



Evaluation of urban-waste compost and natural zeolite effects on chemical properties of saline soil

Khalid Ahmad Yaqoobi*, Sayed Ahmad Sayedi, Noorulhaq Mohamadi, Zamaryali Tani, Ghani Dad Saeedi

Assistant Professor, Department of Soil sciences and irrigation, Faculty of Plant Sciences, Afghanistan National Agricultural Sciences and Technology University (ANASTU), Kandahar, Afghanistan

Abstract

The effects of urban waste compost and natural zeolite on chemical properties of saline soil were studied in this research. Soil was treated with five different treatments by weight such as control (only soil), compost 15% + 85% soil, composte 30% + 70% soil, zeolite 10% + 90% soil, zeolite 20% + 80% soil. These materials were mixed well and the treatments were conserved into pots for 10 days, in the experimental conditions; later, the parameters such as soil pH, saturated soil extract electrical conductivity (EC), organic material (OM), lime, cation exchange capacity (CEC) and exchangeable sodium (Na) were analysed. The result revealed that natural zeolite has more effeciacy in chemical reactions such as CEC which showed 2.41 and 3.77 times more CEC in 10% and 20% application of zeolite compare to control, and exchangeable sodium which showed 22.39% and 41.6% increase in 10% and 20% of zeolite application respectively, and caused better change in chemical properties of the soil. Notworthy, urban waste compost also cuntributed remarkably in increasing soil organic matter as well as soil EC, lime and CEC particularly in 30% compost applied treatment.

Keywords: urban-waste composte, zeolite, saline soil, chemical propertiese

Introduction

Soil is a key component of the earth's system, controlling hydrological, geochemical, biological, and ecological cycles (Keesstra *et al.*, 2016; Brevik *et al.*, 2015; Smith *et al.*, 2015) [13, 8, 25]. Climate change on the other hand, associated with the rise in temperature and precipitation variability, has accelerated land deterioration, reduced crop production and increased food insecurity (Asseng *et al.*, 2019) [3]. As a result, salt-affected soils have increased globally to approximately 930 Mha (Rengasamy *et al.*, 2006) [22], with saline-alkaline soils accounting for the majority of this area. This problem has constrained the scientific community to seek significant solutions to remediate soil salinity and increase plant resistance to salinity and drought. There are several approaches that can be used for reducing such problems, one of which is the utilization of soil amindments such as urban waste compost, which improve soil structure (Diacono, Montemurro, 2010) [9], and natural zeolite. Compost is the remaining parts of plant, animal, urban waste and lavatory matter that came under manure condition (Taiwo, 2011; Leo *et al.* 2013) [28, 16]. Compost, increasing soil porosity and soil water holding ability, preserving soil from erosion, and release plant essential nutrients. Urban waste compost is recently used for soil degradation recovery (Sadiqy *et al.*, 2016; Abdulmutalib *et al.* 2016) [24, 1]. Urban waste compost is a type of valuable organic fertilizer for improving soil physical, chemical and environmental condition. The significant rule of compost is in lessening of runoff water and toxic charecteristics of heavy metals (Smith *et al.*, 1999) [26]. Compost usage as organic material could make relationship between water, soil and plant from different alternative ways, such as water holding capacity, reducing water flow, evaporation decline, drainage ability, and roots growth (Hupe *et al.*, 1998 & Stirling, 2000) [12, 27]. Compost works effectively in decreasing slop area damage. In the US, these materials used to stable slop area beside ways (Block, 1999; Stirling, 2000) [6, 27]. Stablelozed soils

