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Effect of Irrigation System Basin and Furrow in Saline Distributions Patterns and Productivity Corn (Zea Mays L.)

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Abstract: *A field study with corn was carried out during spring seasons of 2015 in Al-Rasheed Township southern of Baghdad, Iraq. The aim study is to determine the effects of irrigation system on water and yield productivity and salinity distribution in soil. Corn cultivar was grown using different styles of surface irrigation included conventional basin irrigation, were done after 50% of available water depletion (CBI), deficit irrigation (basin partial irrigation-irrigation from 70% of treatment CBI used) (BPI), conventional furrow irrigation (CFI), and Shallow furrow irrigation (SFI). Total irrigation water requirement (applied water) were 884, 618, 592 and 636 mm for CBI, BPI, CFI and SFI treatments respectively. Soil samplings indicated that the salinity distribution EC did not increase, the rang 5-7 dS.m^{-1} and SAR rang 1.36-6.39 (mg L$^{-1)½}$ within 0.3 m of root zone for all treatments in end growth, that's mean don't exceed critical limit or threshold to optimum growth of corn and the proclivity of corn reached 6531, 5368, 7912 and 5465kg h^{-1} for CBI, BPI, CFI and SFI treatments, respectively.*

Key words: *basin & furrow irrigation, EC & SAR distribution, corn*

I. Introduction

In arid and semi-arid regions of Iraq, basin and furrow irrigation is adopted on almost all major planted crops (corn, bean, cotton, sunflower, etc.). At the same time water is the most limiting factor in this regions, therefore we need best irrigation management because inconvenient irrigation management causes water shortages due to increasing farm water losses, and productivity decreases.

Surface irrigation is often referred to as flood irrigation, implying that the water distribution is uncontrolled and is, inherently inefficient. In reality, some of the irrigation practices grouped under this name involve a significant degree of management. Surface irrigation comes in three major types: level basin, furrow and border strip.

Result of Graterol et al (1993) indicted the reduced amount of irrigation water applied does not consistently reduce yields, water use efficiency may be increased. Li et al. (2007) found the partial irrigation is new technology irrigation aimed to saving water and improving the efficiency of water use without yield affected and as a result of many researchers applying this technology for irrigation water shortages in the world, especially in arid and semi-arid areas, it has been applied in all of the United States of America, Australia, New Zealand, Uzbekistan, India, Iran, Denmark, Turkey, Spain, China (Wang et al., 2012; Romero et al., 2012 and Liang et al., 2013).

Masood (2013) carried out experiment included six irrigation treatments: conventional furrow irrigation (CFI), Alternate partial furrow irrigation(APFI- during all growth stages of sunflower), APFI+CFI at initiation stage ($APFI_i$), APFI+CFI at vegetative growth stage ($APFI_v$), APFI+CFI at flowering stage ($APFI_f$) and finally APFI+CFI at grain maturity stage ($APFI_m$) to identify actual water consumption use, the amount of water added for sunflower crop, and the result found the alternate partial furrow irrigation reduced the amount of irrigation water added and varied with irrigation treatments used. corn (Zea mays L.), is an important crop worldwide, not only because it is the third cereal after wheat and rice and more important than either as a forage crop, but also because of its numerous uses, In this study, an experiment was designed and conducted in the field to study the salt movement and distribution in soil and irrigation amount under different irrigation methods and yield corn (*Zea mays* L.) crop.

II. Material and methods

The experiment was carried out during spring seasons of 2015 in Al-Rasheed Township southern of Baghdad, Iraq (33° 04' 37" N, 44° 30' 30"). Some soil properties (Table 1, Fig. 1) were determined according to methods described in Black (1965) and Page et al. (1980).

Maize (corn) (synthetic cv. 5018) was transplanted manually, at a depth of 2-5 cm on 18/April/ 2015, and harvested on 29/July/2015.The experiment was Randomized Complete Block Design (RCBD) with three replications. Experimental plots were 6 m^2 (3m × 2m) and plants spaced 0.25 m (0.75 cm between rows). Plots were separated 3 m from each other. This study included following treatments: 1. Conventional basin irrigation, were done after 50% of available water depletion (CBI), 2. Deficit irrigation (basin partial irrigation-irrigation from %70 of treatment 1 used) (BPI), 3. Conventional furrow irrigation (CFI), 4. Shallow furrow irrigation (width of furrow 0.25 m, depth = 0.15 m and 0.35 m spaced between furrows) (SFI). Nitrogen application 100 kg N ha^{-1} using urea as a fertilizer, Phosphorus and potassium were applied in the rates of 60 P ha^{-1} and 50 kg K ha^{-1} respectively to all treatments (Ali, 2012).

