Response to the anonymous reviewer 2# (RC2)

General comments

ET is very important in water resource management. This manuscript presented an experimental study combing with soil water balance modeling and mathematical modeling. The research is worthy, well-structured and written. But I do not recommend to publish it in present form.

Response: We would like to thank the reviewer 2# for his accurate and frank review and used their precious suggestions to improve the paper. We tried to answer to all the comments made and we are ready to prepare and submit a new version of the manuscript. The point by point answers are written in blue.

Specific comments

1) The irrigation amount is the most important component in this study and needs to accurately measured. Unfortunately, the manuscript did not provide reliable information on it.

Response: We do have in-situ observations of irrigation at field scale, but unfortunately not at plot scales, and the available in-situ observations of irrigation were also not directly measured through water meters, but instead through an indirect method. While we can infer the more detailed irrigation data at plot scales with the recorded the irrigating time span for each plot, we are afraid that the derived data is not accurate enough due to the potential inconsistence of water flow rate per unit time at this scale. Given the irrigation volumes for the entire plots can be easily and reliably calculated through a well-built relationship between the power consumption of the pumping irrigation well (P) and the actual total irrigation amount of all plots (Q): $Q = P \times \eta$, (where η is the ratio of the power consumption per unit water pumped, which was specifically determined at the field station), a compromising way was used to test the estimated irrigation, in which, the estimated irrigation volumes of the six plots were averaged and tested against the observations at field scale. Although the estimated average irrigation crop demand within the plots (831.6 mm, via the soil moisture data-based method) compares well with the actual irrigation volume (868.8 mm, via the relationship between Q and P), we are still aware that without more detailed irrigation data for each plot is a drawback of the validation of the methods, so that related discussions upon the possible uncertainties caused by it will be included in the earlier version of the manuscript and further evolved in this revision.

2) two irrigation amounts were used in this study, one calculated from the difference between S_{max} and S_{ini}, the other estimated from power consumption. But I do (not) understand which is the real value and which is the measured value (L272).

Response: Sorry for the misleading wording in the manuscript. We considered the irrigation amounts determined from power consumption is the "real value", and the one calculated from the difference between S_{max} and S_{ini} as the "estimated value" or the value to be validated. We will reorganize this part to clarify it.

3) The definition of S_{max} was not clearly given.

Response: Clear definition will be included in the coming revision, i.e., "Where S_{max} is the maximum soil water storage of root zone (0-110cm) after one irrigation event began".

4) According to the text, the irrigation was delivered at a rate of 2250/ha/min (L264) and each irrigation event lasted 20-30 min, therefore the irrigation amount was about 6 mm for each time and total irrigation amount was about 60 mm for the growing season. If it is not mistake, it is much lower than the estimation and is not acceptable.

Response: Thanks for point out this careless mistake arising from our calculation, this value should be ~32500 L/ha/min or 3.25 mm/min in the manuscript. We have corrected this mistake in our revision.

5) I think it is possible to make accurate measures with water meter in such small experimental plot.

Response: Yes, it is reasonable but failed to collect accurate measures with water meter in the small experimental plots, and we are planning to install this kind of instruments before the start of the coming growing season. We are aware that without such detailed irrigation data for each plot is a drawback of the validation of the methods, so that related discussions upon the possible uncertainties caused by it will be included in the earlier version of the manuscript and further evolved in this revision. Please also see our response to Question 1 of RC2.

6) About the mathematical model, the setting is quite important. In section 2.3.2, equation (7) shows that the lower boundary was defined by soil matric potential (L175), which in section 2.3 3), it was set to free drainage (L202). It is not acceptable.

Response: While we don't think there are any contradictions between the setting of the lower boundary as free drainage and the equation (7) in which it was defined by soil matric potential, the 1-D Richards Equation (equation 4-7) will be reorganized to eliminate the potential confusion.

7) Moreover, root uptake is also an important factor in water redistribution simulation, but the manuscript did not give the information about the root distributions of the crops.

