University of Birjand

تنشهای محیطی در علوم زراعی
Environmental Stresses In Crop Sciences
Env. Stresses Crop Sci.
Vol. 15, No. 1, pp. 199-213 (Spring 2022)

http://dx.doi.org/10.22077/escs.2020.3503.1870

Original article

Impact evaluation of different irrigation regimes on moisture and salinity distribution around the roots of maize plant under drip irrigations

P. Majidi Chaharmahali[1], H.A. Kashkuli[1], D. Khodadadi Dehkordi[1*], A. Mokhtaran[2], A. Egdernezhad[1]

1. Department of Water Engineering and Sciences, Ahvaz Branch, Islamic Azad University, Ahvaz, Iran
2. Research Assistant Professor, Agricultural Technical and Engineering Research Department, Center for Agriculture and Natural Resources Research and Training, Khuzestan Province, Agriculture Research, Training, and Promotion Organization, Ahwaz, Iran

Received 4 July 2020; Accepted 18 August 2020

Extended abstract

Introduction

Drip irrigation delivers moisture to the soil surrounding the plant root, leaving the uncultivated ridges mostly dry. The dynamics of dryness and moisture can help adjust the soil salinity and redistribute moisture and salinity (Li et al., 2013; Wang et al., 2011). Further, the distribution of soil salinity in arid regions is affected by a multitude of factors, including the water table (Ming et al., 2016), groundwater salinity, (Abliz et al., 2016), irrigation system (Lie et al., 2013; Zhang et al., 2017), and soil texture (Hu et al., 2011; Zhang et al., 2014). Given the complexity of investigating moisture and salinity distribution in the soil and their uptake by plant roots, the subject has been addressed by several studies around the world. The present study attempts to investigate and evaluate the effects of different irrigation regimes (two-, three-, and four-day) using a tape drip irrigation system on the diffusion and distribution of salinity and moisture around the root of summer maize over two crop years (2018–19) in the South Khuzestan region, where a heavy soil texture is predominant.

Materials and Methods

Located between the 29°57’ N and 33°0’ N relative to the equator, and between 47°40’ E and 50°33’ E relative to the prime meridian, Khuzestan Province occupies 64,057 square kilometers in Southwest Iran. The present study was carried out in a research farm at the Center for Agriculture and Natural Resources Research and Training, Ahwaz, Khuzestan Province, in summers 2018 and 2019. With clay and silty clay soil textures, shallow and saline groundwater (1.5 m depth), and its particular climate, this research farm can be representative of the farmlands of Central and Southern Khuzestan. The required volume of water during each irrigation by the drip tape irrigation system under different irrigation regimes (two-, three-, and four-day) was calculated for different plant development stages and treatments, thus enabling control over the different irrigation hours in different regimes. the farm soil was sampled at four stages, namely before planting, upon germination, during the middle development stage, and after planting), for physical and chemical characterization and monitoring salt levels from three depths (0–25, 25–50, and 50–75 cm) at a 20 cm distance from the tape by manual excavation using an auger (10 cm in diameter and 20 cm in length). Soil salinity and other quality criteria were measured in the lab. Further, the SMC was measured by the weight percent method, which involves weighing and drying the samples.

*Correspondent author: Davoud Khodadadi Dehkordi; E-Mail: davood_kh70@yahoo.com.

Results and Discussion

The present study addressed moisture and salinity distribution in the soil profile around the plant root under different irrigation regimes. The moisture distribution results showed that all irrigation regimes (two-, three-, and four-day) could maintain the moisture around the FC, slowing down the vertical flow and minimizing penetration into depths. The soil salinity results showed that, considering the soil salinity conditions at the start of the growing season, using the drip tape irrigation first reduced and then increased salinity in the first year of cropping. In contrast, in the second growing season, soil salinity at the end of the growing season using two-, three-, and four-day irrigation regimes was cut to a fourth and a third of its initial level. This shift in the behavior was, however, due to the differences in the quality of irrigation water. This outcome shows the susceptibility of using the drip tape irrigation system in soils that are prone to sodicization and salinity, which requires preparing the conditions to ensure the sustainable function of the irrigation system. The final set of samples showed that, under all irrigation regimes, the emitter output effectively reduced soil salinity, and that this reduction is more effective with frequent irrigations, washing the salts further away from the source. Further, the 0–25 cm deep layer was found to have the least salinity among the studied layers. All irrigation regimes (two-, three-, and four-day) were successful in controlling salinity in the root zone, but the two-day treatment, with a shallower irrigation depth and shorter irrigation intervals, offered the best leaching. The results of performance analysis in two years showed that the year did not have a significant effect on grain and dry matter yield. The results also showed that irrigation regimes did not have a significant effect on dry matter yield but significant on grain yield at 5%.