All plots were irrigated with well water (ECi =1.8 $dS.m^{-1}$). The soil depth of the effective root zone is increased from 0.30 m at planting to 0.45 m vegetative growth and the stage of composition yield for corn. Irrigation system was surface flow irrigation through line pipe provided with meter gages for measuring water applied. Soil water content was measured gravimetrically. The amount of water consumed from the root zone between two successive irrigations as a water depth, was calculated from the following equation (Allen *et al.*, 1998):

$$d = D \times P_b \times (Q_2 - Q_1)/100 \qquad (1)$$

Where:
d = Depth of water added
D = Root zone depth (m)
P_b = Bulk density of soil ($\mu g.m^{-3}$)
Q_2 = Percentage of soil moisture at field capacity
Q_1 = Percentage of soil moisture before irrigation

Table 1: Some chemical and physical soil properties

Properties	Unit	Value
pH	---	7.48
Organic matter	$gm.kg^{-1}$	6.10
Available N	$mg.kg^{-1}$	23
Available P		15.21
Available K		251.4
Sand	$gm.kg^{-1}$	292
Silt		500
Clay		208
Texture		Silt loam
Bulk density	Mg m^{-3}	1.30
Water content at FC	$cm^3.cm^{-3}$	0.39
Water content at WP		0.123
Available water		0.267

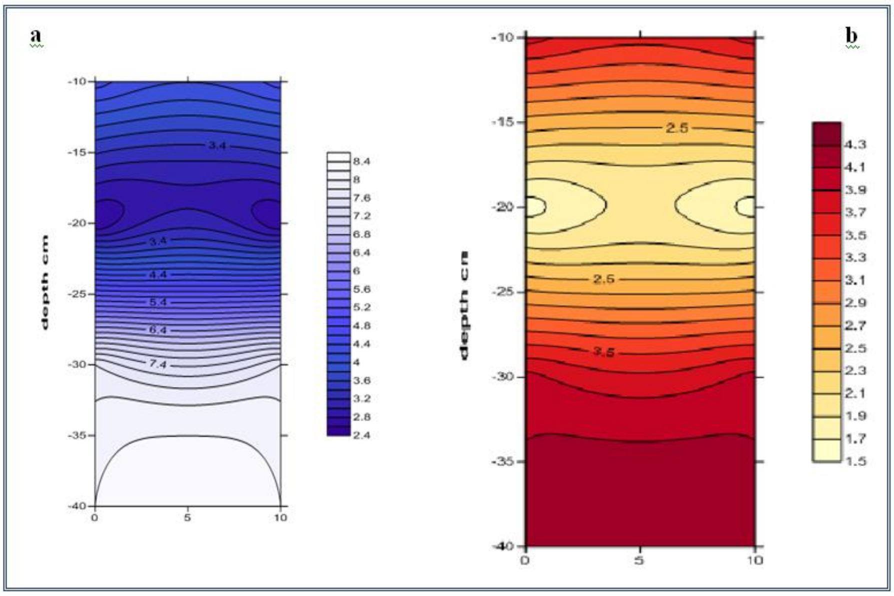


Fig. 1: EC (a) and SAR (b) value of soil before planting with depth.

Fertilizers were placed in bands on the side of each row and covered by soil (side dressed). Weeds and all the required farming management were done as recommended. At harvest time, two central rows in each plot were harvested to determine grain yield and then; yield per hectare was calculated.