Response: The reason for the omission of root distribution information in the manuscript is that the inverse model we adopted does not require any a priori information of root distribution parameters. Root water uptake parameters were estimated by minimizing the residuals between simulated and measured soil water contents (Zuo *et al.*, 2002; Guderle and Hildebrandt, 2015). That is, the distribution of soil water contains the information of root-water-uptake distribution. It's a great advantage of this method because the parameters of those rooting profile functions are cumbersome to measure in the field, and the relevance for root water uptake distribution is also uncertain. This issue has been discussed in previous work of Schneider *et al.* (2010); Guderle and Hildebrandt (2015), and some related discussions also be included in the revision. To solve the concern, general root distribution information of maize, alfalfa and pea in this region has been included in section 2.2 (Site description) in the revision.

8) About the location of the TDR systems in the experimental plots. Because the irrigation method is furrow irrigation, the soil water contents are different with location. From table 2, the saturate water content is about 34% and the field capacity is about 20%. If the preferential flow is limited, as suggested in the manuscript, the water content should be higher than 20%, even 24h after the irrigation event. But the measured value is only 21.9% for S_{max} and 14% for S24. Therefore, I doubt the TDR systems were not in the suitable location. Therefore, the information is not enough and correct.

Response: Thanks for pointing out this limitation. We agree that soil water contents following furrow irrigation may be different at various locations in a ridge film-mulched field, however, we also argue here that this kind of different can be largely neglected in practice. The reasons are as followed: 1) while TDR probes in our field experiment were installed under the film-mulched ridges, the height of ridge shoulders in the experimental plots is relatively low (<5cm), substantial infiltration could occur through the film holes made for maize-growth (see Fig.1 in the appendices); 2) lateral water transfers could be substantially enhanced during the period of irrigation due to the soil water potential differences between ridges and furrows. This judgement also can be supported by some researchers conducted at similar environments, i.e., Zhang *et al.* (2016). Given the effect of plastic mulched furrow irrigation on soil water distribution remains elusive (Abbasi *et al.*, 2004; Zhang *et al.*, 2016), potential uncertainties caused by the location of TDR install are discussed to solve the reviewer's concern in the revision.

The reviewer noticed that "the measured value is only 21.9% for S_{max} and 14% for S_{24}", and argued that "the water content should be higher than 20%, even 24h after the irrigation event". As such, it was doubt by the reviewer that the preferential flow may occur in the soil profiles and the TDR systems were probably not in the suitable location. After carefully checking our data, we now can confidently say that our judgement ("preferential flow is limited") is reasonable. **Firstly**, both the S_{max} and S_{24} were defined as the moisture storages within the entire soil profiles in this work, so they are the average values of soil moisture at different stages of irrigation, which can never be kept at a relatively high level (i.e., > s_{fc}, the soil field capacity), due to the relatively large hydraulic conductivities of coarse-textured sandy soil. I guess the reviewer misunderstood the conceptions of soil water content and the soil water storage we provided in the manuscript, probably due to our unclear wording. We will clarify the descriptions in our revision. **Secondly**, if the TDR systems were not in the suitable locations, different situations should happen at NT1 (unmulched, and with almost flat surface) and other plots (NT2-6, mulched). However, the fact is that almost similar results were observed in the soil moisture dynamics at all the soil profiles following an irrigation event (see Fig.2 in the appendices).

Figures.