***Keywords*:** Drip-tape irrigation, Irrigation interval, Salinity and moisture distribution

Table 1. General specifications of the research station in 2018-20

Index	Temperatures				Mean moisture Rainfall			Mean	
	Mean		Absolute						
	Max	Min	Max	Min	Max	Min	Mean	Evapo-rtation	Wind speed
	°C		°C		%		mm	mm	m/s
Long-term meteorological index (annual)	33.5	19.3	54	-7	62.2	23.5	218.7	856.7	2.9
Meteorological index of the first year	39.2	20	49.4	8	62	16.3	0	941.8	4.5
Meteorological index of the second year	38.8	20.7	48.4	7.4	68.3	21.7	0	707.3	4

Table 2. Irrigation water quality

Year	EC	pH	TDS	Na^+	Ca^{2+}	Mg^{2+}	Cl	SAR
	dS/m		mgr/L	----------meq/L----------				
1397	3.61	8.14	2441	24.08	5.65	5.03	24.58	10.40
1398	1.91	7.26	1268	11.91	2.72	3.05	12.47	7.02

Table 3. Soil characteristics

Soil deapth	Clay	Silt	Sand	Soil texture	F.C	P.W.P	Density
cm	----------%---------				----------%----------		gr/cm^3
0-25	48	42	10	**Clay**	24.5	11.8	1.35
25-50	47.5	36.5	16		24.2	11.8	1.44
50-75	49	35	16		24.2	11.8	1.54

