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Comparative Study of Rice straw bio char and Compost on Rice Growth and Yield under Saline Sodic Soil Conditions

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ABSTRACT

Two field experiments were raised at Farm of El-Sirw Agriculture Research Station, Dammitta province, Egypt through 2018 and 2019 seasons. The present study was performed to compromise the influence of rice straw biochar and other two soil amendments of rice straw compost and gypsum on rice growth and yield of three contrasting rice varieties,Giza177 (salt sensitive variety), Giza 178 (salt tolerant variety) and Giza179 new (salt tolerant variety) under saline sodic soil. The field experiments were designed in spilt plot design with four replications. The three rice varieties were scattered in the main plot, whereas the amendment treatments; control, gypsum(G), rice straw compost (RS) and rice straw biochar (RSB) were put in the subplots. The tested rice varieties were significantly different in growth parameters, yield attributes and yields in both seasons. Giza 179 as a new salt tolerant variety provided the maximum values of rice growth characteristics and most of yield contributes and yields without significant difference with Giza178 were considering yields. Applying varying soil amendments greatly improved rice growth and yields in addition to yield attributes comparing to the control treatments. Rice straw biochar surpassed significantly other two amendments, particularly in the first season, meanwhile in the second season the three soil amendments were equally in increasing grain yield. Thereby, rice straw biochar could be applied each two years but rice straw compost has to apply in two successive season to get its efficiency.

Keywords: Biochar- Saline soil- Sodic-Gypsum -Rice

INTRODUCTION

Egypt located at semi arid zone and has large salt affected soil area . The quality of salt affected soil is low that hamper agriculture production, particularly rice crop production since it is the dominant crop under such area. Rising the quality of such area will ensure high rice grain yield. Applying soil amendments either organic and chemical are one option to increase the fertility and quality of the salt affected soil particularly that contain high sodium content. In paddy fields under sodic condition, soil fertility and quality improvement is reflecting on raising rice grain yield if suitable and inexpensive aimed trials are taken (Qiu *et al.,* 2013). Hence, developing practical methods of taming soil properties and yield of crop in stressed paddies has imperative practical. (Kei *et al.,* (2004) referred that biochar is developed via decomposing residues of agriculture naturally biochar is developed aperture structure, great surface area, intense degree of stability and excessive adsorption properties. Biochar can rise reserves of carbonin the soil, support soil elements, assemble fertility of soil, and improve yield (Chan *et al.*,2007; Lehmann *et al.,* 2003; Novak *et al.,* 2009 and Steiner *et al.,* 2007). In general, properties of biochar mainly depend rely on the type and quality of crop residues decomposing process. Biochar also, can be formed from a varied scale of biomass sources, such as crop residues, shrubs, green waste, and livestock manures. Wang *et al.* (2013) indicated that rice husk biochar can improve crop yield and accumulation of dry matter under stressed paddies by enhancing root growth and stimulating the absorption of N,P, and K by plant tissues. Combining rice straw into the soil has become a shared practice which tended to rise crop yield and soil fertility in huge parts of China (Wanget *et al.,* 2015). Liu *et al.*(2016) reported that addition of biochar had a apparent positive outcome on soil features as (SOC, pH, available K, and P), but these impacts somewhat depend on the biochar plant residue resources. They also, reported that rice straw biochar (RB) encouraged K uptake by rice plants, and presented better potential for rising rice grain yield than bamboo biochar (BB) and rice straw biochar (RS). However, BB did not rising significantly grain yield, even though it enhancing soil pH and SOC in the stressed paddies. Overall, the implementation of RB can improve soil properties, progress rice yield, and recuperate plant nutrient uptake in stressed paddy soils. Jin *et al.*(2018) stated that using biochar significantly reduced Na accumulation in rice plant tissues, meanwhile it apparently enhancing rice dry matter, grain yield and increased rice grain quality. The results indicated that biochar application for saline-sodic soil has benefits to decrease stress and increase rice yield and quality formation. Huang *et al.* (2019) indicated that biochar diminished soil Na adsorption ratio by 25.7% – 32.6% under salinity of irrigation water. Additionally, biochar diminished salinity stress by providing higher leaf relative water content and lower Na/K ratio, furthermore, boosted photosynthesis and relieved leaf senescence during reproductive stages, resulted in improve grains formation. Biochar application of 10t ha^{-1} significantly improved

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wheat growth and grain yield. Zayed *et al.,* 2013 and 2017 found that applying gypsum or rice straw compost had certain positive effect in improving chemical and physical properties of saline sodic soil in the northern part of Egypt and significantly increased the rice growth, yield attributes and rice grain yields The current study was performed with main goal that to fetch high grain yield of rice under saline sodic soil in Delta (north part of Egypt) with keeping soil sustainability.

