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Effect of gypsum and farmyard manure on yield and yield components of rice (*Oryza sativa* L.) under saline sodic soil at Amibara, Ethiopia

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Key words: Farmyard manure, Gypsum, Rice, Salt-affected soil

Abstract

Abundance of soil with saline sodic property in Amibara irrigated farms is becoming a threat to crop productivity. As part of the solution to such problem soils, combine application of gypsum and farmyard manure has not been investigated well in the area. Therefore study was conducted at Worer Agricultural Research Center using rice as a test crop during 2018 cropping season to evaluate their effect on yield and yeild componets of rice. Factorial combinations with three rates of FYM (0, 10 and 20t ha-1) and five rates of gypsum (0%, 25%, 50%, 75%, 100% GR) were laid out in randomized complete complete block design with three replications. Composite surface soil samples before experiment and from each treatment after harvest were collected for laboratory analysis. Most growth and yield components parameters were significantly ($P \leq 0.05$) different due to the main and the interaction of GYP and FYM. Straw yield, tillering number, effective tillering number and grain yield were affected significantly by the interaction effect of GYP and FYM. The highest grain yield (4.27t ha-1) were obtained at application of 20t ha-1 FYM +75 % GR. From the results it could be concluded that application of 20t ha-1 FYM + 75 % GR enhance grain yield of upland rice grown on saline sodic soil of Amibara district.

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Introduction

Salinity causes different kinds of stress in rice at different growth stages (Todaka *et al.*, 2012). It limits germination and germination energy, number and duration of seedling emergence, vegetative growth and population density, leaf efficiency, flowering and maturity (Ashraf and Harris, 2004). In rice production it has long been reported grain yield is much more depressed by salt stress than vegetative growth (Rao *et al.*, 2008). The negative interactions of salts with plants may decrease growth and consequently nutrient use efficiency (Parida and Das, 2005). Hence, development of the most suitable reclamation technology or a combination of technologies may be critical to optimize the physical and chemical properties in saline-sodic and sodic soils. Studies in different areas of the world have compared the effectiveness of various amendments in improving the physicochemical properties of saline-sodic soils (Walker and Bernal, 2008). The relative effectiveness of gypsum has received the most attention because it is widely used as reclamation amendment. However, it is mainly blamed for its slow reaction but much popular due to its low cost and availability (Heluf, 1995).On the other hand, FYM and compost have been investigated for their effectiveness in improving the physical conditions of soils for crop growth besides their role as fertilizers (Tejada *et al.*, 2006).

However, these amendments have very little effect on improving soil salinity and sodicity when they are applied alone (Madjejon *et al.*, 2001). On the other hand, combined application of these treatments preferably FYM and gypsum on saline-sodic soils helped in maximizing and sustaining yields and in improving soil health and input use efficiency (Tejada *et al.*, 2006; Walker and Bernal, 2008).Similar to other arid and semi-arid regions, severe soil salinity/sodicity problems have been reported in Middle Awash central rift valley of Ethiopia.the report showed that substantial parts of farm areas are consistently and continuously being affected by salinity problem (Melese *et al.*, 2016). Despite the wide spread presence of salt affected soils in Middle Awash central rift valley of Ethiopia, the existing technology and strategies to control and mitigate soil salinity and sodicity, and improve nitrogen use efficiency are not adequate compared to the extent of problem. Therefore, The overall objective of this study was assess the response of rice and its nitrogen use efficiency to such application and To evaluate the effects of gypsum and farmyard manure on yield and nitrogen use efficiency of rice.

Materials and methods

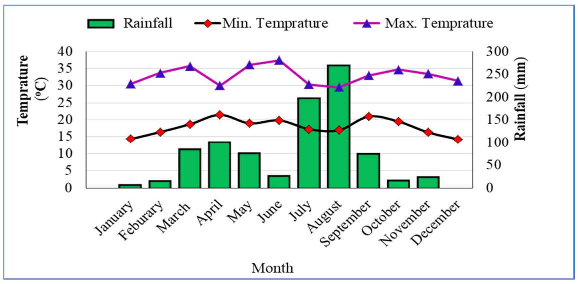
Description of the Study Area

Location

The study was conducted at Werer Agricultural Research Center in Amibara district, Gabiressu zone of Afar National Regional State in the Middle Awash Valley. Geographically, it is located at 09°13′- 09°50′ N and 40°05′- 40°25 ′E and the elevation is about 740 meters above sea level. The experimental site is 280 km far from Addis Ababa and close to the main high way linking Addis Ababa to Djibouti.