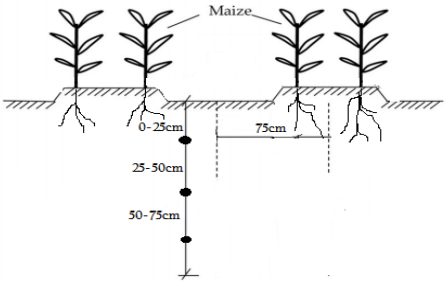

Fig. 2. Horizontal soil profile

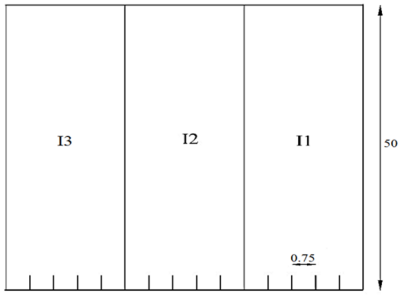

Fig. 1. Drip Irrigation plan implemented

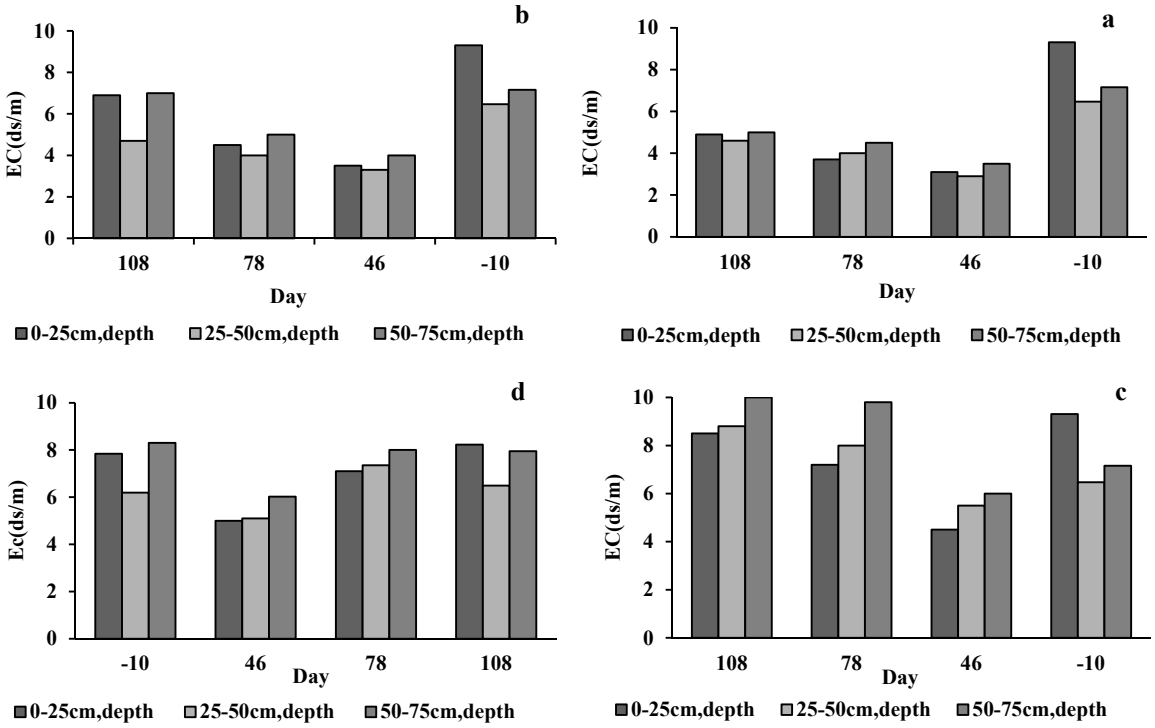

Fig. 3. Salinity changes and soil salts during the growing season under different regimes-2018 year. (a) two-day irrigation, (b) three-day irrigation, (c) four-day irrigation, 9d) surface irrigation

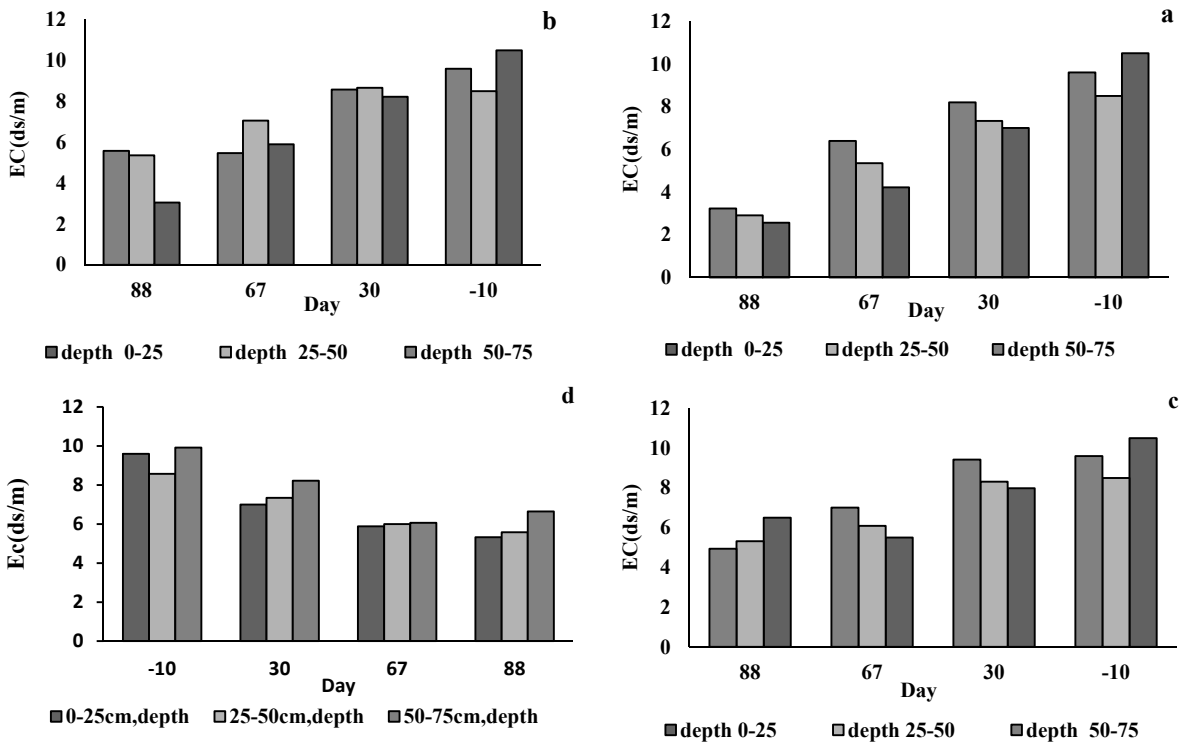

Fig. 4. Salinity changes and soil salts during the growing season under different regimes- 2019 year. (a) two-day irrigation, (b) three-day irrigation, (c) four-day irrigation, 9d) surface irrigation

