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ORIGINAL ARTICLE

STUDYING THE EFFECT OF SOME MINERAL AND ORGANIC CONDITIONER ON THE AVAILABILITY OF SOME NECESSARY NUTRIENTS IN SANDY MIXTURE SOILS IRRIGATED WITH SALINE WELL WATER

Baida Alawi Hassan*, Haifa Jassim Hussein and Najla Jabr Mohammed

Department of Soil and Water Resources, College of Agriculture, University of Basra, Iraq.
E-mail: baydaallawi@gmail.com

Abstract: The field experiment was conducted in Al-Zubayr district, Al Raha area,Basra province, Iraq during season 2018 in order to know the effect of three types of conditioners (zeolite, rice straw ash and zeolite mixed with rice straw ash) and with three levels of addition (0, 5 and 10 tons.ha^{-1}) on the availability of nutrients in soils irrigated with saline well water (16 dSi.m^{-1}). Then adding the amendments to the soil with the surface layer and at three levels for each amendment (0, 5 and 10 tons.ha^{-1}). The results showed that the addition of mineral and organic amendments led to a significant increase in the availability quantity of elements in the sandy loam irrigated with saline water. The excelled of the zeolite amendment and the zeolite amendment mixed with rice straw ash with a mixing percentage (50%) on the rice straw ash amendment in increasing the concentration of the necessary elements for the plant, which in turn was reflected on the total yield of tomato plants. The concentration of nutrients increased with the increase in the level of the added amendment. The level of 10 ton.ha^{-1} achieved the highest values of nitrogen, phosphorous and potassium amounting to 91.47, 43.31 and 234.61 mg.kg^{-1} soil respectively with a significant difference from the level 5 ton ha^{-1} and the level of 5 tons.ha^{-1} was excelled to the level 0 tons.ha^{-1} (the control treatment), followed by the treatment of zeolite amendment mixed with rice straw ash and the addition level of 10 tons.ha^{-1} was 96.67, 48.77 and 255.53 mg kg^{-1} soil. The results also showed that the zeolite treatment at the level of 5 tons.ha^{-1} was excelled on the treatment of zeolite mixed with rice straw ash 5 tons.ha^{-1}, which amounted to 72.47, 34.05 and 189.73 mg.kg^{-1} soil respectively and rice straw ash (5 tons.ha^{-1}) showed a significant increase in the concentration of available nutrients compared to the control treatment without the addition of the amendment.

***Key words*:** Zeolite, Rice straw ash, Availability of the elements, Saline well water.

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1. Introduction

Organic and mineral amendment play a very important role in solving many of the problems that suffer from poor sandy soils. When added to the soil, they work to be part of the adsorption complex, which works to catch and retain ions and prevent them from losing through volatilization or washing and releasing them to soil solution gradually in addition to increasing the biomass in the soil [Hortensia (2013), Abd AL-Hseen and Manea (2020)]. Agricultural crops are affected by the amounts of dissolved salts in the irrigation water, where the increase in the concentration of dissolved salts in irrigation water and soil, especially harmful ones such as sodium and chloride, reduce the efficiency of the plant to absorb water and nutrients, which affects plant growth and crop productivity Pongsivapai *et al.* (2016) showed that the addition of conditioner improved sandy soils, either singly or mixed with organic and mineral fertilizers led to an increase in the cation exchange capacity and organic matter and improved

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chemical properties of these soils. Reducing soil salinity, increasing the availability of phosphorous and potassium and improving plant growth and productivity. Therefore, the mineral has an effective role in sandy soils where nutrients and water are lost. These results agree with Shokouhi *et al.* (2015) that zeolite contributes to sustainable agriculture by preventing the occurrence of environmental problems by increasing the availability of nitrogen and phosphorous and increasing the efficiency of water use in the soil. The use of rice straw ash improves aeration in the root area, increases the ability of the soil to water-holding, increases the availability of phosphorous, potassium and magnesium and improves soil fertility because it contains many elements such as nitrogen, potassium and calcium. Muthadhi *et al.* (2007) showed that rice straw ash is a good amendment and is widely available and contains many elements and that the use of ash increases the availability of phosphorous, potassium and magnesium, improves soil aeration in the root zone and increases the ability of the soil to water-holding. Chitgupekar *et al.* (2014). The scarcity of fresh water and the high degree of salinity in well water in the southern regions of Iraq, especially in Basra province and its use in irrigating agricultural crops, made us study the possibility of using natural conditioners to improve the traits of fertile soil by increasing the average of availability of nutrients and reducing the harmful effect of salt stress.