MATERIALS AND METHODS

The current trial was carried out in 2018 and 2019 seasons at the Farm of El-Sirw Agriculture Research Station, Dammietta governorate Egypt. The clayey and chemical analysis of soil is listed at (Table1) to find out the effect of applying some soil amendment; Gypsum and other two organic amendments (rice straw compost and biochar) and control treatment on growth and productivity of some rice varieties, Giza 177, Giaz178 and Giza179. The experiment was laid out in split plot arranged in randomized complete block with four replications. The rice varieties i.e. Giza 177 , Giza 178 and Giza179 were put in the main plots. The soil amendments i.e, gypsum(2.5 t fed^{-1}), rice straw compost (2.5 t fed^{-1}) and rice straw biochar (2.5 t fed^{-1}) were distributed in the subplots. The size of each plot was $10m^2$. The experimental site was kept in the same place in the two seasons. After 30 days the seedling was transplanted with 3 seedlings $hill^{-1}$, spaced at 20 x 20 cm for all studied varieties. Transplanting was done on April, 20^{th}, and harvesting on September1,st. Nitrogen fertilizer was added in 4 equal doses (15 days after transplanting (DAT), maximum tillering stage, panicle initiation, and mid of booting stages) as recommended under saline sodic soil. All plots received 165 kg N ha^{-1} in the form of urea, 35 kg P_2O_5 in the form of calcium super phosphate and 48 K_2O ha^{-1} in the form of potassium sulphate.

Table 1. Chemical analysis of soil at the experimental sites in 2018 and 2019 seasons.

Seasons	ESP	pH	EC dS m^{-1}	SAR	Cations meq L^{-1}: $Ca^{++} + Mg^{++}$	Cations meq L^{-1}: Na^+	Cations meq L^{-1}: K^+	Anions Meq L^{-1}: SO^-_4	Anions Meq L^{-1}: Cl^-	Anions Meq L^{-1}: HCO^-_3
2018	74.7	8.1	8.0	19	20.0	60.0	0.32	27.5	46.3	8.0
2019	76.0	8.00	7.0	17	18.0	52..0	0.31	22.0	47.0	7.0

Available nutrients mg kg^{-1}

	N	P	K	Zn	S	Fe	Cu
2018	28.0	9.12	245.0	1.22	10.7	5.00	6.2
2019	26.0	9.35	280.0	1.16	10.5	5.13	6.0

At flowering, five hills from each plot were randomly collected to assess leaf area index, dry matter, chlorophyll contents of flag leaf (SPAD value). At harvest, panicles of ten guarded hills for each plot were taken to determine panicles number $hill^{-1}$ and plant height (cm). Ten main panicles from each subplot were brought to measuring panicle length (cm), number of the filled, unfilled grains panicle $^{-1}$and one thousand grain weight (g). In the six inner rows the plants of each subplot were collected, dried, threshed, then grain yield and biological yield were determined at 14 % moisture content and converted into t ha^{-1}. Data are gathered were subjected to standard statistical analysis of variance following the methods designated by Gomez and Gomez (1984) using the program (CO-STAT). The treatment means were compared via Duncan's multiple range test (Duncan, 1955). ** and * symbol used in all Tables designate the significant at 5% and 1% levels of probability, respectively, while Ns means not significant.