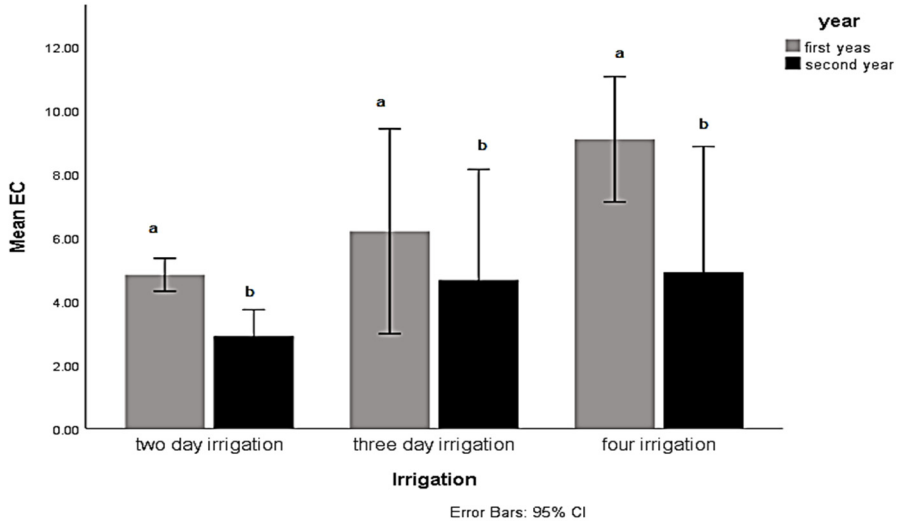

Fig. 5. Results of independent t-test at a significant level of 0.05 during two cropping years