2. Materials and Methods

The field experiment was conducted in one of the fields of Al-Raha area of Al-Zubair district in the south of Basra province during the 2018 season. To study the effect of adding some mineral and organic amendment at different levels on the content of availability made nutrients in sandy loam soils irrigated with well water of high electrical conductivity (16 dS-Si). Soil analysis was conducted before field cultivation, where soil samples were taken randomly from different locations in the study area to form a composite sample, then dried pneumatically, milled and sieved from a sieve whose holes are 2 mm. The chemical and physical properties are shown in the Table 1. The analyzes were conducted in the laboratories of the Department of Soil Sciences and Water Resources at the College of Agriculture, University of Basra. straw Rice Husk (RRH) samples of Amber cultivar (*Oriza Sativa* L.) were collected from the agricultural fields of Al-Shamiya district of Al-Qadisiyah province. The impurities and dust were removed after cleaning and washing with distilled water. The samples were air-dried and then burned in the Mfful Furnace at a temperature of 1000°C for 3 hours to obtain Rice straw ASH (RHA) ash. While the zeolite amendment was prepared by the General Company for Agricultural Supplies affiliated to the Ministry of Agriculture in the form of single minutes packed with 25 kg plastic bags per bag.

The soil of the field was prepared by plowing and then the furrow was opened and then the soil of the field was fertilized with one level of animal waste (6 tons.ha^{-1}) and the conditioners were added to the soil mixed with the soil and at three levels for each amendment (0, 5 and 10 tons.ha^{-1}) zeolite, scale ash and zeolite amendment mixed with ashes of rice straw. Mineral fertilizers were added at levels of 320 kg.N.ha^{-1} to soil in the form of urea fertilizer (46% N) and in two batches, the first before planting, mixed with the soil and the second after 30 days from the planting date. As for phosphate fertilizer, it was added at a level of 90

Table 1: Some chemical and physical properties of the study soil before cultivation.

Total carbonate	Organic matter	cation exchange capacity	Electrical conductivity(Ec)	pH
g. Kg^{-1}	g. Kg^{-1}	Centimol.kg^{-1}	Ds.m^{-1}	-----
146.17	0.61	3.41	5.24	7.78
Soluble magnesium	Soluble calcium	Availability potassium	Availability phosphorous	Availability Nitrogen
mmol.L^{-1}		mg. Kg^{-1}		
10.91	12.75	53.29	7.18	18.34
soluble chloride	soluble bicarbonate	soluble carbonate	soluble sodium	soluble potassium
mmol.L^{-1}				
19.62	3.18	0	23.31	0.48
Clay	silt	sand	Texture	Soluble sulfate
g. Kg^{-1}				mmol.L^{-1}
				10.22

kg.p.ha^{-1} of soil in one batch when planting and potassium fertilizer was added at a level of 120 kg.ha^{-1} of soil in the form of potassium sulfate in one batch (recommendations of the Ministry of Agriculture, General Authority for Agricultural Services, 1991) Crop service operations continued from maintaining emitters, combating against diseases and insects and protecting plants from cold by covering them with transparent plastic, in addition to hoeing, weeding and other operations until the end of the growing season, with plants irrigated with well water with an electrical conductivity of 16 ds.m^{-1}.

Two factors were used in the experiment.

A. The type of added soil amendment, including:

1. Zeolite amendment
2. Rice straw ash amendment
3. Zeolite amendment mixed with rice straw ash.

B. The level of the added amendment, including:

1. 0, 2. 5 and 3. 10 tons.ha^{-1}

Soil samples were collected at the end of the agricultural season, as composite samples were taken from the middle of the experimental unit and placed in plastic bags until they were transported to the laboratory, where they were air-dried, then milled and sieved through a sieve with holes 2 mm in diameter and the availability quantity of nutrients nitrogen, phosphorous and nitrogen was measured according to the methods mentioned in Singh *et al.* (2012).