RESULTS AND DISCUSIONS

Growth parameters:

For the performance of rice varieties, the tested rice varieties were markedly varied in growth performance under saline sodic conditions in both seasons(Table2). The measured growth parameters; leaf area index, dry matter accumulation and chlorophyll content recorded great variation as indicator for salt tolerance level of studied rice varieties in the terms of Giza 177, Giza 178 and Giza179 rice varieties. Giza 179 new salt tolerant variety showed the largest leaf area index, highest values of dry matter production gm^{-2}. In the previous mentioned concern, Giza 178 showed the second order after Giza 179 rice variety. Giza 177 apparently behaved the worst performance since it possessed the lowest values of leaf area index (LAI), minimum values of dry matter accumulation gm^{-2} and lowest values of chlorophyll leaf content in both seasons. The current obtained data obviously confirmed that fact that Giza 177 is sensitive salt variety as seen previously detected under saline sodic soil well considering its growth performance. Right now, it is hold true that Giza 179 as new salt tolerant variety is more tolerant variety than Giaz178. Similar results has been detected by Zayed *et al.*(2017) and Amira, (2018).

Regarding the effect of amendments effect, data analysis variance indicated that the varying tested soil amendments, including gypsum, rice straw compost, rice straw biochar certainly exerted significant and positive effect on rice growth involving, leaf area index, dry matter production and chlorophyll content and plant height in both study seasons(Tables 2&5).

As it is detected all applied amendments significantly improved the rice growth parameters in both seasons comparing to the control treatment. It was noted that rice straw biochar treatment was found to be more efficient to improve rice growth parameters followed by rice straw compost and then gypsum. The Rice straw biochar significantly surpassed other two treatments, since it gave the highest values of leaf area index, dry matter, chlorophyll content in SPAD value and tallest plants in the first and second seasons(Tabels2&5). The benefit role of amendments might be mainly due to improve soil quality and fertility. Furthermore, applying soil amendments might showed great effect in decreasing soil sodium content and enrich soil in nitrogen and potassium as well phosphorous and zinc. The latter mentioned elements is suffering from low availability under saline sodic soil. Applying such amendments, particularly rice straw biochar and rice straw compost might had high be affinity to reduce the soil pH values under saline sodic soil by releasing more carbonic acids resulted in more nutrient soil availability. The benefit role applying soil chemical and organic matter involving rice straw biochar on soil reflected on rice salinity tolerance and improving ion selectivity toward potassium uptake against sodium. The increasing rice salt tolerance and nutrient uptake might improved photosynthesis, plant pigments formation resulted in high dry matter production, large leaf area a soil unit area developing large leaf area index. Improving rice growth under such condition increased auxin and gibberellins formation induced cell division and elongation resulted tallest internodes and subsequently tallest plants against stunt ones developed under saline soil as a resulted of salinity harmfulness. The current findings are in a good harmony with those reported by (Wang *et al.* 2013; Zayed *et al.* 2013; Liu *et al.* 2016; Jin *et al.* 2018; Zayed *et al* 2017 and Huang *et al* 2019) .

Table 2. Effect of soil amendments on some growth traits of some rice varieties in 2018 and 2019 seasons under saline soil conditions.

characters treatments	leaf area index		Dry matter (gm^{-2})		Chlorophyll (SPAD value)	
	2018	2019	2018	2019	2018	2019
Variety						
Giza177	3.61b	3.87c	540.1c	592.2c	36.02c	36.1c
Giza178	5.30a	5.45b	889.3b	886.8b	37.7b	38.8b
Giza179	5.40a	5.57a	933.6a	963.4a	38.9a	39.4a
F test	**	**	**	**	**	**
LSD 0.05	0.11	0.075	7.82	17.9	0.154	0.137
amendments						
Control	3.89d	4.10d	759.6d	782.1c	36.7d	37.0c
Gypsum	4.78c	4.97c	781.1c	813.3b	37.4c	38.2b
Rice straw Compost	5.03b	5.18b	797.8b	824.2ab	37.8b	38.4b
Rice straw Biochar	5.38a	5.59a	812.2a	836.9a	38.2a	38.8a
F test	**	**	**	**	**	**
LSD 0.05	0.10	0.101	7.84	13.5	0.187	0.197
Interaction	**	**	**	**	**	**

***, ** and Ns designate P < 0.05, P < 0.01 and not significant, respectively. Means of each factor designated by the same latter are not significantly different at 5% level using Duncan's Multiple Range Test**

With respect to the effect of the interaction, data analysis variance revealed that the interaction between rice varieties and soil amendments had a significant impact on leaf area index, dry matter production and chlorophyll content in both seasons. The data of the interaction came to fixed that the applying soil amendments showed positive effect particularly rice straw biochar on improving rice salinity tolerance that was clear with Giza177 salt sensitive variety (Tables3and 4). The highest values of leaf area index, dry matter and chlorophyll content were produced by Giza179 when rice plants were grown under applying rice straw biochar in saline sodic soil. On the other side, the lowest values of the previous stated traits in this chapter were noticed by Giza177 salt sensitive variety when it did not receive any of soil amendments in the first and second seasons(Tables3&4).