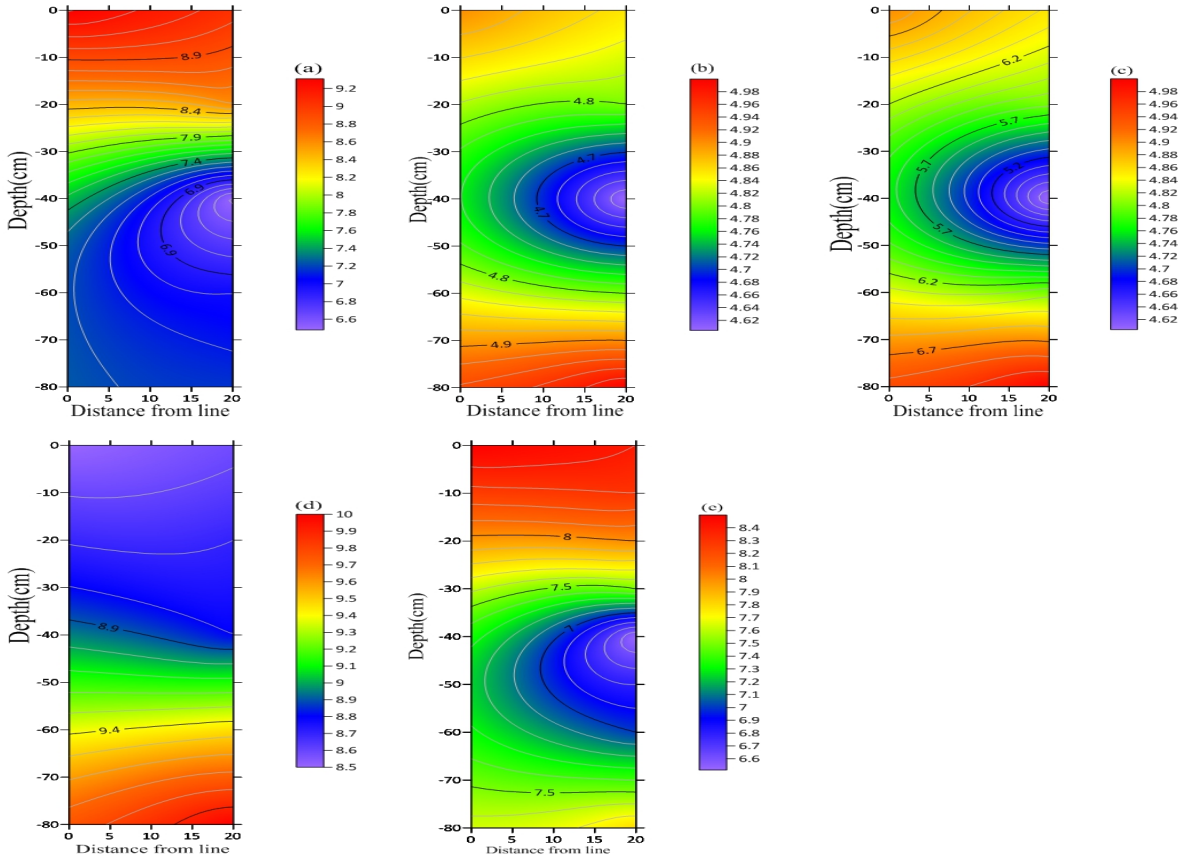

Fig. 6. Salinity changes in soil depth in the first year of cultivation 2018: (a) Soil salinity before irrigation, (b) Soil salinity at the end of the growing season in 2-day irrigation, (c) Soil salinity at the end of the growing season in 3-day irrigation, (d) Soil salinity at the end of the growing season in 4-day irrigation, (e) Soil salinity at the end of the growing season in surface irrigation