3. Results and Discussion

Availability nitrogen in the soil

When reviewing the results of the effect of adding zeolite and zeolite amendment mixed with rice straw ash and rice straw ash to sandy loam soil and irrigated with water with electrical conductivity 16 dSm^{-1} on the availability nitrogen content of the soil. It is clear from Fig. 1 that there are different effects of the amendments used in the study on the soil content of available nitrogen. The zeolite amendment was distinguished by its high ability to record the highest content of availability nitrogen in sandy soil, which amounted to 129.73 mg.kg^{-1} soil, followed by inefficiency by the zeolite amendment mixed with ash Rice straw, which amounted to 96.67 mg.kg^{-1} soil and that the reason for the significantly excelled of the zeolite amendment on the rest of the amendments may be due to the fact that the mineral zeolite improves the use of nutrients, especially the nitrate and ammonium ion, increases the absorption of nitrogen and also works to release the ammonium ion in the soil. It reduces the loss of nitrogen in the soil through the washing process in sandy soils and prevents the volatilization of ammonia for its ability to reduce the process of reversing nitrification while reducing ammonia volatilization as a result of urea fertilizer when mixing the mineral with sandy soil. The mixing zeolite with soil leads to an increase in plant growth and productivity and the reason for this is due to improving the efficiency of nitrogen use and improving soil properties as a result of mixing zeolite with soil. These results are also consistent with Salman (2017) regarding an increase in nitrogen concentration in the soil as a result of adding a amendment of rice straw ash compared to the rest of the conditioners used in the study. The results showed that the amount of available nitrogen in the soil continues to rise with the increase in

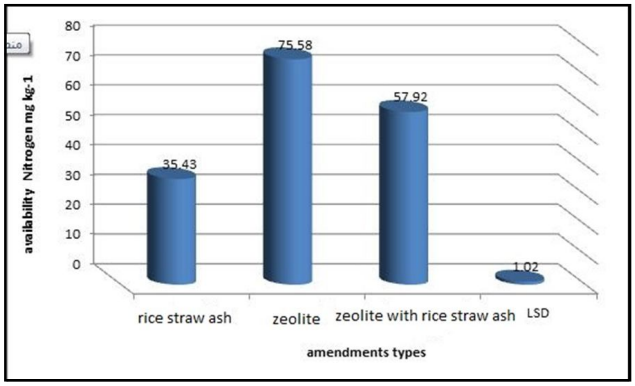

Fig. 1: The effect of the amendments types on the values of availability nitrogen (mg.kg^{-1} soil) in the field soil post-harvest

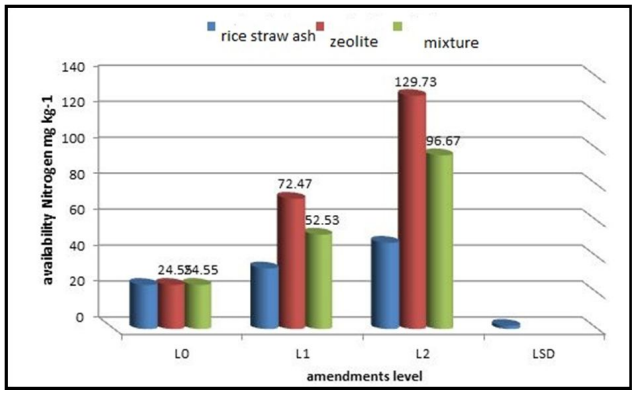

Fig. 2: Effect of the type and level of amendments on the values of availability nitrogen (mg.kg^{-1}) in sandy soil post-harvest

the level of zeolite and rice straw ash added (5 and 10 tons.ha^{-1}), respectively (Fig. 2) which indicates the importance of the mineral in preserving nitrogen in the soil and continuing its availability for plants and this is a fertility indicator of great importance for soil and plants.

The results in Fig. 3 show that there is a significant effect of the interaction of the amendments type and the level of it added to the soil on the concentration of available nitrogen in sandy, sandy soils to which the amendment is added. The zeolite amendment added at the level of 10 tons.ha^{-1} significantly excelled on the rest of the amendments in giving the highest nitrogen concentration in the treated soil. It reached 129.73 mg.kg^{-1} soil. It was followed by treatment of zeolite amendment mixed with rice straw ash at the level of 10 tons.ha^{-1}, zeolite amendment at the level of 5 tons.ha^{-1} and zeolite amendment mixed with rice straw ash at the level of 5 tons.ha^{-1} amounted to 96.67, 72.47 and 52.53 mg.kg^{-1} soil respectively. The main reason for the high values of available nitrogen in the soil to which zeolite is added is due to the basic mechanism represented by the adsorption of ammonium on the inner and outer surfaces of the zeolite and its preservation from volatilization or washing with irrigation water [Latifah *et al.* (2017)].