Climate

According to Werer Agricultural Research Center long term climatic data (1987 - 2018), the relative humidity ranges between 37 and 55%. The mean maximum temperature is 38°C and means minimum temperature falls down to 15°C. The mean monthly rainfall distribution of the study area are indicates, July and August are the wettest month and high rainy season (Figure 2). It clearly indicates that bi-modal nature of rainfall distribution in the study area (Figure 2). According to the classification of agro-ecological zones the climate is semi-arid with a bimodal rainfall of 533 millimeters annually (MoARD, 2005). The average daily sunshine hour is 8.5 with an average solar radiation of 536 calories per square centimeter per day (cal/cm2/day) (Girma and Awulachew, 2007). Annual evapotranspiration rate of Amibara is 2829mm.



Experimental Site Selection

A visual survey of the field preceded the actual soil sampling. The site which is representative for saline sodic soil and appropriate to conduct the experiment with relatively flat in topography and free from shade was selected.

Soil Sampling Before Land Preparation

Soil samples before land preparation were collected by walking in a zigzag pattern over the area of the experimental site of about (80m x 20m) wide. Based on the soil heterogeneity 15 representative soil samples were collected at depth of 0-30cm using soil auger to identify the physicochemical properties of the soil and to calculate gypsum requirement before treatment application and planting.

During sample collection any foreign material such as plant residues and gravels were discarded. Similarly, undisturbed soil samples were collected from the same depth using core sampler for determination of bulk density. Finally, about 1 kg of composite soil sample was prepared, bagged, properly labelled, and transported to the laboratory. The soil samples was spread on a polythene sheet for air drying, grounded and sieved with 2mm sieve. For soil organic carbon and total nitrogen analysis soil sample was ground to pass through 0.5mm sieve.

The physicochemical properties which were analysed includes: bulk density, particle density, total porosity, texture, soil reaction (pH), electrical conductivity, organic carbon, organic matter, total nitrogen, available P, exchangeable bases, soluble base and CEC by following standard procedure described under the post-harvest soil analysis. Derived parameters such as percent base saturation, exchangeable sodium percentage and sodium absorption ratio were also calculated. Gypsum requirement of soil was determined by Love day (1974) method.

Experimental Design and Treatments

The experimental design was Randomized Complete Block Design (RCBD) with three replications. Experimental arrangement was factorial treatments combination of two factors. Factor one was gypsum (GYP) with five levels; 0% ,25% , 50%,75 % and 100% soil gypsum requirement and factor two was farmyard manure (FYM) with three levels; 0,10 and 20 t /ha. The overall treatment combination was fifteen.

Table 1. Treatments and combination

Treatment code	Treatment combination
T1(control)	(GYP) 0% and (FYM) 0 t/ha
T2	(GYP) 25 % and (FYM) 0 t/ha
T3	(GYP) 50% and (FYM) 0 t/ha
T4	(GYP) 75% and (FYM) 0 t/ha
T5	(GYP) 100% and (FYM) 0 t/ha
T6	(GYP) 0% and (FYM) 10 t/ha
T7	(GYP) 25% and (FYM) 10 t/ha
T8	(GYP) 50% and (FYM) 10 t/ha
T9	(GYP) 75 % and (FYM) 10 t/ha
T10	(GYP) 100 % and (FYM) 10t/ha
T11	(GYP) 0% and (FYM) 20t/ha
T12	(GYP) 25% and (FYM) 20 t/ha
T13	(GYP) 50 % and (FYM) 20t/ha
T14	(GYP) 75% and (FYM) 20t/ha
T15	(GYP) 100 % and (FYM) 20t/ha

Field Management

Recommended plant protection measures, weeding and hoeing were regularly carried out to reduce weed infestation and all the cultural practices were implemented for all plots with the respective treatments. Based on visual observation of soil moisture, regular water supply was applied uniformly to all plots through furrow technique.

Data Collection

Meteorological data were obtained from Werer Agricultural Research Center. Agronomy and physiological, rice growth and yield data were collected as indicated below.