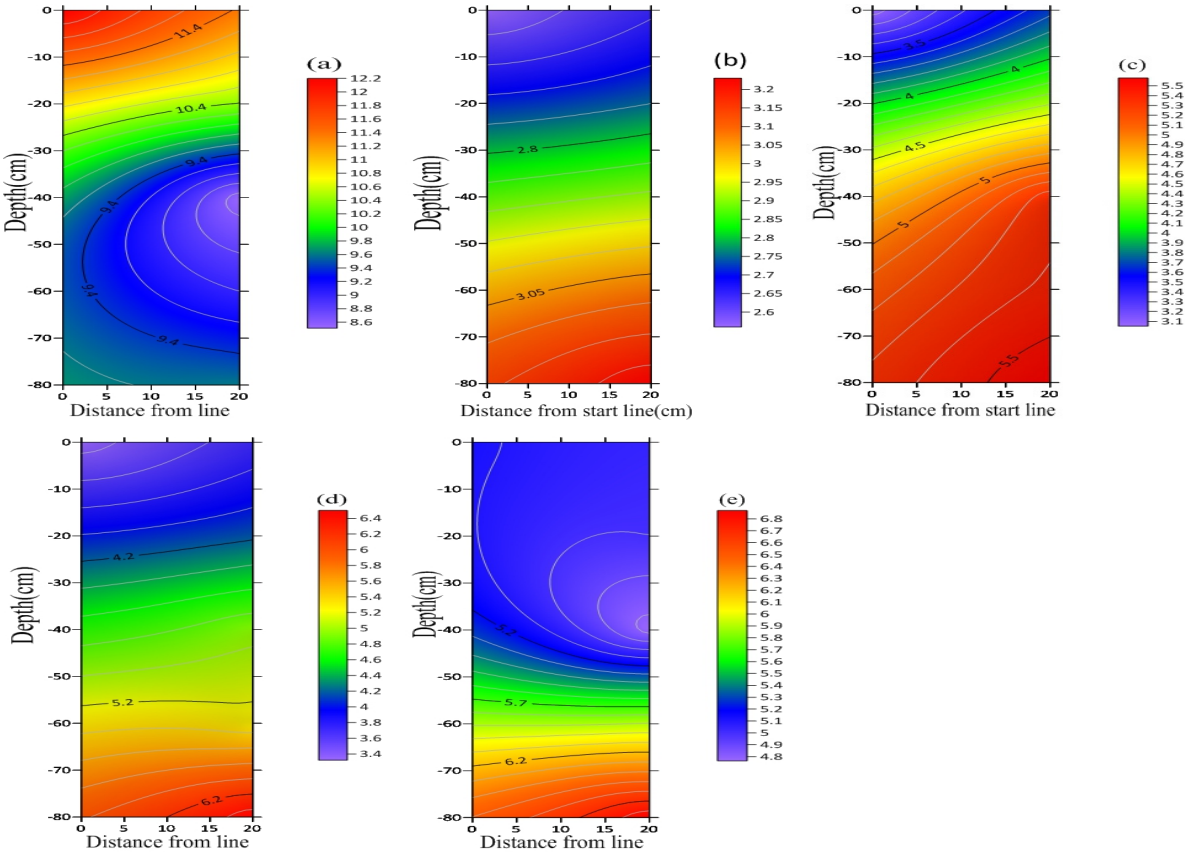

Fig. 7. Salinity changes in soil depth in the first year of cultivation 2019: (a) Soil salinity before irrigation, (b) Soil salinity at the end of the growing season in 2-day irrigation, (c) Soil salinity at the end of the growing season in 3-day irrigation, (d) Soil salinity at the end of the growing season in 4-day irrigation, (e) Soil salinity at the end of the growing season in surface irrigation

Table 4. The process of soil salinity changes in different irrigation methods

Irrigation type	parameter	Before planting first year 2018	after planting first year 2018	Before planting first year 2019	after planting first year 2019
Strip drip irrigation Two day	(ds/m)EC_e	7.64	4.83[a]	9.36	2.90[b]
	ESP	6.36	7.54	8.5	4.17
	Soil type	Saline	Saline	Saline	None saline-none sodium
Strip drip irrigation Three day	(ds/m)EC_e	7.64	6.2[a]	9.36	4.66[b]
	ESP	6.36	9.35	8.5	5.33
	Soil type	Saline	Saline	Saline	saline-none sodium
Strip drip irrigation four day	(ds/m)EC_e	7.64	9.1a	9.36	4.92[b]
	ESP	6.36	12.29	8.5	4.47
	Soil type	Saline	Saline	Saline	saline-none sodium
Surface irrigation	(ds/m)EC_e	7.45	7.6[a]	9.06	5.53[b]
	ESP	7.5	15.05	13.21	8.46
	Soil type	Saline	Saline-sodium	Saline	Saline

a, b Significant at the 5% level and non-significant, respectively

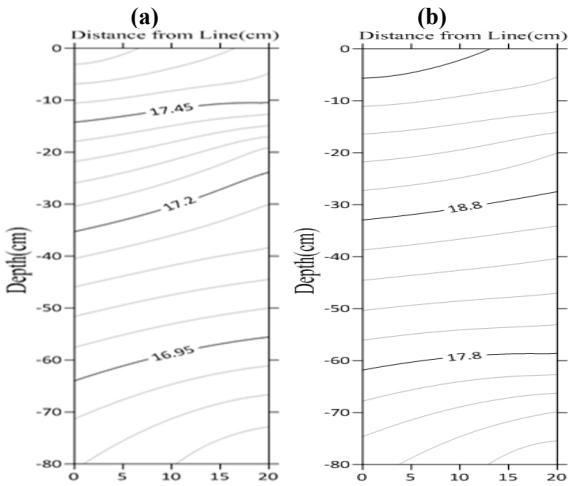

Fig. 9. 2-day irrigation regime (2019), a) one day before b) 24 hours after irrigation

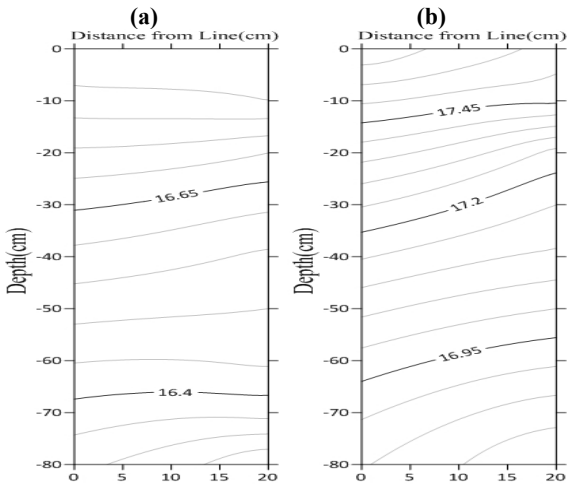

Fig. 8. 2-day irrigation regime (2018), (a) one day before (b) 24 hours after irrigation