by compost, reduce water leaching, thus water holding capacity of soil is increasing, which inturn, reasoning runoff decline and soil improvement (ROU, 2007) [23]. Investigations demonstrated, that increase of organic matter in saline soil, increase soil structure stability and density and soil microbial biomass (Tejada and Gonzalez, 2008) [29]. On the other hand, zeolites are a group of minerals (crystalized hydrated almonium silicate), which mostly effect on soil CEC, and soil surface adsorbtion, which affectively used for separation of poisonous elements from contaminated water and soil. More than 85 kinds of natural zeolite and more than 100 types of non-natural zeolites are known so far. In the last decades abundant efforts have been done for the utilization of inexpensive sources for washing off of contaminated soil from heavy metals, industrially contaminated water, which among mines washing materials zeolites are in the verge of new hope to be practiced. Zeolites application contribute quantiative and qualitative improvements in agricultural products and soil development, through improving plant growth and turgor, decrease in irrigation volume, evaporation reduction, decrease of underground water contamination (Milosevic *et al.*, 2009) [17], increase phosphorous absorbance in sandy and gravely soil, decline soil nitrogen leaching in irrigation and rain water, care of oxygen and soil aeration, preparation of some ions such as, P, Ca, Mg and support to clean soil from toxic and heavy elements (Leonard *et al.*, 1981) [16]. Soil nitrate leaching is waste of money and cause contamination problemes for water resources. Hence, some approaches for nitrate leaching prevention have been prescribed, but since their high cost and less usefulness, most of them are not welcomed. There for, the application of zeolite as an inexpensive source with high working performace, well-thought-out to be used (Barnard *et al.*, 2012). In last few years zeolite application for small scale has been tested, which declines the undesirable outcome of nitrogen fertilizer. Consequently, natural zeolites are good

source of soil amendments due to high water and nutrient holding capacity, which improves infiltration rates, saturated hydraulic conductivity, cation exchange capacity, and prevents water loss through deep percolation (Enamorado-Horrutiner *et al.*, 2016) ^[10]. They can also be used as chelating agents and fertilizer (Tsintskaladze *et al.*, 2016) ^[30].

Furthermore, the combination of zeolite and other common amendments, such as compost, may improve the efficiency of saline soil remediation. Therefore, proper saline soil management is an urgent need for improving crop production and closing the food gap in arid regions. In this regard, the current study aims to assess the effects of zeolite and urban waste compost was conducted on the chemical properties of saline soil.

Materials and Methods

This research was conducted on 2019 at Gorgan University of Agricultural Sciences and Natural Resources in Iran. The site of the experiment was located between 45° 30´ of E and

37° 45´ N. The soil of the experiment was selected from 0 to 30 cm depth of surface soil, in the agricultural lands of Marava Thapa town (between 55° 37´ of N and 55° 28´ of E). Furthermore, urban waste compost from Aqu Qala with three levels (0, 15 and 30%) after sieving by 10 mm sieve, and zeolite in the form of powder, from the mine of Seya Zagh, Simnan in three levels such as 0%, 10% and 20% were used in the experiment. Treatements combination is shown in the following table 1.

Each treatment materials mixed well and preserved in pots for ten days, later on chemical properties from the soil parameters was measured with the following methods: EC by EC mater, organic matter with walkly block (Nelson and Sommar., 1982) ^[19], lime with titration, pH by pH mater from soil extract (Black, 1965) ^[5], exchangeable sodium with extraction method by ammonium acetate and CEC through Boyer method (Morgan, 2005) ^[18]. Data statistical analysis was performed by SAS software. For significance difference (p <0.05) ANOVA test and comparison of mean by LSD test were used.

Table 1: Combination of the treatments

No	Treatment	Combination of treatment (kg)
1	Control	Soil
2	Compost 15%	Soil 85% + Composte 15%
3	Composte 30%	Soil 70% + composte 30 %
4	Zeolite 10%	Soil 90% + Zeolite 10%
5	Zeolite 20%	Soil 80 % + Zeolite 20 %