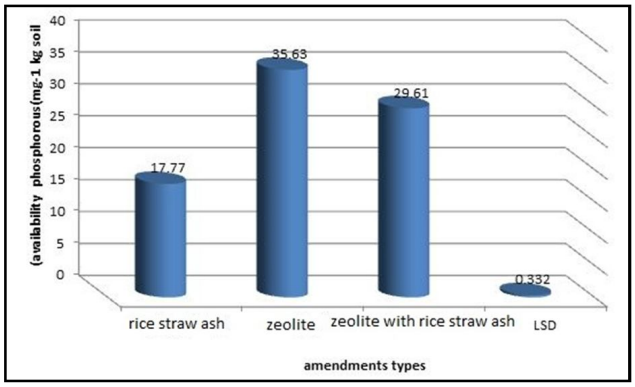

Fig. 3: The effect of the amendments types on the values of availability phosphorous (mg.kg^{-1} soil) in the field soil post-harvest

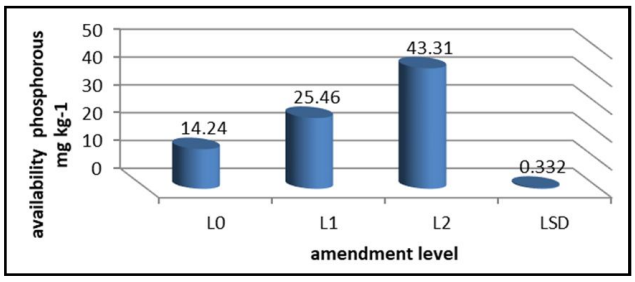

Fig. 4: Effect of the amendment level on the values of availability phosphorus mg.kg^{-1} in sandy soil post-harvest

The addition of rice straw ash amendment at the level of 10 tons.ha^{-1} and rice straw ash at the level of 5 tons.ha^{-1} increased the amount of nitrogen availability in the soil after harvest, adding rice straw ash to the soil is a very important source for feeding microorganisms that reduce nitrogen volatilization in the soil by reversing nitrification, such as nitrogen-fixing bacteria by considering the carbon of rice straw ash as a source of nutrition for organisms in addition to the role of ash in improving the chemical and physical properties of soil. This is reflected on the uptake of nitrogen originally present in the soil by plants and originally added in the form of urea fertilizer [Shao *et al.* (2009)] and this is a very encouraging result for the use of the fertilizers used in the study to improve the soil content of available nitrogen.

Availability phosphorous in the soil

The results of Fig. 4 indicated the difference in the content of sandy loam soil after the end of the agricultural season of availability phosphorous according to the type of amendment added, where the treatment of zeolite and zeolite mixed with rice straw ash was significantly excelled on the treatment of rice straw ash for one unit, where it reached 35.63 and 29.61 mg.kg^{-1} soil respectively. The reason for the excelled zeolite amendment may be due to the fact that the zeolite mineral works to sequester and collect phosphorous ions within its channels, where the mineral is characterized by a large number of cavities and channels in it, which increases the efficiency in sequestering and holding ions in the soil or the environment, thus reducing its loss by leaching and then liberating them increasing the solubility of phosphorus to the soil solution when needed and gradually, which is an important and distinctive characteristic of zeolite mineral, which works to increase the availability of phosphorus in the soil, which confirms the importance of Zeolite mineral in increasing the concentration of availability phosphorus in sandy soils.

It is also noted through the results shown in Fig. 4 that the rice straw ash amendment plays a major role in increasing the concentration of available phosphorus in the soil. The reason for the increase in the concentration of availability phosphorous with the increase in the addition of ash may be due to the increase in the provision of moisture content in the soil, the activity of organisms, the stability of clusters and the surface area, which led to an increase in the availability

phosphorus. Where the rice straw ash is characterized by its high ability to increase the moisture content of the soil due to its ability to hold water particles due to the high surface area of the ash, as it consists of a composition with hollow spherical particles where the capillary movement increases and then the holding of water and nutrients increases [Mohammed *et al.* (2013)]. Where it gave the highest value for the concentration of phosphorous available in the soil, which was 37.12 mg.kg^{-1} compared to the other conditioners. In general, the results showed that the amount of available phosphorous in the soil increased with the increase in the level of the addition of amendment (zeolite, rice straw ash and mixture 5 and 10 tons ha^{-1}), where the level of 10 tons.ha^{-1} excelled on the rest of the levels in giving the highest concentration of available phosphorus in the treated soil which amounted to 43.31 mg.kg^{-1} soil (Fig. 5).