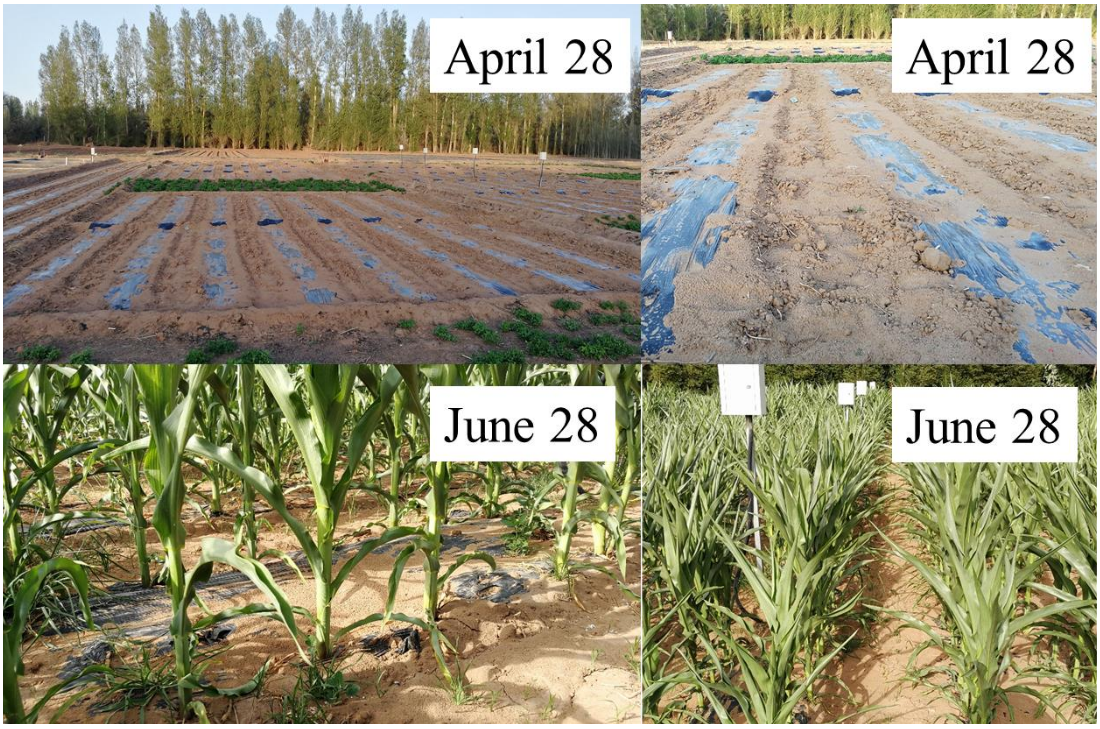

Figure 1. The furrow and ridge in the experimental plots

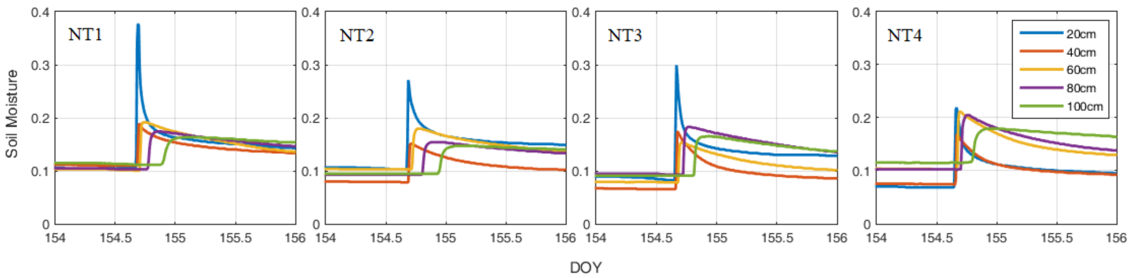

Figure 2. Soil water dynamics of unmulched (NT1) and mulched plots (NT2-4) in different soil depth after one irrigation event. *The biggest difference of soil moisture dynamics between unmulched flat plot (NT1, which is independent of TDR location) and film-mulched ridge plot (NT2-6, which is affected by TDR location) was appear in the top-20cm soil layer (blue line). With the increase of soil depth, this difference is fade away, the soil moisture curve of 100cm (green line) is very close between NT1 and other plots.*

References:

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Guderle M, Hildebrandt A. 2015. Using measured soil water contents to estimate evapotranspiration and root water uptake profiles – a comparative study. Hydrology and Earth System Sciences, **19**: 409-425.

Schneider CL, Attinger S, Delfs JO, Hildebrandt A. 2010. Implementing small scale processes at the soil-plant interface - the role of root architectures for calculating root water uptake profiles. Hydrology and Earth System Sciences,14,2(2010-02-12), **14**: 279-289.

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Zuo, Qiang, Zhang, Renduo. 2002. Estimating root-water-uptake using an inverse method. Soil Sci, **167**: 561-571.