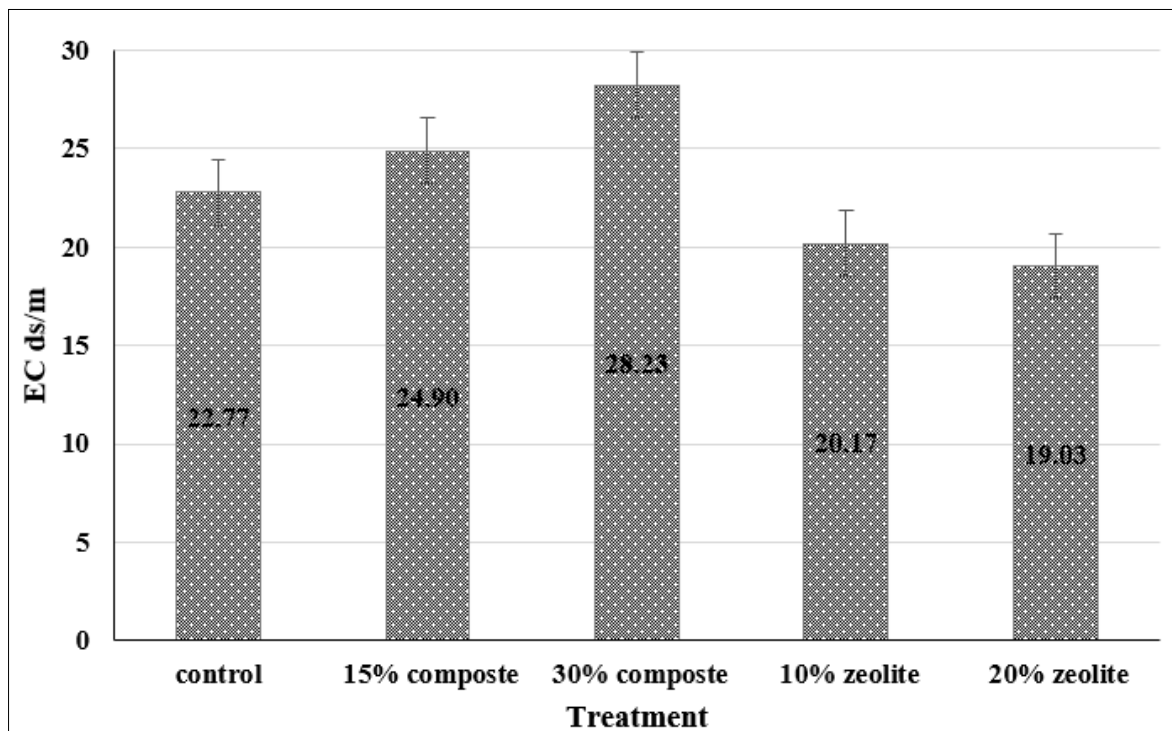


Fig 1: Effects of different percentage of composte & zeolite on soil EC.

Result and discussion

The result of the experiment showed that compost application caused gradual increase in soil EC from 22.76 in control to 24.9 and 28.23 in 15% and 30% compost application respectively, while zeolite decreased soil EC or active salinity level to 20.16 and 19 in 10% and 20% zeolite application respectively as shown in figure 1.

Similar trend is seen in soil pH level for compost application which increased form 7.4 in control to 7.86 and 7.9 in 15% and 30% compost application respectively, but zeolite did not affect soil pH, as shown in figure 2. Similarly, Bastida *et al.* (2008) ^[4] reported that zeolite application could cause a meaningful decrease in EC level and could effectively participate in balancing saline soil nutrients.