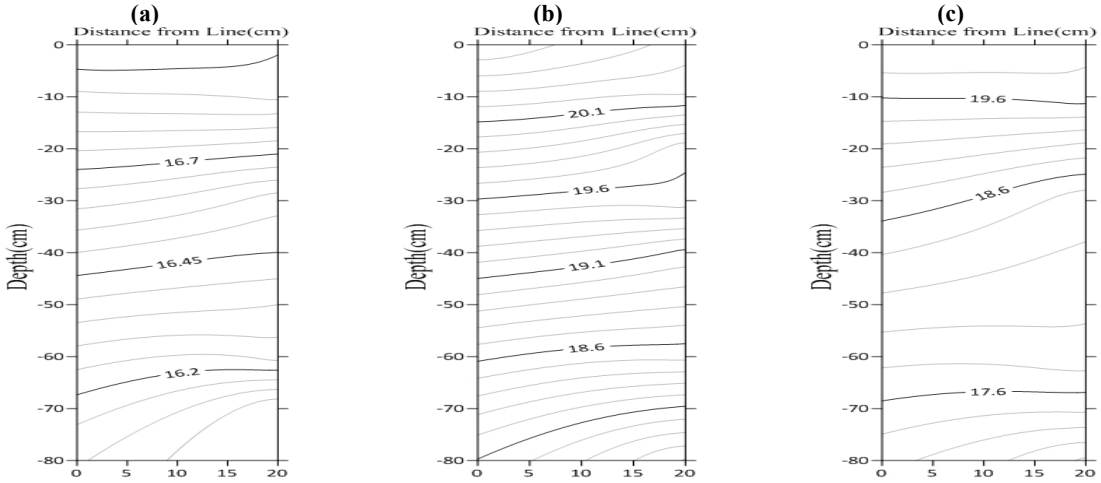

Fig. 10. 3-day irrigation regime (2018), (a) one day before irrigation, (b) & (c) 24 and 48 hours after irrigation

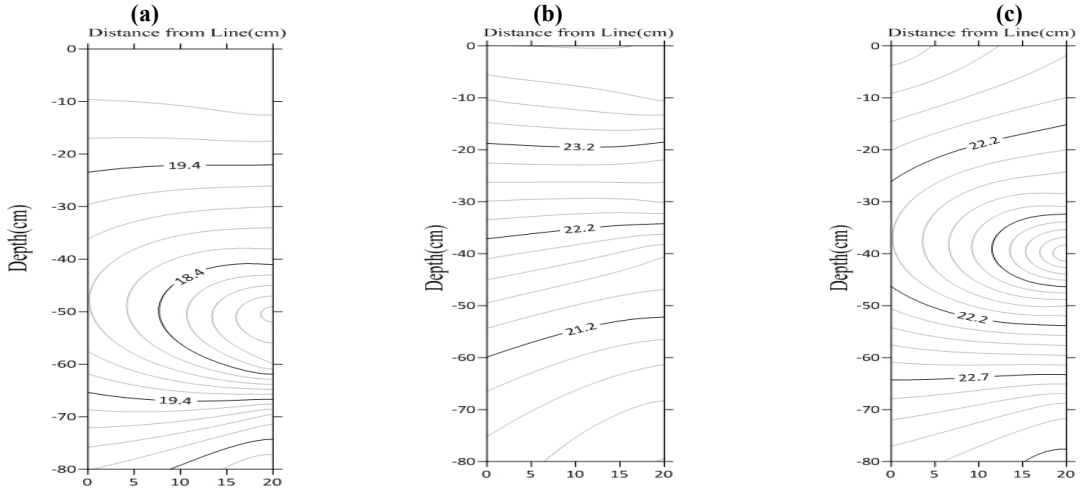

Fig. 11. 3-day irrigation regime (2019), (a) one day before irrigation, (b) & (c) 24 and 48 hours after irrigation

