Dear reviewer:

Thank you for providing many constructive suggestions concerning our manuscript (EGUSPHERE-2022-1390). Here are our specific responses to your comments.

If any questions, please let us know, and we would like to have more discussions with you.

Sihui Yan, Tibin Zhang, and on behalf of all authors

Question 1: Introduction: Line 53: 'this disaster', the phrase to describe saline water irrigation leading to soil salinization may not be suitable. I suggest the authors to correct it.

Response: Thank you for your reminder, we will correct this word to 'This phenomenon is related directly to soil pore size distribution, and in turn to the dispersion and swelling of the clay fraction.'

Question 2: Line 53-55: how the soil salinization is related to the pore size distribution. It needs more explanation or description here.

Response: Cations in saline water could cause soil clay particles to disperse or flocculate to affect changes in soil pore structure, and pore distribution could influence the fluidity of soil water flow channels, which can affect soil water and solute transport and alter soil salinization. We will add more specific descriptions and explanations in the paper.

Question 3: Lines 55-57: I did not see any background about the urgency to study the effects of saline water quality on soil hydraulic properties.

Response: We will add background on soil hydraulic properties before this sentence and add this description: Once the soil is salinized and/or alkalized, soil hydraulic properties, like infiltration rate, saturated hydraulic conductivity and permeability, will change inevitably. Therefore, in order to optimize saline water utilization, the effects of saline water quality on the soil hydraulic properties and pore structure characteristics should be paid more attention.

Question 4: Line 60: 'Clay exchange surface', here is missing the key element that, 'clay' does not exchange but the ions on the clay surface will.

Response: This sentence is revised as: Excess sodium (Na^+) from irrigation saline water is adsorbed onto the clay surface in salt-affected soils where sodium compounds predominate contributing to the disintegration of soil structure.

Question 5: Line 61-62: Please add more information about how the soil structure would be disintegrated due to the predominate sodium.

Response: As percolation progresses, the thickness of the diffusion double electron layers raises due to the relatively larger hydrated radius of Na^+, and the repulsive force between adjacent diffusion double electron layers appears to increase, resulting in the dispersion and swelling of soil particles (Alva et al. 1991; Reading et al. 2015), causing soil structure deterioration due to poor soil cementation (Lines 63-66).

Question 6: Line 99-100: it was the first time to see the prediction index in the objectives of the paper (CROSS and SAR), a newly proposed index (CROSS)… The authors should shortly introduce them in the introduction.

Response: In the introduction, we can add the following description:

Traditional SAR ignored the role of K^+, a newly proposed equation, cation ratio of soil structural stability (CROSS) could integrate the effects of Na^+ and K^+ in soil, which is an important indicator for assessing the quality of brackish water.

Question 7: Materials & Methods

Line 109-110: It would be better to provide the content of total salts of the soil to show the salt concentration of soil is low, EC value could not 100% percent to replace the salt concentration.

Response: We will add information about the amount of salt added.

Question 8: Fig 1: From the Fig 1a, I did not see the bottom of apparatus, for instance the part which connecting leachate catcher.

Response: The silver device at the bottom edge of the soil column is the funnel that collects the leachate, but the lower funnel exit was not captured due to the camera view, so we added Figure 1b schematic to show it more visually.

Question 9: Section '2.3 Measurements': please be more specific about the section title.

Response: We could use 'Soil properties measurements' as the title.

Question 10: Results: Section '3.5 Soil bulk density (BD and total porosity (TP))': I questioned the data of soil BD in this section, if the authors used cutting ring method to obtain the soil BD data. The height of the cutting ring is about 5 cm, which was exactly the interval of the soil depth (5 cm), then how could the authors to manage the cutting ring sampling to make sure involve enough soil in the rings?

Response: Yes, we used the cutting ring method to obtain the soil BD. The fact is that the diameter of the soil column is 20 cm and the area is about 314 cm^2. The cross-sectional area of the column is very large; besides, we avoid sampling soil at the same location for the different soil layers during the experiment.

Question 11: Instead of SAR, using the new prediction index CROSS was one of the main objectives in the manuscript, I suppose to investigate the comparison between these two indexes. However, such a part of information was lack in the results section and discussion section.

Response: Since K0Na1 has no added K^+, the potassium adsorption ratio is 0, and K1Na0 has no added Na^+, the sodium adsorption ratio is 0. Neither the SAR nor the PAR can be analyzed to characterize the cation composition, so we chose CROSS. the superiority of CROSS over SAR has been corroborated by many previous studies, so the differences between SAR and CROSS are not analyzed separately in this paper.

Question 12: Discussion: Line 338, line 363, line 386: Based on the experiment design, it only had two ratios of the K^+/Na^+, which were 1 and 0. In this case, it could not show too much evidence from this manuscript about the ratio of these two ions affecting either soil pores or bulk density. Try to use other ways or change a perspective to discuss the effect of K^+ and Na^+ on soil structure.

Response: We could revise these sentences to:

Additionally, our study showed that K1Na1 was even more beneficial than deionized water for water downward transport.

Saline water with more K^+ could increase the magnitude of cation exchange due to the substitution of Na^+ on exchange sites by K^+ with lower dispersive potential.

For saline water with the same electrolyte concentration, a decrease in K^+ concentration may enhance soil clay dispersion, resulting in the loosening of clay particles from the aggregates.

Question 13: Conclusions: As I proposed the comment for the discussion, I would guess the effect of the ratio or the relative concentrations of K^+ and Na^+ on saline water irrigation to soil, however, at the current version of the manuscript, it would be better to consider other way to conclude this.

Response: Thank you very much for your suggestion, the conclusion section could be rephrased as follows:

We explored the effect of the ratio of K^+ to Na^+ in saline water on soil hydraulic characteristics and structural stability via a soil column experiment. Irrigation with saline water of K^+/Na^+ of 1:0 caused fewer pore blockages due to soil clay particle dispersion than 0:1, which increased soil saturated hydraulic conductivity. The presence of K^+ accelerated the sustained Na^+ replacement and leaching, alleviating salt accumulation and enhancing leaching efficiency. K^+ positively affected the establishment of soil structure due to the transformation of micropores into macropores, and the ever-increasing unobstructed water-conducting channels sped up water and solute transport. The rational use of saline water with adequate K^+ could help mitigate the structural deterioration caused by Na^+. Appropriate adjustment of the relative concentration of K^+ to Na^+ in saline water during infiltration could ameliorate soil structural properties. In addition to Ca^{2+} and Mg^{2+} (primary concerns in earlier studies), the relative concentration of K^+ to Na^+ is an essential indicator for assessing the suitability of saline water quality for irrigation and should be considered when using saline water.