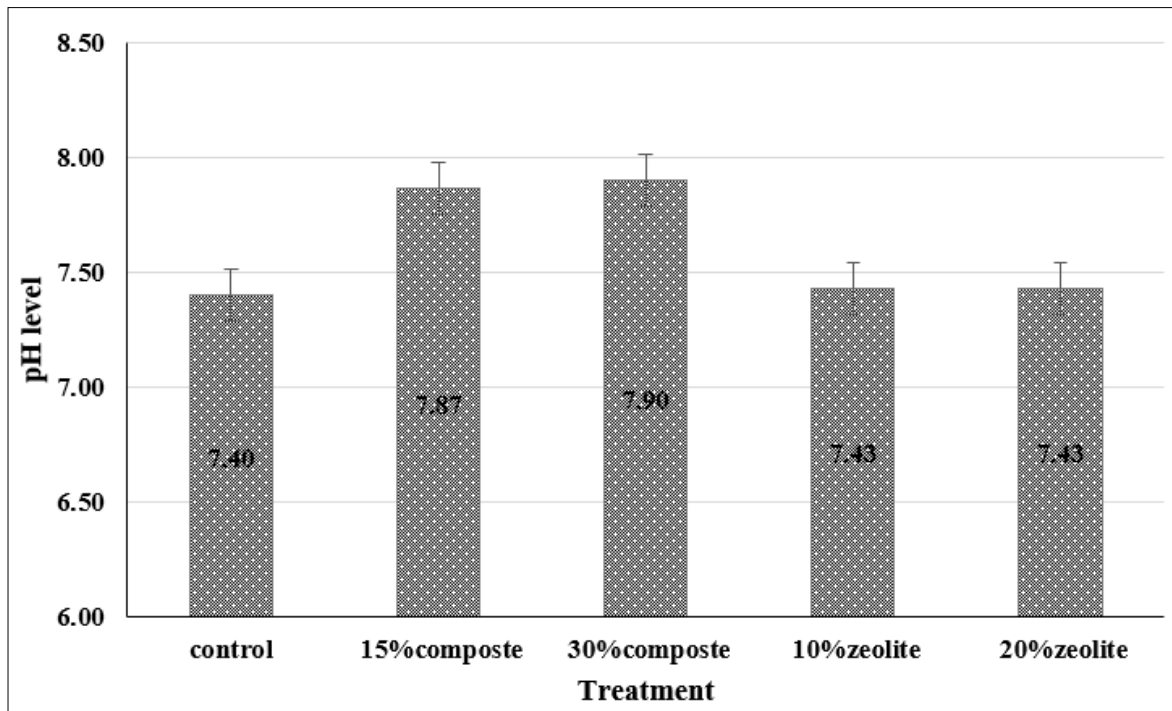


Fig 2: Effects of different percentage of composte & zeolite on soi pH.

Moreover, Noori and Zendadile (2006) [20] studied the response of zeolite on soil EC and salinity on *Raphanus sativus* L. crop, which treated by zeolite, Na₂SO₄, NaCl, control, zeolite + NaCl and zeolite + Na₂SO₄; the result

revealed that zeolite treated plants produced better yield and soil modification and concluded that zeolite does not let salt to move into plant root.