Agronomic parameters

Plant height was measured at maturity from the ground level to the top of the rice panicle from randomly selected ten plants and the average was taken as plant height (cm). Panicle Length was measured from basal node of the rachis to apex of panicle. Number of seed per panicle was counted from ten representative plants then means value was taken. Stand count was taken from the plots within 1m^2 area by throwing a quadrant into the middle portion of each plot and converted into per hectare basis.

Tiller number was counted from each plot and at the same time number of effective tillers (tiller that had panicle) was also recorded.

Thousand seeds weight was randomly selected from harvested yield of each plot and their weight were determined after adjusting the grain at standard 14% moisture content using a sensitive balance.

Total above ground biomass was weighed immediately during harvesting before threshing. Grain yield was measured by harvesting the crop from the net plot area of 3.6m² to avoid border effects. After threshing and measuring the grain yield, the straw yield was measured by subtracting the grain yield from the total above ground biomass yield. Sterility was computed by dividing the number of unfilled spikelets by the total number of spikelet's (filled grains + unfilled spikelets) and it will be expressed as percentage.

Physiological parameters

Fully expanded youngest leaves were selected from different plants. Ten leaves were sampled from the center of each plot and weighed immediately to determine the fresh weight (FW). Then immersed in distilled water in Petr-dishes for 24 hr. in darkness and then turgid weight (TW) was determined. The leaves were dried in an oven at 70 °C for 24 hr and the dry weight (DW) was obtained. Then Relative water content was calculated (Silveira *et al.,* 2003).

Plant tissue sampling and analysis

Ten non-boarder rice plants per plot were randomly selected from each plot for straw and seed analysis at maturity. After washed with distilled water, the samples were dried in oven at 70°C for 24 hours. After drying, the plant tissue samples were ground and passed through 0.5mm sieve for laboratory analysis. Wet acid digestion for N was used for determination of concentration in the samples at laboratory (FAO, 2008). After the concentration is determined the uptake of the nutrient was calculated.

Data Analysis

The collected data was subjected to statistical analysis. Analysis of variance (ANOVA) on grain yield, biomass, and agronomical parameters of rice were carried out using Genstat and SAS version 9.4 statistical software program (SAS, 2016).

Significant difference between and among treatment means were assessed using the least significant difference (LSD) at 0.05 level of probability (Gomez and Gomez, 1984).

Results and discussion

Selected physicochemical properties of surface soil of the study site were analysed based on the analytical results of the composite soil samples collected at depth of 0-30cm from experimental site before treatments application for physicochemical analysis.

The results indicated that texture of the soil of the experimental site was dominated by clay loam. On the basis of particle size distribution, the soil contained sand 28%, Silt 40%, and clay 32%. According to the soil textural class determination triangle, soil of the experimental site was found to be clay loam. Soil bulk density and particle density of the study site were 1.5gcm^{-3} and 2.5gcm^{-3}, respectively. Total porosity of the soil sample was 40% before treatments application.

The soil reaction (pHe) of the experimental site was 8.41, which is moderately alkaline. According to FAO (2008), suitable pH ranges for most crops is between 6.5 and 7.5 in which nutrient availability is optimum. High pH of the study area might be from excessive accumulation of exchangeable Na^+ in the soil. The organic carbon content of the study site was 0.2%. According to Tekalign (1991) the soil had very low organic carbon content indicating moderate potential of the soil to supply nitrogen to plants through mineralization of organic carbon. Soils in salt-affected landscapes produce less biomass than non-saline soils resulting in less soil organic carbon (Wong *et al.*, 2010). The CEC value of the soil sample was high (39cmol kg^{-1} soil), indicating its better capacity to retain the cation. Analysis of soil samples from planting depth showed that the total N content is 0.05% which is low according to Tekalign (1991) indicating that the nutrient was a limiting factor for optimum crop growth. Based on initial soil sample analysis the soils of study area had 20.5 ESP and soluble salt concentration in the soil was 4.12ds/m as measured in electrical conductivity (ECe) which indicates that the soils of the study site was saline-sodic.