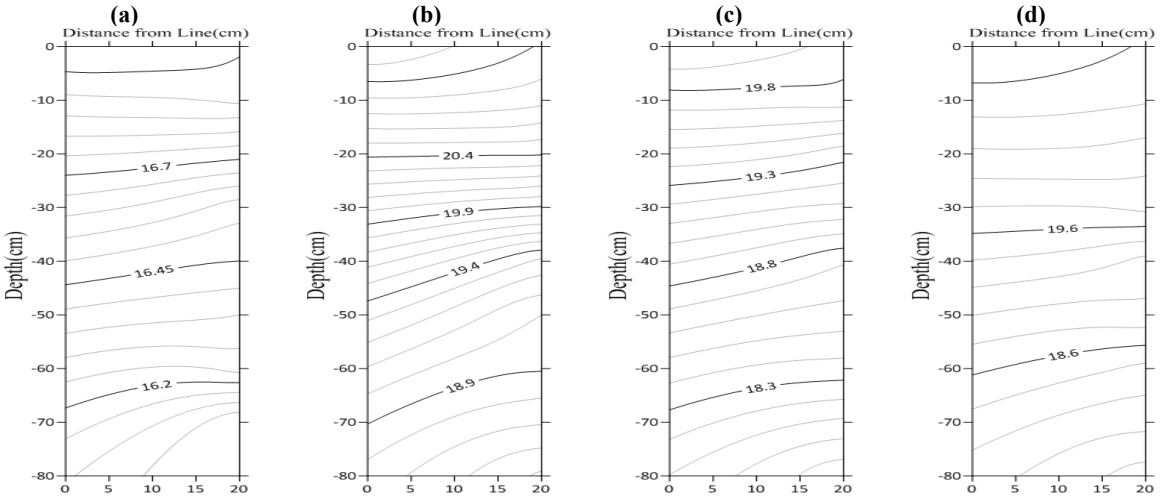

Fig. 12. 4-day irrigation regime (2018), (a) one day before irrigation, (b), (c) & (d) 24, 48 and 72 hours after irrigation

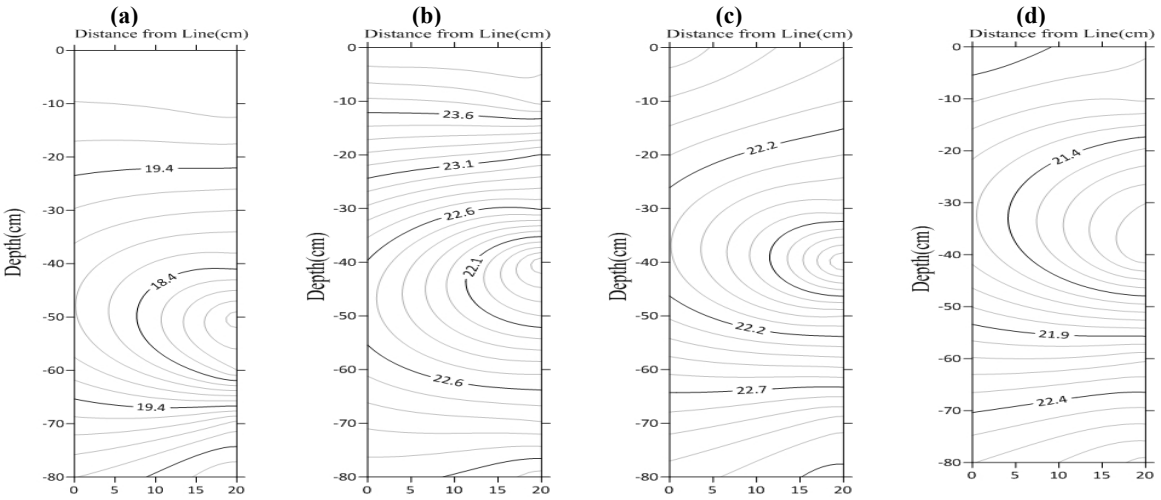

Fig. 13. 4-day irrigation regime (2019), a) one day before b, c & d) 24, 48 and72 hours after irrigation

Table 5. Results of composite analysis of variance

		M.S	
S.O.V	**df**	**Seed yield**	**Dry matter of aerial parts**
Year (Y)	1	0.134 $^{n.s}$	0.992 $^{n.s}$
Irrigation regime (I)	2	3.575*	2.774*
Y * I	2	0.018	0.990 $^{n.s}$