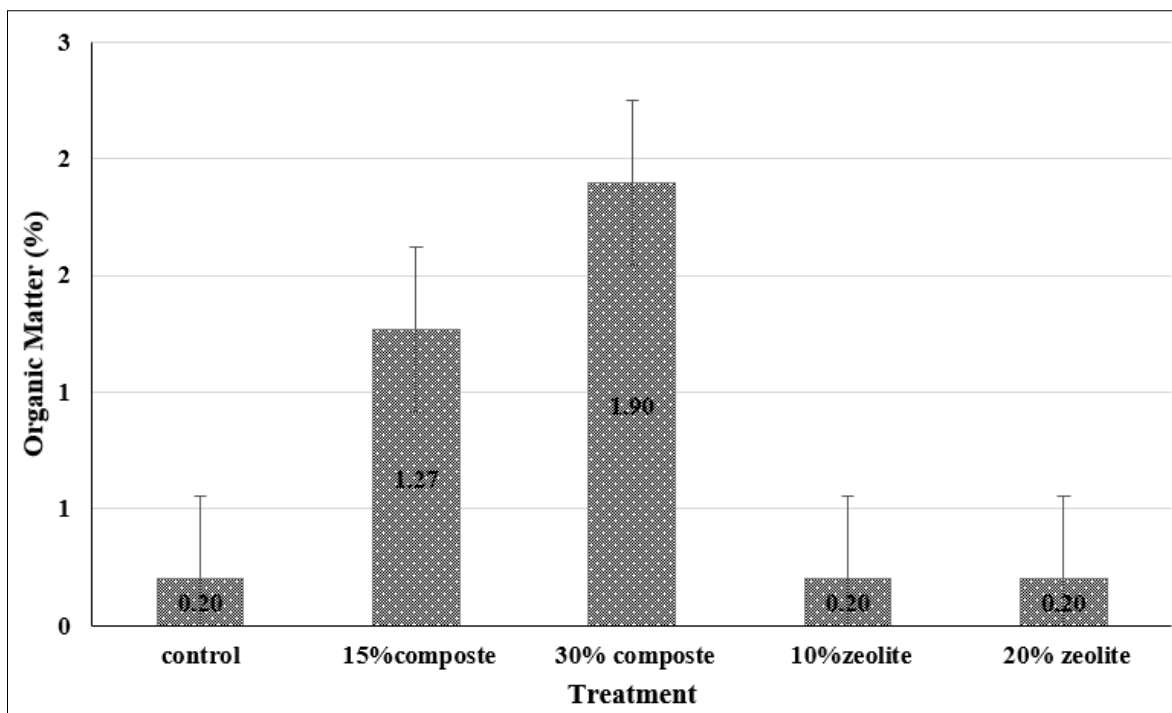


Fig 3: Effects of different percentage of composte & zeolite on soi. O.M

Urban waste compost as a source of organic matter significantly increased organic matter content of the soil from 0.2% in control to 1.26% and 1.9% in 15% and 30% compost application treatments respectively; however, zeolite application did not influence organic matter content as seen in figure 3. This result is similar with the findings of Filcheva and Tsadilas (2002) [11], who reported that there was no significant effect of zeolite on soil organic carbon.

Lime content is also significantly increased in compost application which shows 22.94% and 38.94% increase in 15% and 30% compost application respectively compare to control treatment; while zeolite application caused very little or insignificant variation in lime content as shown in figure 4.

Ravali *et al.* (2020) [21] reported that Zeolite has significant effect on soil pH, EC, CEC

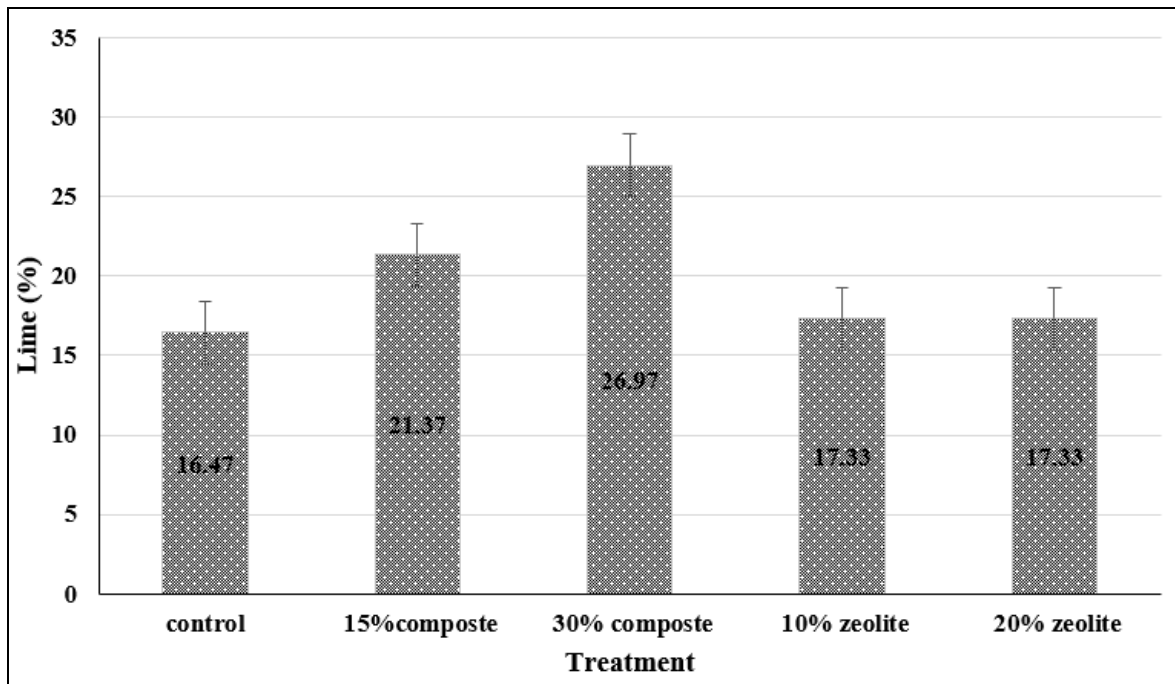


Fig 4: Effects of different percentage of composte & zeolite on soil lime

Soil CEC is a main characteristic, and has a vital rule on soil fertility. Most importantly, CEC of the experimental soil was significantly increased in all treatments of compost and zeolite application compare to control. The highest CEC

was calculated in zeolite application which shows 2.41 and 3.77 times more CEC in 10% and 20% application of zeolite compare to control as shown in figure 5.