Also measured the electrical conductivity and sodium adsorption ratio (SAR) in different period of season (before, middle and end of season) at depth soil 0-0.1, 0.1-0.2, 0.2- 0.3 and 0.3-0.4 m by equation (3):

$$SAR = \frac{[Na^+]}{\sqrt{\frac{[Ca^{++}]+[Mg^{++}]}{2}}} \ldots\ldots\ldots\ldots(2)$$

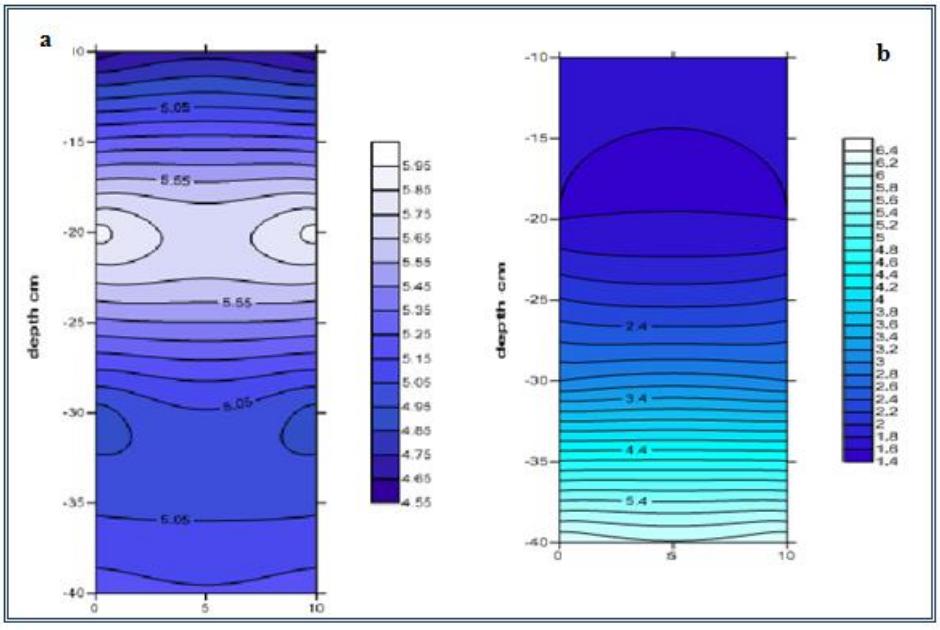
The obtained data were analyzed and the significant compared at p≤ 0.05 using GenStat software

III. Result and Discussion

Results of Fig. 2 and 3 show the salt distribution in soil EC and sodium adsorption ratio SAR to CBI and BPI treatment in middle and end of growth season, the results show decreased in EC and SAR values at middle and end of season compare to before planting, and has been more apparent in the CBI treatment compared to BPI. Due to the irrigation amount of receiving 884 and 618 mm to CBI and BPI treatment respectively, this helped to movement of salt outside soil profile. For the CBI treatment with larger irrigation amounts, a small of salt accumulated in the surface layer during the redistribution process because leaching process led to salt movement out of this layer.

The values of EC and SAR for CFI and SFI treatments in middle and end of growth season are decreased for all depth except 0-0.1 m depth in CFI compare before planting (Fig. 4 and 5). The reason may be the loss of salt in furrow is mainly caused by the salt accumulation mainly comes from the salt brought by irrigation and salt moved upwards by capillary raise or soil evaporation. Salt accumulation in ridge mainly comes from the salt brought by irrigation and salt movement evoked by soil evaporation and plant transpiration whereas the loss of salt is mainly caused by the uptake of crops (LiJuan & Qi, 2013), as well as the amount of water receiving 592 mm less than to conventional treatment (Fig. 6). For the CFI treatment with less irrigation water, however, almost all salt brought by each irrigation process accumulated in topsoil because of limited irrigation depth, which resulted in higher soil salinity in topsoil. Either shallow treatment was a clear fluctuation in EC values and SAR, may be the reason is the lack of depth equivalent to section soil despite receiving 636 mm development evaporation, but we also show the water movement was not clear in this irrigation treatment.

The reduced irrigation depth in Deficit irrigation (BPI), conventional furrow irrigation (CFI) and shallow furrow irrigation (SFI), due to different water amount added which depending irrigation styles and rate of wet volume. This was clear to saving water amount 2920, 2480 and 2660 m3 h^{-1} for CFI, SFI and BPI treatment, respectively compared to CBI treatment. We conclude the increase percentage in soil salinity in all treatments was small and did not affect in productivity of the crop, this due the values of EC did not exceed the critical values used for the optimum growth of maize, so we reached good productivity for all treatment compared to corn yield in Iraq (Fig. 7), because EC values did not increase, the rang 5-7 dS.m^{-1} and SAR rang 1.36-6.39 (mg $L^{-1})^{½}$ within 0.3 m of root zone for all treatments in end growth, that's meant don't exceed critical limit or threshold to optimum growth of corn.