The results in Fig. 6 show that there is a significant effect of the interaction between the type and level of the amendment added to the soil in the concentration of available phosphorous in the soil. The zeolite amendment added at the level of 10 ton.ha^{-1} excelled on the rest of the treatments. Where it gave the highest values of availability phosphorous, which amounted to 56.59 mg.kg^{-1} soil, followed by treatment of zeolite amendment mixed with rice straw ash and the addition level of 10 tons.ha^{-1} was 48.77 mg.kg^{-1} soil. The results also showed that the treatment of zeolite at the level of 5 tons.ha^{-1} was excelled on the treatment of zeolite mixed with rice straw ash 5 tons.ha^{-1}, which amounted to 34.05 and 25.82 mg.kg^{-1} soil respectively (Fig. 6). Rice (10 tons.ha^{-1}) and rice straw ash (5 tons.ha^{-1}) led to an increase in the values of availability phosphorous for treated soil compared with the control treatment without adding the amendment, where the results show a high concentration of available phosphorous in sandy soil as a result of mixing the conditioners with the soil, which increases with the increase in the level of the added available.

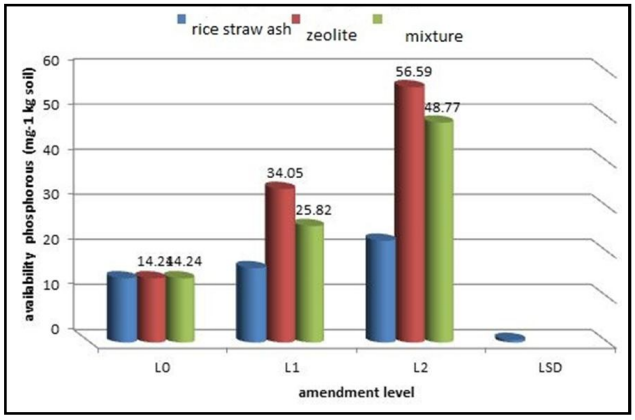

Fig. 5: Effect of the type and level of the amendment on the values of availability phosphorous (mg.kg^{-1} soil) in the field soil post-harvest

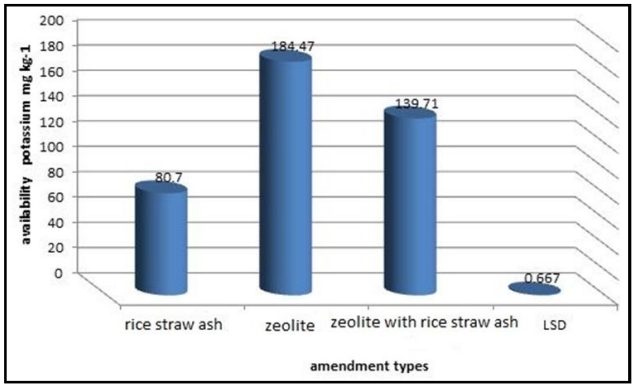

Fig. 6: Effect of the type and level of the amendment on the values of availability phosphorous (mg.kg^{-1} soil) in the field soil post-harvest

Potassium availability in the soil

The results in Fig. 7 showed that there were significant differences between the types of amendments used in the content of potassium in the sandy loam, where the treatment of adding zeolite amendments was excelled on the potassium content in the soil at an average of 325.20 mg.kg^{-1} soil and with a significant difference over the rest of the amendments added, then followed by the zeolite amendment mixed with Rice straw ash, which gave a concentration of potassium at an average of 255.53 mg.kg^{-1} amendments soil. The reason for the excelled of zeolite amendments may be due to the high adsorption of zeolite mineral and the control of the ion exchange process in the soil to which the mineral is added, which acts as a fertilizer store and a gradual supply of nutrients in the soil that the pores and voids are very characteristic of zeolite mineral and that the surface area of the inner surfaces of these channels is very high per gram of zeolite, which makes the ion exchange process effective.