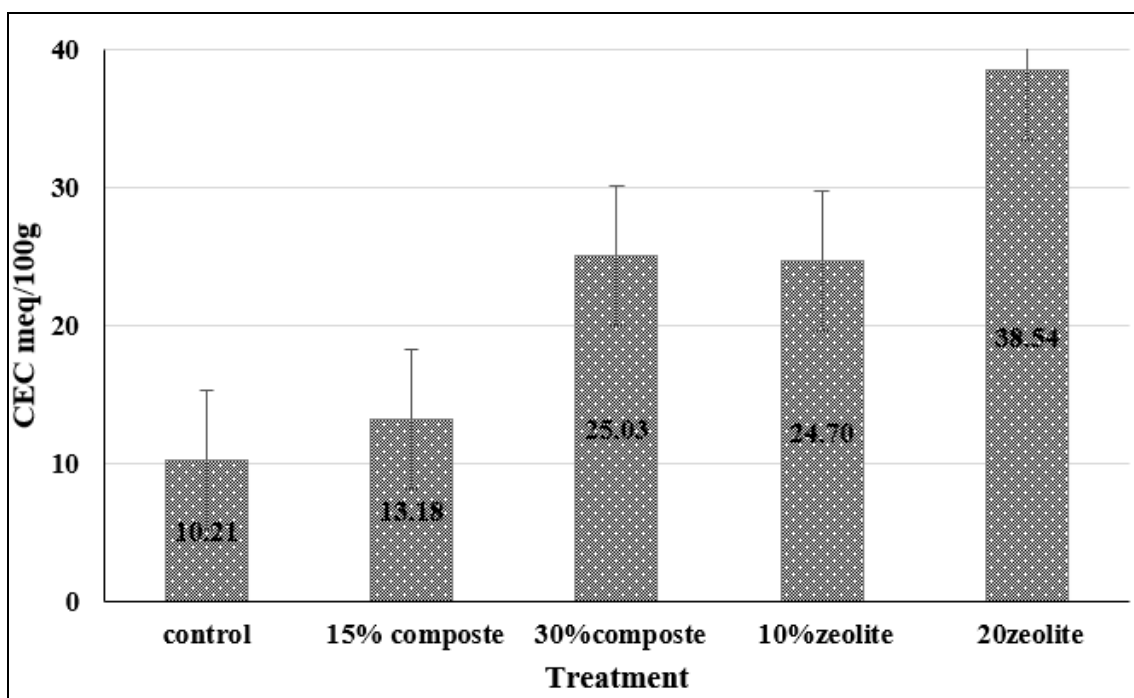


Fig 5: Effects of different percentage of composte & zeolite on soil CEC.

30% compost and 10% zeolite application caused almost similar CEC change compare to control. Similar result is reported by Al-busaidi *et al.* (2008) [2] that zeolite has great impact on salinity and adding zeolite in soil, covers salinity effect and improves soil nutrients balance. Latifah *et al.* (2017) [14] also observed increase in the CEC with the application of zeolite. Ravali *et al.* (2020) [21] reported that the highest soil CEC were recorded in zeolite 7.5 t/h followed by zeolite 5 t/h.

Exchangeable sodium which is the main source of salinity in soil is significantly affected by zeolite application which shows 22.39% and 41.6% increase in 10% and 20% of zeolite application respectively; however, 30% compost application also shows significant increase up to 11.67% compare to control as seen in figure 6. Eventually, the analysis of variance indicated that all parameters of the experiment were significant within treatments at ($p < 0.01$) difference as shown in table 2.