Table 2. Selected properties of the untreated composite saline sodic soil

Parameter	Value
Texture (%)	Clay loam
Clay (%)	32
Silt (%)	40
Sand (%)	28
Bulk density(gcm^{-3})	1.5
Particle density(gcm^{-3})	2.5
Total porosity (%)	40
ECe (ds/m)	4.12
pH	8.41
OC (%)	0.2
OM (%)	0.34
Av.P(mg kg-1)	16
TN (%)	0.05
CEC (cmol (+)/ kg-1)	39
Exchangeable base	
Na (cmol (+) kg-1)	8
Ca (cmol (+) kg-1)	29
Mg (cmol (+) kg-1)	4
K (cmol (+) kg-1)	2.5
ESP (%)	20.5
Soluble base	
Na (meq/l)	38.13
Ca (meq/l)	8.4
Mg (meq/l)	6
k (meq/l)	0.4
SAR	14.49

Table 3. Selected chemical properties of farmyard manure used for amendments

Parameters	Value
pH	6.5
C	16.3 %
N	1.2%
P	14 mg/kg
Ca	49 mg/kg
Mg	7 mg/kg
C:N	13.5

Where, OC= organic carbon; C: N =Carbon to nitrogen ratio

Relative water content (RWC)

The main effects of farm yard manure had highly significant ($P \leq 0.01$) influence on relative water content (RWC) of rice leaves while the main effect of gypsum and the interaction effect of gypsum and farmyard manure had not significantly affected relative water content of leaves.Relative water content increases significantly when the level of farmyard manure has increased from 0 to 10 and 20t ha-1. maximum RWC (87.45%) was recorded at 20 t/ha FYM and minimum (57.31%) at 0t ha-1 FYM. The results suggest that farmyard manure could be used in augmenting rice leaves water content through improving fertility of poorly fertile soil by high exchangeable sodium percentage than gypsum.

Plant height

The main effects of application of FYM and GYP rate highly significantly ($P \leq 0.01$) affected plant height. However the interaction effect of farmyard manure and gypsum was not significant to plant height. The highest plant height was observed at the treatment that received 20t/ha farmyard manures (88.67cm). This may be due to the expected improved water availability for the plant and its contribution of nutrient elements for growth. The rapid mineralization of N from organic matter and steady supply of nutrients from FYM might have met the N requirement throughout the crop growth and especially at the critical stages of crop growth, which manifested the highest plant height. This finding was supported by Mohd *et al.* (2007) who suggested that the increase in plant height could be due to better availability of nitrogen and the enhancing effect of nitrogen on the vegetative growth by increasing cell division and elongation due to FYM but the finding contradict with Dutta *et al.* (2001) where different treatments did not influence the plant height in rice.

The second highest plant height was observed at treatment 100% soil gypsum requirement. According to Mahmood *et al.* (2009), nutrient supplementation in the form of Ca and sulphur S through the use of gypsum, contribute significantly to crop grow improvement. The lowest plant height is observed at control plot.

Root length of rice

The analysis of variance showed that the main effect of farmyard manure significantly ($P \leq 0.05$) affected root length and the main effect of gypsum and the interaction effect of gypsum and farmyard manures had non-significantly effect on root length. The tallest root length (17.1cm) was obtained from 20t ha-1 farmyard manure. Several previous studies revealed that organic amendments can improve root growth of crops. This may be associated with the enhancement of biological activities in crop rhizosphere by amino acid and some physiologically active substances in the organic fertilizers such as farmyard manure (Yang *et al.,* 2004). The farm yard manure and HA caused an increase in the organic carbon content in the soil (Gondek and Filipek-Mazur 2005) and positively affected the root growth of rice crop. The incorporation of organic manure into soil can bring beneficial effects on crop root growth by improving physical and chemical environments of rhizosphere (Sidiras *et al.*, 2002).

A decrease in soil organic matter content can cause a decrease of root growth (Önemli 2004). The shortest root length (14.93cm) was obtained from the control (Table16). Shaaban *et al.* (2013) also revealed that after application of organic matter soil sodium adsorption ratio declines 56%, and root length of rice increases 140%. Sodium induces soil structural deterioration (slaking, aggregate destruction, and clay and organic colloid dispersion), leading to subsequent water infiltration and percolation problems, low oxygen diffusion in the soil profile, and poor rooting (Robert and Ronny, 2012).