It is observed from Fig. 7 that the efficiency of the zeolite amendment mixed with rice straw ash increases the amount of potassium in the soil. Zeolite has a high selectivity for potassium ion, due to the characteristic silicate structure of zeolite, which contains cavities in the form of open channels that are occupied by water and cations such as potassium, which are subject to ion exchange and its high ability to preserve potassium and

gradually release to the soil solution [Cairo *et al.* (2017)]. The presence of rice straw ash with zeolite led to an increase in the amount of potassium in the soil. This may be due to the rice straw ash containing a very high percentage of silicon, which has a major role in increasing the soil absorption of nutrients in addition to increasing the soil content of potassium, nitrogen and phosphorous and these results agree with what was found by Moraetis *et al.* (2016). The results showed that the amount of availability potassium in the soil increased with the increase in the level of zeolite and rice husk ash added (5 and 10 tons.ha^{-1}), respectively (Fig. 8), which indicates the importance of the amendment in maintaining potassium in the soil and continuing its availability for plants and this is a fertility indicator with the importance of soil and plants. This is due to the high potassium content of zeolite, as zeolite is a source of potassium through the process of ion exchange with soil cations and the mineral increases the moisture content of the soil, which leads to an increase in the release of potassium with an increase in the moisture content and that the ash of plant residues

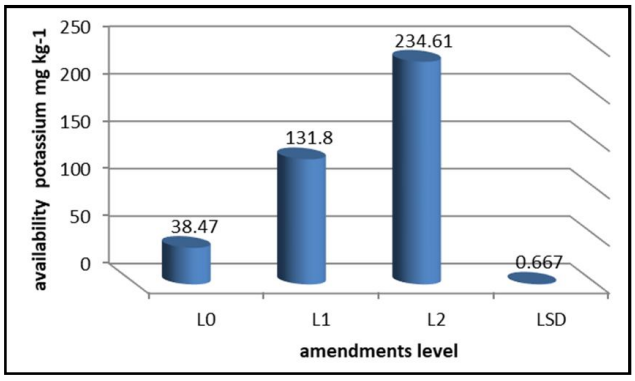

Fig. 7: Effect of the amendment level on the values of availability potassium mg.kg^{-1} in sandy soil after harvest

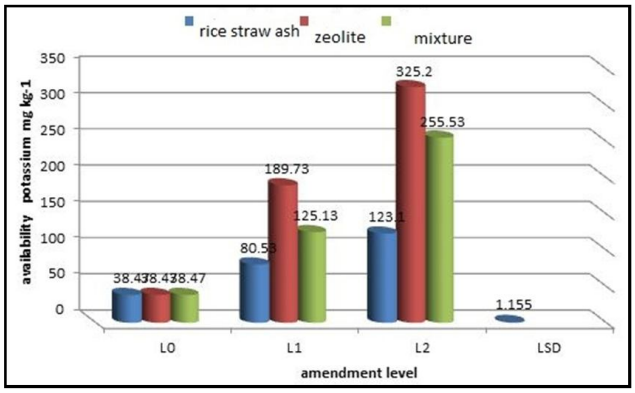

Fig. 8: Effect of the type and level of amendments on the values of availability potassium (mg.kg $^{-1}$soil) in sandy soil post- harvest

has a significant role in improving the soil's fertility characteristics by preparing the soil with nutrients necessary for plant growth and increases the soil's ability to retain water. So the use of these materials will have a great economic return from the environmental point of view (reducing environmental and agricultural pollution and these results are consistent with the findings of Al-Ammari (2015).

The results of Fig. 7 show that there is a significant effect of the interaction between the type of amendment and the level of addition of the amendment in the concentration of potassium available to the soil. Adding 10 tons.ha^{-1} to the rest of the treatments, which amounted to 325.20 and 255.53 mg.kg^{-1} soil, respectively, while the treatment of rice straw ash amendment with the addition level of 10 tons.ha^{-1} and it reached 123.10 mg.kg^{-1} (Fig. 8). The reason for the excelled of the amendment containing zeolite may be due to the role of zeolite in increasing the availability of potassium. These results are in agreement with those of Kabba *et al.* (2018).

4. Conclusion

The efficiency of the amendment used in the study differed in improving the fertility characteristics of sandy loam and irrigated with water of high electrical conductivity. The best treatment was for the soil treated with zeolite amendment and the amendment took the following order in increasing the availability of the nutrients nitrogen, phosphorous and potassium in the sandy loam: zeolite > zeolite mixed with rice husk ash > rice straw ash.

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