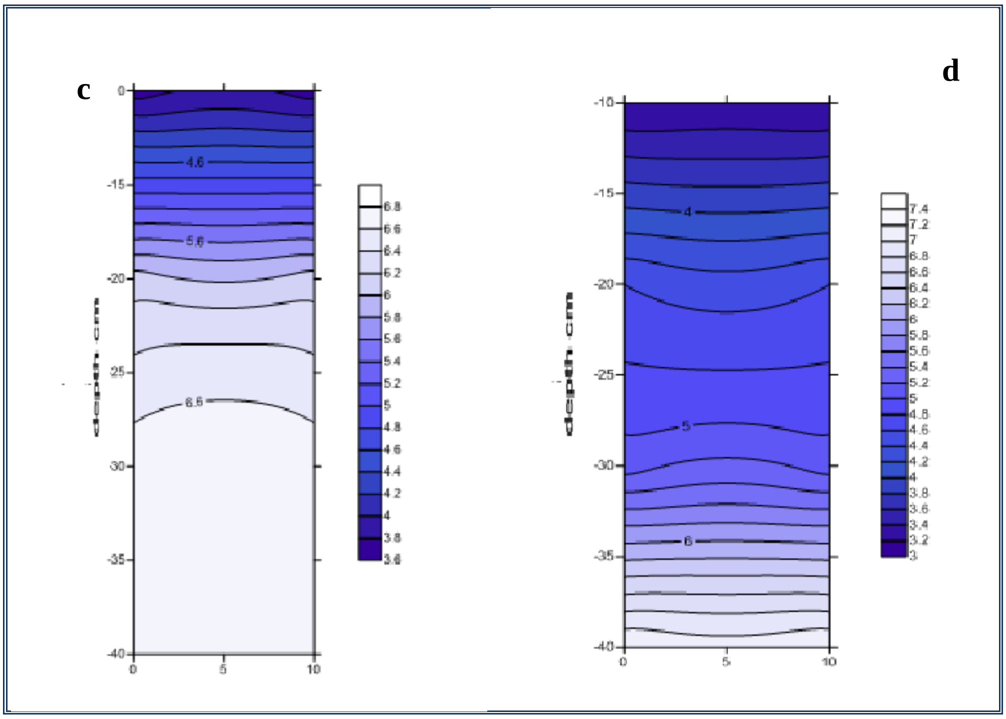
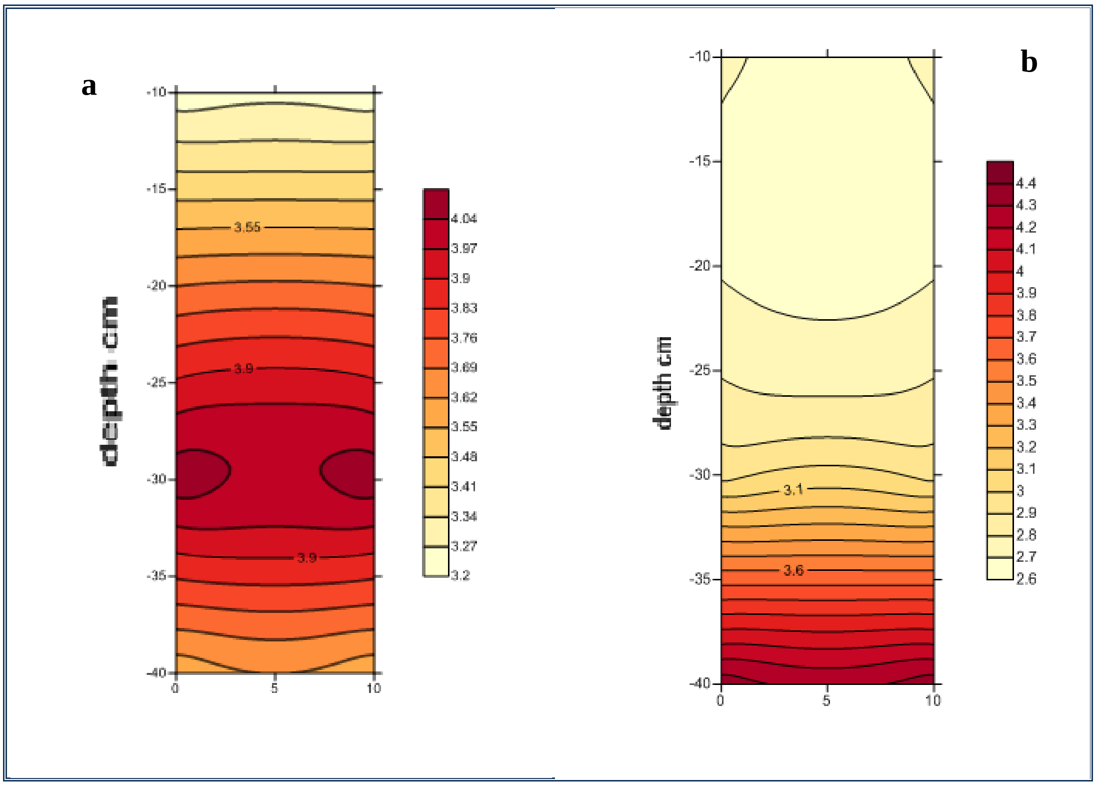


