Salt accumulation and Sorghum Yield Drip-Irrigated with Saline Water on a Sandy Field

○ Bouya Ahmed Ould Ahmed[1] and Tahei Yamamoto [1]

1. Introduction

Sorghum (Sorghum bicolor) is grown in widely different climates under both irrigated and non-irrigated conditions, especially in semi-arid and arid regions. Drip irrigation system (DIS) requires less water, since only a portion of the soil surface is wetted, which means that evaporation losses are reduced and water use efficiency is improved. On the other hand, DIS has the ability to minimize the salt near the plant roots.

Salinity affects crop growth by decreasing water availability to roots due to osmotic effect of external salt and by toxic effects within the plant. A widely adopted method for the estimation crop consumptive water use is the evapotranspiration pan method. Regular assessment of the changes in soil water and electrical conductivity are important strategies for good irrigation management. Previous processing paper was discussed about the effect of irrigation regimes and irrigation interval on the water use efficiency of sorghum under drip irrigation with saline water (Bouya et al., 2004).

The objective of this study was to determine (i) salt accumulation under DIS and (ii) evaluate the accuracy of TDR for the measurement of soil water and electrical conductivity during irrigation with saline water.

2. Materials and Methods

Experiments were conducted in a green house at the Arid Land Research Center, Tottori University (35^{o} 32'N and 134 ^{o} 13' E) using an experimental drip irrigation system (DIS). For the different treatments, irrigation based on pan evaporation began on 21st April and ended on 15th July (harvesting). The amount of irrigation water (mm) was based on the wetted area (20 cm length × 20 cm width). The main treatments were two irrigation regimes and two irrigation intervals (1-day and 2-days). Fertilizer (180 kg ha^{-1} N, 45 kg ha^{-1} P, 80 kg ha^{-1} K) was applied uniformly to each plot during plowing. A randomized complete block design with three replications was adopted. The dimensions of each plot were 1.2 m × 1.2 m. In each plot, the sub-main pipe of DIS was divided into three lateral lines; each lateral line had 4 emitters, 40 cm apart. Irrigation with the saline water commenced at the seedling stage with water EC (dS/m) of 3.85 witches, was gradually increased to 7.32 at 4 weeks late Soil water content (θ_w) and soil solution electrical conductivity (EC_w) distribution were assessed for each treatment by soil sampling every two week from selected depths at 5 cm radius from crop base in directions perpendicular to laterals line. A TDR sensor was used at two depths (10 and 25 cm) considered is the zoon of high root density to continuously monitor variations in θw and EC_w.

3. Results and discussion

Plant development

Plant height was determined by measuring tagged plants in each plot every week for a total of 12 times during the growth period from 21st April to end of June (Table 1). There was a significant difference in plant growth among the treatments in the daily and 2-days irrigation intervals. No difference was observed among treatment during the ES for 2-days irrigation interval, but for the 1-day irrigation, Ep0.50 treatment was not effective. Leaf area index (LAI) was measured every week during growing crop stage (Table 1). The mean LAI was higher under the 1-day irrigation (2.1 and 2.6 during LS) than 2-days irrigation (1.9 and 2.2) for Ep0.50 and Ep1.00 regimes respectively. The increased with crop growth and Ep1.00 showed higher values than Ep0.50. The low irrigation regime (Ep0.50) significantly decreased LAI for all treatments where salt accumulation occurred in root zone (20-30 cm) possibly because there was not enough water to leach salts from the active root zoon.

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[1] Tottori University, Arid Land Research Center. 1390 Hamasaka, Tottori 680-0001

Keywords: Drip irrigation scheduling, Sorghum, Salt, and TDR measurement

Table 1 Variation of crop parameters during experimental period

	Daily irrigation					2-days irrigation interval				
	ES	MS	LS	Yield (Mg/ha)	WUE (mm/g)	ES	MS	LS	Yield (Mg/ha)	WUE (mm/g)
Plant height (m)										
Ep0.50	0.12a	0.67b	0.97a	--	--	0.11a	0.42a	0.75a	--	--
Ep1.00	0.17a	0.97c	1.25b	--	--	0.16a	0.61b	0.96a	--	--
Leaf area index										
Ep0.50	0.2a	1.7b	2.1a	--	--	0.3a	1.5a	1.9a	--	--
Ep1.00	0.5a	2.4c	2.6c	--	--	0.4a	1.8b	2.2b	--	--
Yield and WUE										
Ep0.50	--	--	--	2.7ab	0.61b	--	--	--	1.97a	0.49a
Ep1.00	--	--	--	4.15c	0.70bc	--	--	--	2.55ab	0.53a

Yield and crop water use efficiency

The grain yield for Ep1.00 regime was 4.15 Mg / ha for 1-day irrigation and 2.9 Mg / ha for 2-days irrigation interval (Table 1). This was significantly better than yield for p0.50 (2.7 and 1.97 Mg / ha for 1-day irrigation and 2-days irrigation) intervals. Statically the yield decreased by about 30-40 % for Ep0.50 regime than Ep1.00 and decreased about 8 -12 % for Ep1.00 regime in 2-days irrigation interval compared with Ep1.00 for daily irrigation. The grain yields for 1-day irrigation exceed that for 2-days irrigation by about 20 -38 % (Table 1). The highest WUE (70%) was for Ep1.00 in 1-day irrigation and the lowest (49%) was for Ep0.50 for 2-days irrigation interval (Table 1).

Moisture and salinity distribution in the soil cross section

From results of statistical analysis, water content varied significantly among treatments for different depths. Salinity relatively increased at all irrigation regimes; the highest salinity was recorded at 10 and 20 cm soil depths for Ep0.50 in 2-days irrigation interval. This could have been due to the low volume of water applied. The relation between soil water content and electrical conductivity determined by TDR method and those determined by soil sampling are presented in Fig. 1. The correlation was higher for water content than ECw. Water content showed higher correlation than ECw (R^2 = 0.90 and 0.85) respectively. From These results we confirm that the TDR could accurately determine θw and ECw as reported in Hossein et, al. (2004).

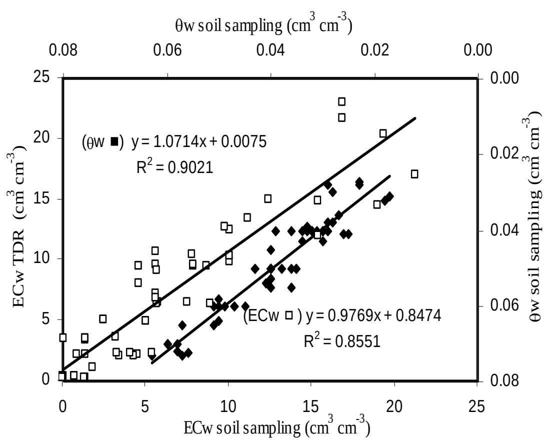

Fig. 1 relation between qw and ECw measurred by TDR and soil sampling.

4. Conclusion

Plant height, LAI and root mass increased with increasing irrigation water. Irrigation increased yield from Ep0.50 to Ep1.00 and daily to 2-days irrigation intervals due to the characteristics of sand which had a low field capacity. Results showed that 1-day irrigation with saline water could support sorghum growth in a sandy soil. TDR method was tested and formed suitable for continuously use in dune sand for recording θw and ECw especially when the soil is moist or not very dry.

References

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