As for yield attributes, the current study showed that marked and significant differences were noted among the evaluated rice varieties; Giza177,Giza178 and Giza179 regarding all estimated yield attributes; panicle numbers, panicle length, number of the filled grains, number unfiled grains, panicle and 1000-grain weight in the first and second seasons(Tables 5, 6 and 9). Continuously, Giza 179 as a new salt tolerant variety showed its superiority over other two varieties even salt tolerant one Giza178 rice variety regarding yield attributing characteristics in both season under saline sodic soil. Giza178 rice variety went in the second order after Giza179 regarding yield attributes in both seasons (Tables5,6& 8).

Table 3 . Effect of the interaction between rice varieties and soil amendments on leaf area index and dry matter in 2018 and 2019 seasons

Factor	leaf area index			Dry matter(gm^{-2})		
	2018					
	Giza 177	Giza 178	Giza 179	Giza 177	Giza 178	Giza 179
Control	3.16h	4.38e	4.15f	524.8i	869.9f	884.1e
Gypsum	3.57g	5.25d	5.52c	525.2i	884.2e	934.0c
Rice straw Compost	3.60g	5.75b	5.75b	547.1h	895.3de	950.9b
Rice straw Biochar	4.12f	5.82b	6.20a	563.1g	908.0d	965.4a
LSD 0.05	0.173			13.5		
	2019					
Control	3.38h	4.57e	4.35f	564.2g	856.1e	926.2c
Gypsum	3.80g	5.45d	5.68c	607.9f	880.5d	951.6b
Rice straw Compost	3.85g	5.82bc	5.87b	591.5b	900.5cd	980.7a
Rice straw Biochar	4.45ef	5.95b	6.37a	605.3f	910.1c	995.2a
LSD 0.05	0.175			23.5		

Table 4. Effect of the interaction between rice varieties and soil amendments on chlorophyll content in 2018and 2019 seasons.

Factor	Chlorophyll content (SPAD value)					
	2018			2019		
	Giza 177	Giza 178	Giza 179	Giza 177	Giza 178	Giza 179
Control	34.4h	37.2e	38.5b	34.3h	38.5d	38.1d
Gypsum	35.7g	37.6d	38.8b	36.3g	38.8d	39.6b
Rice straw Compost	36.8f	37.8cd	38.8b	36.8f	38.8d	39.7ab
Rice straw Biochar	36.9ef	38.1c	39.5a	37.2f	39.2c	40.0a
LSD 0.05	0.324			0.342		

Table 5. Effect of soil amendments on some yield attributes of some rice varieties in 2018 and 2019seasons under saline sodic soil conditions

Characters treatments	Plant height (cm)		Panicle number $hill^{-1}$		Panicle length (cm)	
	2018	2019	2018	2019	2018	2019
Variety						
Giza177	91.8b	91.6c	13.2c	12.9c	20.3c	20.8c
Giza178	93.1b	94.0b	16.0b	16.2b	22.0b	22.6b
Giza179	95.8a	96.6a	17.8a	17.7a	23.1a	23.5a
F test	**	**	*	**	**	**
LSD at 0.05	2.23	1.93	1.49	1.36	0.90	0.65
Treatment						
Control	91.7b	91.9c	14.2b	13.6c	20.7b	21.0c
Gypsum	92.9b	93.3bc	15.8a	15.8b	21.9a	22.3b
Rice straw Compost	93.7ab	94.6ab	16.0a	16.2ab	22.0a	22.6ab
Rice straw Biochar	96.0a	96.5a	16.6a	16.8a	22.6a	23.3a
F test	2.37	1.93	1.13	0.95	1.04	0.79
LSD at 0.05	**	**	*	**	**	**
Interaction	Ns	Ns	Ns	Ns	Ns	Ns

