1000-GW	Grain	Straw	1000-GW
Soil amendments (A)							
Control		1.042d	1.150d	39.15d	1.841d	1.933d	20.16d
PG		1.468b	1.531b	39.81b	2.242b	2.430b	21.18b
VC		1.379c	1.463c	39.57c	1.982c	2.058c	20.86c
PG+1/2 VC		1.842a	1.943a	40.72a	2.587a	2.646a	21.21a
F_{test}		**	**	**	**	**	**
$LSD_{0.05}$		0.009	0.007	0.146	0.005	0.006	0.018
$LSD_{0.01}$		0.014	0.010	0.222	0.009	0.009	0.028
N-Fert. (B)							
N_{50}		1.302c	1.399c	39.44c	2.065c	2.174c	20.66c
N_{75}		1.403b	1.504b	39.78b	2.175b	2.259b	20.84b
N_{100}		1.593a	1.656a	40.21a	2.248a	2.368a	21.06a
F_{test}		**	**	**	**	**	**
$LSD_{0.05}$		0.003	0.003	0.036	0.004	0.004	0.019
$LSD_{0.01}$		0.005	0.006	0.050	0.006	0.008	0.027
Interaction A x B							
Control	N_{50}	0.980l	1.115j	39.11	1.755l	1.885l	20.11i
	N_{75}	1.056k	1.159i	39.16h	1.855k	1.925k	20.15h
	N_{100}	1.089j	1.176h	39.17h	1.913j	1.988i	20.23g
PG	N_{50}	1.315h	1.418f	39.60f	2.159f	2.363f	20.94e
	N_{75}	1.399g	1.460e	39.71de	2.257e	2.412e	21.14c
	N_{100}	1.690c	1.716c	40.13c	2.311d	2.517c	21.45b
VC	N_{50}	1.299i	1.345g	39.43g	1.946i	1.958j	20.65f
	N_{75}	1.353g	1.459e	39.48g	1.985h	2.057h	20.93e
	N_{100}	1.486e	1.586d	39.79d	2.014g	2.159g	21.01d
PG+ 1/2 VC	N_{50}	1.613d	1.718c	39.62ef	2.401c	2.489d	20.93e
	N_{75}	1.806b	1.938b	40.78b	2.605b	2.642b	21.16c
	N_{100}	2.108a	2.148a	41.75a	2.755a	2.807a	21.55a
F_{test}		**	**	**	**	**	**
$LSD_{0.05}$		0.007	0.007	0.073	0.009	0.012	0.039
$LSD_{0.01}$		0.010	0.009	0.101	0.013	0.017	0.054

*indicate significant $p < 0.05$,** indicate significant $p < 0.01$ and ns indicate not significant.

4. CONCLUSION

Field experiments were conducted to improvement of some soil properties and productivity both of wheat and rice by application of phosphogypsum, vermicompost and nitrogen fertilization under salt-affected soils. It could be concluded that:

1- Electrical conductivity (EC) , exchangeable sodium percentage (ESP), soil bulk density and soil penetration resistances were highly significant decreased ($P \leq 0.01$) by individual application of soil amendments and recorded lowest values with 100% from gypsum requirements as PG + 4ton from VC after harvesting of Rice and Wheat

2- Cation exchange capacity (CEC), soil porosity and soil basic infiltration rate were highly significant decreased by application of the soil amendments and recorded highest values with 100% from GR as PG + 4ton VC after harvesting of Rice and Wheat

3-1000-grain weight, grain and straw yield of Rice and Wheat were highly significant increased by application of the soil amendments and recorded highest values due to the interaction between 100% from GR as PG x 2ton from VC x N_{100}

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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