Number of seed per panicle, panicle length and biological yield

Statistical analysis output data showed that number of seed per panicle was significantly (P≤0.05) affected by the main effect of gypsum and farmyard manure. The highest number of seed per panicle was recorded from application of 50% gypsum requirement (91.36) followed by 75% soil gypsum requirement (90.58) and 20t/ha FYM (90.57), respectively. Whereas, the lowest number of seed per panicle (81.63) was obtained from the control. The main effect of gypsum significantly (P≤0.05) affected panicle length and the main effect of farmyard manure was highly significant (P≤0.01) to affect panicle length but the interaction effect of FYM with GYP was not significant to affect panicle length of rice. The highest panicle length (19.93cm) was recorded at a plot that received 20t ha-1. FYM. The same result was reported by Slavish *et al.* (2011) who revealed maximum panicle length was noted in plants treated with organic fertilizer.

Analysis of variance showed that biological yield was highly significantly (*P*≤0.01) affected by the main effect of gypsum and farmyard manure. The highest biological yield was recorded from 20t/ha farmyard manure (7.43t/ha) which may be due to enhancement of favorable effects on soil physical and chemical properties, particularly with favorable Ca^{2+}:Na^{+} ratios in the soil solution (Murtaza *et al.*, 2009). Whereas the lowest biological yield was (4.217t/ha) was obtained from 0 t/ha FYM. Decreased biological yield may be due to reduced N availability in soil (Moradi and Ismail, 2007).

Table 4. Main effect of farmyard manure and gypsum on relative water content of the leaf number of seed per panicle, biological yield, panicle length, plant height and root length

FYM Level	RWC%	NSPP	BY t/ha	PL(cm)	PH(cm)	RL(cm)
0 t/ha	57.31^{a}	82.0^{a}	4.21^{a}	17.7^{a}	74.5^{a}	14.9^{a}
10 t/ha	72.45^{b}	89.8^{b}	6.47^{b}	18.6^{b}	81.1^{b}	16.0^{b}
20 t/ha	87.45^{c}	90.5 ^{b}	7.43^{c}	19.9^{c}	88.6^{c}	17.1^{c}
LSD $_{(0.05)}$	4.5	5.1	0.36	0.77	2.876	0.4
GYP Level						
0 %GR	67.8	81.6 a	4.9^{a}	17.7^{a}	76.4^{a}	15.9
25 %GR	71.6	88.1 ^{ab}	5.9^{ab}	19.0^{b}	80.6^{b}	16.0
50 %GR	72.5	91.3 ^{b}	6.3^{b}	19.1^{b}	81.5^{b}	15.9
75 %GR	74.2	90.5^{b}	6.9^{C}	19.1^{b}	81.6^{b}	16.2
100 %GR	75.9	85.7 ^{ab}	6.0^{b}	18.6^{ab}	87.0c	16.12
LSD $_{(0.05)}$	NS	6.6	0.475	1	3.713	NS
CV %	8.3	7.8	8.1	5.5	4.7	4

Similar letters or no letters with column indicate that there is no significant difference among treatment levels, α= 0.05, based on LSD test. Where RWC (relative water Content), NSPP (Number of seed per panicle), BY (Biological yield), PL (Panicle Length), PH (plant Height), RL (Root Length).

Tiller and effective tiller

Tillering is one of the most important agronomic traits because tiller number per plant determines panicle number, a key component of grain yield. Regarding number of tillers per plant analysis of variance (ANOVA) indicated that the interaction effect of gypsum and farmyard manure highly significantly affect ($P \leq 0.01$) to tiller production at maturity. The main effect of gypsum and farmyard manure application is also highly significantly affecting tiller production. The highest tiller number (7) was obtained from the application of 20t ha-1 FYM+75% soil gypsum requirement which is statistically equal to 20t/ha FYM +100% GYP. The reason of more tillers may be the results of low saline environment and the ameliorative effect of amendments. The lowest tiller number (2.8) was obtained from control plot Babu *et al.* (2001) reported significant influence on number of tillers per hill due to individual and combined application of organic manures (FYM, green manure and filter cake) along with Gypsum. Dash *et al.* (2011) also demonstrated that as compared to the control, all the treatments that received organic amendments alone or in combinations significantly increased number of tillers in rice.