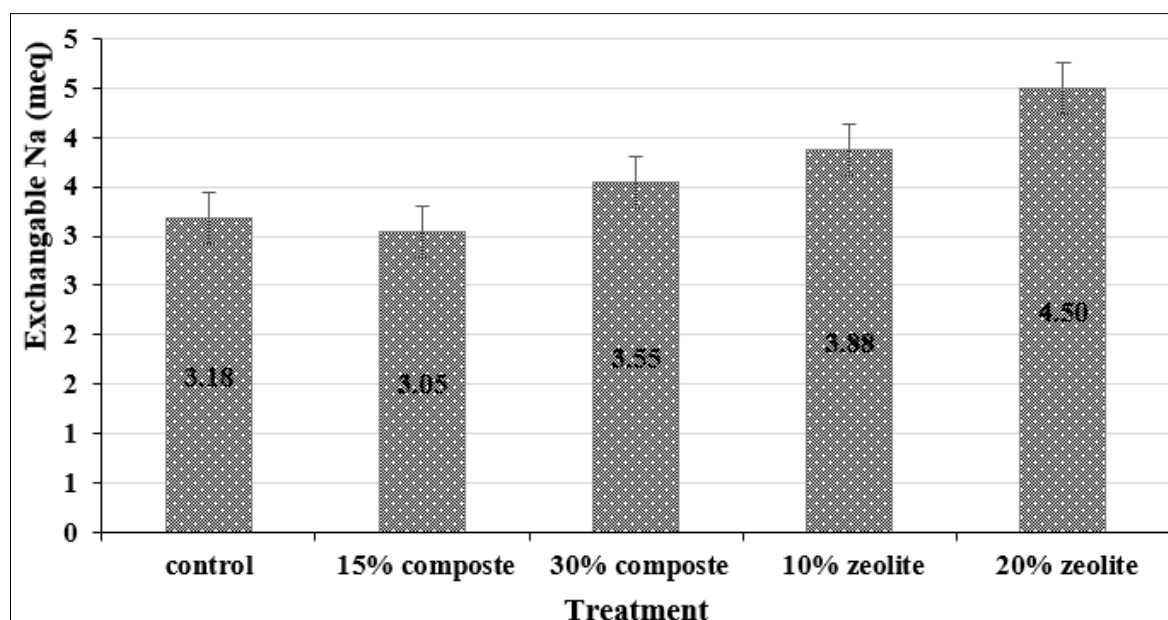


Fig 6: Effects of different percentage of composte & zeolite on soil (Na)

Table 2: Analysis of variance of the effect of urben composte and zeolite on saline soil chemical properties

No	Sources	DF	PH	EC	O.M	Lime	CEC	Na(meq/l)
1	Rep	2	0.01 ^{ns}	0.33 ^{ns}	0.0066 ^{ns}	0.03 ^{ns}	0.58 ^{ns}	0.002
2	Tr	4	0.19 ^{**}	41.10 ^{**}	1.90 ^{**}	58.58 ^{**}	379.7 ^{**}	1.02 ^{**}
3	Er	8	0.007	0.18	0.001	0.09	1.07	0.004
4	C.V		1.12	1.88	5.18	1.57	4.64	1.89

*And** indicates the difference in significances, and ns indicates the lack of significances- pH: Soil reaction, EC: Electric conductivity (Soil salinity) s, O.M: Soil organic matter, Lime: Soil lime, CEC: Cation exchange capacity

Conclusion

Salt-affected soils have increased globally which limets plant growth and production, thuse the problem has compelled the reasercheres to seek solutions for saline soil remediation. Amonge several approaches used for improving salinity problems, the utilization of soil amindments such as urban waste compost, which improves soil structure and nutrient requirements, and natural zeolite which increase soil reactions such as CEC and exchangabel sodium, are promising in saline soils. The findings of the reasarch entitled the evaluation of urban waste compost and natural zeolite effects on chemical propertis of saline soil suggested that compost application significantly increased soil EC, pH, organic matter, lime and soil CEC; while zeolite effect was significantly prominent in soil CEC and exchangeable sodium. Moreover, the effects of 30% compost and 20% zeolite were more pronounced compare to other treatments.

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