***, ** and Ns designate P < 0.05, P < 0.01 and not significant, respectively. Means of each factor designated by the same latter are not significantly different at 5% level using Duncan's Multiple Range Test**

Table 6. Effect of soil amendments on number of filled and unfilled grains panicle^{-1} of some rice varieties in 2018 and 2019seasons under saline soil conditions

Characters Treatments	Number of filled grain panicle^{-1}		Number of unfilled grain panicle^{-1}	
	2018	2019	2018	2019
Variety				
Giza177	90.9b	92.7c	20.2a	20.3a
Giza178	128.5a	128.3a	9.59b	9.85b
Giza179	130.3a	123.9b	8.22c	8.61c
F test	**	**	**	**
LSD at 0.05	3.97	3.05	1.19	0.69
Treatment				
Control	107.7c	107.7c	20.8a	21.2a
Gypsum	117.0b	115.9b	10.5b	10.7b
Rice straw Compost	118.8b	115.7b	10.0bc	10.2b
Rice straw Biochar	122.6a	120.6a	9.26c	9.57c
F test	**	**	**	**
LSD at 0.05	2.68	2.17	0.90	0.645
Interaction	**	Ns	Ns	Ns

***, ** and Ns show P < 0.05, P < 0.01 and not significant, respectively. Means of each factor designated by the same latter are not significantly different at 5% level using Duncan's Multiple Range Test**

Giza179 exerted the maximum value of panicle numbers, longest panicles, the highest values of filled grains panicle^{-1}, the lowest values of number of unfilled grains and heaviest panicle weight in both seasons as seen in Tables5,6& 8. Giza 177 did not perform well under the situation of study since it developed the lowest values of all measured yield attributes and the maximum values of unfilled grains panicle^{-1} in the first and second seasons as it is listed in Tables5,6&8. Giza 177 produced the heaviest 1000-grain weight. Giza179 and Giza178 were at apart. Regarding number of the filled grains panicle^{-1} and panicle weight in couple study seasons. Giza179 new salt tolerant variety showed high value of salinity withstanding since it behaved better regarding its growth under stresses that might be due its high ability to avoid ion toxicity, high osmotic pressure under saline sodic soil indicating its possessing ion selectivity mechanism tolerance and high tissue tolerance. Giza177 seemed to be salt sensitive one that might be due to less ability to avoid ion toxicity because more Na^+ uptake similar results has been reported by Zayed *et al*. (2017).

Considering the effect of amendments application of yield attributes, significant and positive effect was detected on yield attributes characteristics owing to applying varying soil amendments involving gypsum and rice straw compost and rice straw biochar in the first and second season(Tables5 and 8). The tallest plant was obtained by applying rice straw compost without significant difference with rice straw Compost in both season.

The maximum number of panicles and tallest panicles were noticed by applying rice straw biochar without significant difference with rice straw compost at the second season meanwhile in first season the three tested soil amendments didn't differ all of the gave the maximum values of number of panicle and panicle length (Table5). The highest number of the filled grain and the lowest number of unfilled grains was noticed by applying rice straw biochar in both seasons (Table 6). The three soil amendments appear the same effect in increasing panicle weight in the first season as compared with control treatment meanwhile gypsum came in the second order in the second season (Table8). The heaviest 1000-grain was produced by applying biochar in both seasons without statistically difference with rice straw compost in the first season. Joining rice straw into the soil is becoming a well-known practice could rise yield of crop and fertility of soil in large parts of the world. The treatment of biochar had a positive impact on soil properties as (pH, available P, SOC, and available K), but these influence partly depend on the biochar feedstock materials. In our experiment, rice straw biocahr encouraged K uptake by rice plants, and presented greater potential for improving rice grain yield than and rice straw under stresses. Increasing K soil content and K plant uptake might be increased rice salt tolerance and growth under salt stress and ultimately rice grain yield. Overall, the application of rice straw biochar can improve soil properties, increase rice yield, and improve crop nutrient uptake Furthermore, rice straw biochar rice straw compost and gypsum application could diminish sodium ion accumulation of rice plant, while it obviously augmented rice dry biomass, grain yield and improved rice grain quality. The results advocated that biochar application each two years to saline-sodic paddy soil has advantages to diminish stress and promote the increase of rice yield and quality formation under saline-sodic soil. Similar results has been cited by (Wang *et al.* 2013; Zayed *et al.* 2013; Liu *et al.* 2016; Jin *et al.* 2018 and Huang *et al* 2019) .