Table 5. Interaction effect of gypsum and farmyard manure on rice tillering number

FYM level	GYP level				
	0 % GR	25% GR	50%GR	75% GR	100% GR
0t/ha	2.8^{a}	4.1^{b}	4.4^{b}	4.4^{b}	4.4^{b}
10t/ha	5.1^{c}	5.5^{d}	5.7^{d}	5.7^{d}	5.6^{d}
20t/ha	4.9^{c}	6.3^{e}	6.5^{e}	7.0^{f}	6.7^{ef}
LSD (0.05)	0.38				
CV (%)	4.3				

Interaction means followed by the same letter within each column and row for the parameters are not significantly different at α= 0.05, based on LSD test.

The number of productive or effective tillers per plant is an important yield parameter under salinity and sodicity because it determines the grain bearing panicles. The main effect of FYM and GYP as well as the interaction of FYM and GYP showed significant effect ($P<0.05$) to effective tiller number at maturity. Maximum effective tiller number (6.6) was obtained from 20t ha-1 FYM +75% Soil gypsum requirement. While the minimum Effective tiller number (2) was obtained from the control these may be due to the highest exchangeable sodium at control plot which makes the tiller become non effective.

Table 6. Interaction effect of gypsum and farmyard manure on rice effective tillering number.

FYM level	GYP level				
	0 % GR	25% GR	50% GR	75% GR	100% GR
0t/ha	2.0^{a}	3.3^{b}	3.6^{bC}	3.6^{bC}	3.3^{b}
10t/ha	4.6^{d}	4.6^{d}	4.6^{d}	4.6^{d}	4.6^{d}
20t/ha	4.0^{c}	5.6^{e}	6.0^{e}	6.6^{f}	6.0^{e}
LSD (0.05)	0.53				
CV (%)	7.1				

Interaction means followed by the same letter within each column and row for the parameters are not significantly different at α= 0.05, based on LSD test. ETN (Effective tiller number).

Straw yield and grain yield

The analysis of variance showed that straw yield of rice was significantly ($P \leq 0.05$) influenced by the interaction effect of gypsum and farmyard manure as well as highly significantly ($P \leq 0.01$) affected by the main effect of gypsum and farmyard manure. The highest straw yield (4.39t/ha) was obtained at treatment 10t ha-1 FYM + 75 % gypsum requirement which may be due to improvement of physical as well as chemical properties of soils by added gypsum and farmyard manure which proved beneficial for the increasing of rice straw yield. While the lowest straw yield (1.317t ha-1) was obtained from control plot.

Table 7. Interaction effect of gypsum and farmyard manure on rice straw yield

FYM level	GYP level				
	0 % GR	25%GR	50%GR	75%GR	100%GR
0 t/ha	1.317^{a}	2.267^{b}	2.450^{b}	2.383^{b}	2.450^{b}
10 t/ha	3.273^{c}	3.267^{c}	3.633c	4.393^{e}	3.267^{c}
20 t/ha	3.833^{cde}	4.267^{de}	4.367^{e}	4.333^{de}	3.733^{cd}
LSD (0.05)	0.609				
CV (%)	11.1				

Interaction means followed by the same letter within each column and row for the parameters are not significantly different at α= 0.05, based on LSD test. SY (Straw yield).

Application of farmyard manure and gypsum was apparently affected the grain yield of rice grown on saline sodic soil. Interaction effect of farmyard manure with gypsum showed significant ($P \leq 0.05$) difference on rice grain yield. Based on the interaction analysis the highest grain yield (4.27t ha-1) was obtained at application of 20t ha-1 FYM +75% gypsum requirements. These may be due improved physical and chemical environment by the amendments for the better growth of rice. These increases in grain yields of rice could be attributed to increased nutrient availability or indirectly through improved soil properties of saline sodic soil with GYP and FYM application. Farmyard manure itself is a good source of many essential plant nutrients. These nutrients are released to plants upon decomposition and thus help promote plant growth. In addition to this supply of nutrients, FYM might have helped in developing buffering capacity in the soil and might have suppressed the effect of alkalinity and sodicity on plant growth. Similarly, the gypsum through its ameliorating property might have suppressed the effect of excess Na on plant growth. Gypsum might have helped in supplying nutrients as it helps reduce volatilization losses of urea and add Ca and sulfur (S) to soil (Haq *et al.*, 2007). The results confirm the findings of several researchers who reported increased yield due to integrated use of farmyard manure and gypsum (Sharma and Minhas, 2004). However, the lowest grain yield (1.86t ha-1) was recorded from the control

Table 8. Interaction effect of gypsum and farmyard manure on rice grain yield.

	GYP level				
FYM level	0 % GR	25%GR	50% GR	75%GR	100%GR
0t/ha	1.8^{a}	1.9^{a}	1.9^{a}	2.1^{ab}	2.3^{ab}
10t/ha	2.3^{ab}	2.1^{ab}	2.8^{cd}	3.1^{de}	3.2^{de}
20t/ha	2.4^{bc}	3.3^{e}	3.4^{e}	4.2^{f}	3.0^{cde}
LSD $_{(0.05)}$	0.51				
CV (%)	11.2				

Interaction means followed by the same letter within each column and row for the parameters are not significantly different at α= 0.05, based on LSD test.GY (Gray yield).

Thousand Seed weight, sterility and stand count of rice

The main effect of gypsum was significant ($P \leq 0.05$) and the main effect of farmyard manure was highly significantly ($P \leq 0.01$) affects stand count of rice (Number of hill per m^2). The highest number of hill per m^2 (410) was scored at 20t ha-1. However, the lowest number of hill per plot in m^2 (364) was scored from the plot that received 0% t/ha FYM Considering the main effect of GYP, the highest and the lowest value were recorded from 100% gypsum requirement and 0% gypsum requirement respectively. The results are being consistent with Ghulam *et al.* (2012) who reported that higher number of plants m^2 was obtained from plots received organic fertilizer. Analysis of variance also showed that thousand seed weight (TSW) of rice was not significantly influenced by the main effect of gypsum and the interaction effect of gypsum and farmyard manure. The main effect of farmyard manure highly significantly ($P \leq 0.01$) affected thousand seed weight. Relatively maximum TSW (21.13g) was obtained from plot that received 20t/ha farmyard manure. The result Coincide with Haq *et al.* (2007) who observed up to 43% increase in the 1000-grain weight of rice with the application of FYM to a saline sodic soil while relatively minimum TSW (18.55g) was obtained from the control. Analysis of variance showed that statistically significantly on sterility of rice seed affected by the main effect of gypsum and interaction effect of gypsum and farmyard manure. However the main effect farmyard manure significantly affects sterility. The highest sterility (22.73%) was obtained from the control plot. These may be due to high exchangeable sodium content is high at the untreated plot. While the lowest sterility (10.07 %) was obtained from application of 20t ha-1 FYM

Table 9. Main effect of farmyard manure and gypsum on stand count, sterility and thousand seed weight of rice

FYM Level	SC (hill/m^2)	TSW (g)	Ster (%) Total N uptake(kg/ha)
0 t/ha	349.3^{a}	18.5^{a}	22.7^{b} 32.03^{a}
10 t/ha	375.5^{b}	20.5 ^{b}	12.8^{a} 49.41^{b}
20 t/ha	410.0^{c}	21.1 ^{b}	10.0^{a} 61.06^{c}
LSD $_{(0.05)}$	12.54	1.3	0.36 8.59
GYP Level			
0 %GR	364.0^{a}	19.7	17.2 39.29^{a}
25 %GR	370.6^{ab}	19.5	15.0 44.57^{a}
50 %GR	381.2^{bc}	20.4	12.1 47.52^{ab}
75 %GR	382.7^{bc}	20.4	17.1 48.28^{ab}
100 %GR	394.2^{c}	20.2	14.6 57.86^{b}
LSD $_{(0.05)}$	28.03	NS	NS 11.09
CV %	4.4	9.1	29 24.2

Conclusion

Therefore, based on the results of the study it can be Concluded that that most growth, yield components and grain yield parameters were significantly ($P \leq 0.05$) different due to the main and the interaction effects of gypsum and farmyard manure. Straw yield, tillering number, effective tillering number and grain yield were affected by the interaction effect of gypsum and farmyard manure. stand count, number of seed per panicle, biological yield, panicle length, plant height and root length were affected by the main effect of gypsum and farmyard manure while relative water content ,thousand seed weight and sterility was affected by the main effect of farmyard manure. However, where salt affected soils is a problem similar further studies are warranted at various locations using different varieties of rice and different rates of gypsum and farmyard manure to provide conclusive recommendation.

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