As for the interaction effect between some amendments and rice varieties on number of the filled grains, data in (Table 7) showed that applying of biochar for Giza179 gave the maximum number of the filled grains panicle^{-1} moreover, Giza178 and Giza177 gave the maximum values of filled grains by applying rice straw biochar compared with other treatments. The minimum values of filled grain were produced by control treatment with the three rice varieties.

Table 7. Effect of interaction between rice varieties and some amendments on number of filled grains panicle^{-1}in 2018 season

Factor	Number of filled grains		
	Giza177	Giza178	Giza179
Control	80.9f	121.3c	121.1c
Gypsum	91.2e	129.9b	130.1b
Rice straw Compost	93.9de	130.4b	132.2b
Rice straw Biochar	97.6d	132.6b	137.8a
LSD at 0.05		4.64	

Table 8. Effect of soil amendments on number of panicle weight and 1000-grain weight of some rice varieties in 2018 and 2019seasons under saline soil conditions

Trait	Panicle weight(g)		1000-grain weight(g)	
Season	2018	2019	2018	2019
Variety				
Giza177	2.46b	2.60b	26.7a	27.0a
Giza178	2.82a	2.80ab	19.8c	19.6c
Giza179	2.82a	2.94a	24.8b	23.5b
F test	*	*	**	**
LSD 0.05	0.30	0.22	1.00	0.462
Treatment				
Control	2.52b	2.53c	23.2c	22.7c
Gypsum	2.68ab	2.79b	23.6bc	23.3bc
Rice straw Compost	2.70ab	2.86ab	23.9ab	23.4b
Rice straw Biochar	2.90a	2.96a	24.3a	24.2a
F test	*	*	**	**
LSD 0.05	0.274	0.160	0.547	0.583
Interaction	Ns	Ns	Ns	Ns

***, ** and Ns indicate P < 0.05, P < 0.01 and not significant, respectively. Means of each factor designated by the same latter are not significantly different at 5% level using Duncan's Multiple Range Test**

Yields:

Data in Table9 showed that varietal differences were obtained, regarding grain, biological yields and harvest index during study seasons. The maximum values of grain, biological yield and harvest index was produces by Giza179 without statically difference with Giza178, meanwhile the lowest values was found by Giza177. As for effect of some soil amendments, the obtained data showed that using soil amendments had a significant impact on grain yield , biological yield and harvest index in the two seasons . The highest values of grain yield was produced by applying rice straw biochar in both seasons without significant difference with those obtained by gypsum and rice straw compost in the second season. The maximum values of biological yield and harvest index were notice by applying the three tested soil amendments without significant difference among them in both seasons. It was obviously that in the second season since the experiment site was kept in the same place the biochar produced the highest values of grain yield and biological yield without significant differences with those produced by rice straw compost and gypsum, while in the first season rice straw biochar surpassed both of gypsum and rice straw compost. The final result indicated to the efficiency of rice straw bio-char in improving saline sodic reclamation but in the second season it did not achieve more important that might be owing to unacceptable high level of biochar under saline sodic soil (Jin *et al.*,2018). Also the gypsum and rice straw compost were at apar with rice straw compost that might be due to reaching sufficient rate when they were secondly reapplied in the same place in the second season (Zayed *et al.*, 2013 and 2017). Applying the studied amendments might be improved soil quality and fertility resulted in improving salt stress rice withstanding that ensured well rice growth, high photosynthesis rate pre heading one and current one, high dry matter production, optimum dry matter partitioning, proper yield components and finally high grain yield. The results has been cited by Wang *et al.* (2013), Liu *et al.(*2016), Jin *et al.(*2018), Huang *et al* (2019) and Zayed *et al.*(2013and 2017) .

Table 9. Effect of soil amendments on yields and harvest index of some rice varieties in 2018 and 2019seasons under saline soil conditions

Trait	Grain yield ($t\ ha^{-1}$)		Biological yield ($t\ ha^{-1}$)		Harvest index (%)	
Season	**2018**	**2019**	**2018**	**2019**	**2018**	**2019**
Variety						
Giza177	3.73b	3.97b	9.99b	10.1b	0.379b	0.390b
Giza178	5.55a	6.22a	11.5a	11.6a	0.481a	0.516a
Giza179	5.88a	6.25a	12.1a	11.9a	0.462a	0.502a
F test	**	**	**	**	**	**
LSD 0.05	0.22	0.21	0.657	0.363	0.026	0.025
Treatment						
Control	4.38c	4.60b	10.5c	10.7b	0.42b	0.44b
Gypsum	5.21b	5.61a	11.3ab	11.1ab	0.44ab	0.48a
Rice straw Compost	5.09b	5.74a	11.3ab	11.3a	0.45a	0.49a
Rice straw Biochar	5.54a	5.69a	11.7a	11.8a	0.46a	0.47a
F test	**	*	*	*	*	*
LSD 0.05	0.250	0.16	0.37	0.55	0.023	0.028
Interaction	**	**	Ns	Ns	Ns	Ns

***, ** and Ns show P < 0.05, P < 0.01 and not significant, respectively. Means of each factor designated by the same latter are not significantly different at 5% level**

The interaction between soil amendments and rice varieties had a significant impact on grain yield in the two seasons (Table10). The maximum grain yield was noticed by applying rice straw biochar for Giza179 in the two seasons. In the first season, both combination of Giza179 with gypsum and rice biochar were at the same level of significant regarding rice grain yield. In the second season both rice varieties of Giza178 and Giza179 with three soil amendments were at a par considering rice grain yield.

Table 10. Effect of interaction between rice varieties and some amendments on grain yield in 2018and 2019 seasons

factor	Grain yield ($t\ ha^{-1}$)					
	2018			**2019**		
	Giza177	**Giza178**	**Giza179**	**Giza177**	**Giza178**	**Giza179**
Control	3.23g	4.72e	5.20d	3.45d	5.59b	5.56b
Gypsum	3.75g	5.80bc	6.10abc	4.02c	6.41a	6.41a
Rice straw Compost	3.77fg	5.70c	5.80bc	4.24c	6.52a	6.46a
Rice straw Biochar	4.20ef	6.01bc	6.43a	4.17c	6.36a	6.55a
LSD 0.05		0.34			0.27	

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دراسة مقارنه تأثير بيوتشار ومكمورة قش الأرز على نمو ومحصول الأرز تحت ظروف الأراضي الملحية الصودية

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أقيمت تجربتان حقليتان بمنطقه السرو الزراعية بمحافظه دمياط- مصر خلال موسمي الزراعة 2018 و2019 وكان الهدف من الدراسة معرفه تأثير بعض من محسنات التربة على صفات النمو ومحصول ثلاث أصناف من الأرز وهم جيزة 177 صنف الأرز الحساس للملوحة، صنف الأرز جيزة 178 المتحمل للملوحة و صنف الأرز جيزه179الجديد المتحمل للملوحة ، وكان التصميم المستخدم القطع المنشقة مره واحده في أربعه مكررات حيث احتوت القطع الرئيسية على أصناف الأرز واحتوت القطع الشقية على المصلحات وهم الجبس وكومبوست قش الأرز وبيوتشار قش الأرز بالإضافة إلى معامله المقارنة، وذلك تحت ظروف الاراضى الملحيه الصودية. وكانت أهم النتائج المتحصل عليها كالتالي : اختلفت الأصناف معنويا في التأثير على صفات النمو والمحصول حيث أعطى صنف الأرز الجديد المتحمل للملوحة جيزه179 أعلى القيم من صفات النمو ومعظم مكونات المحصل ولم يختلف صنف الأرز جيزة 178 كثيرا عن صنف الأرز جيزة 179 حيث تفوقا الاثنان في إعطاء أعلى محصول حبوب بالمقارنة بصف الأرز الحساس للملوحة جيزة 177 وأثرت المصلحات معنويا على صفات النمو والمحصول بالمقارنة بالكنترول حيث أعطى بيوشار قش الأرز أعلى القيم من الصفات المدروسة وأيضا محصول الحبوب في الموسم الأول وفى الموسم الثاني تساوى مع الجبس وكومبوست قش الأرز.