Fig. 2: Distribution of soil salinity EC under CBI treatment in middle season (a) and end season (b), and BPI treatment in middle season (c) and end season (d).



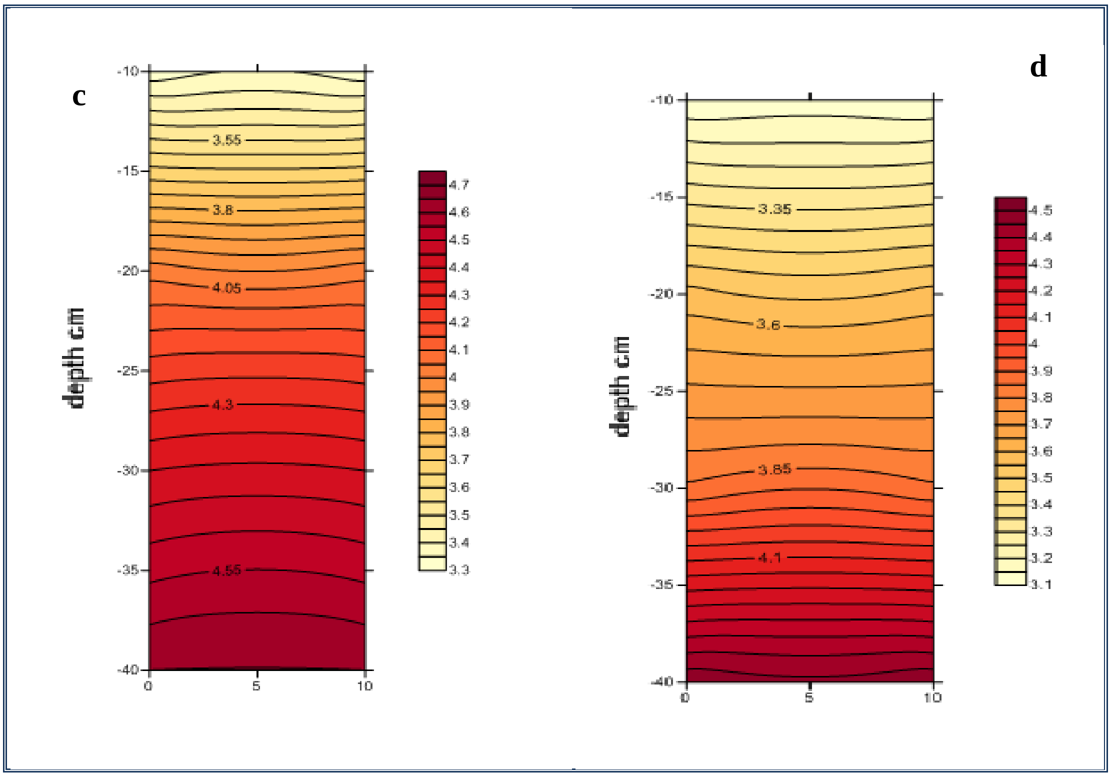
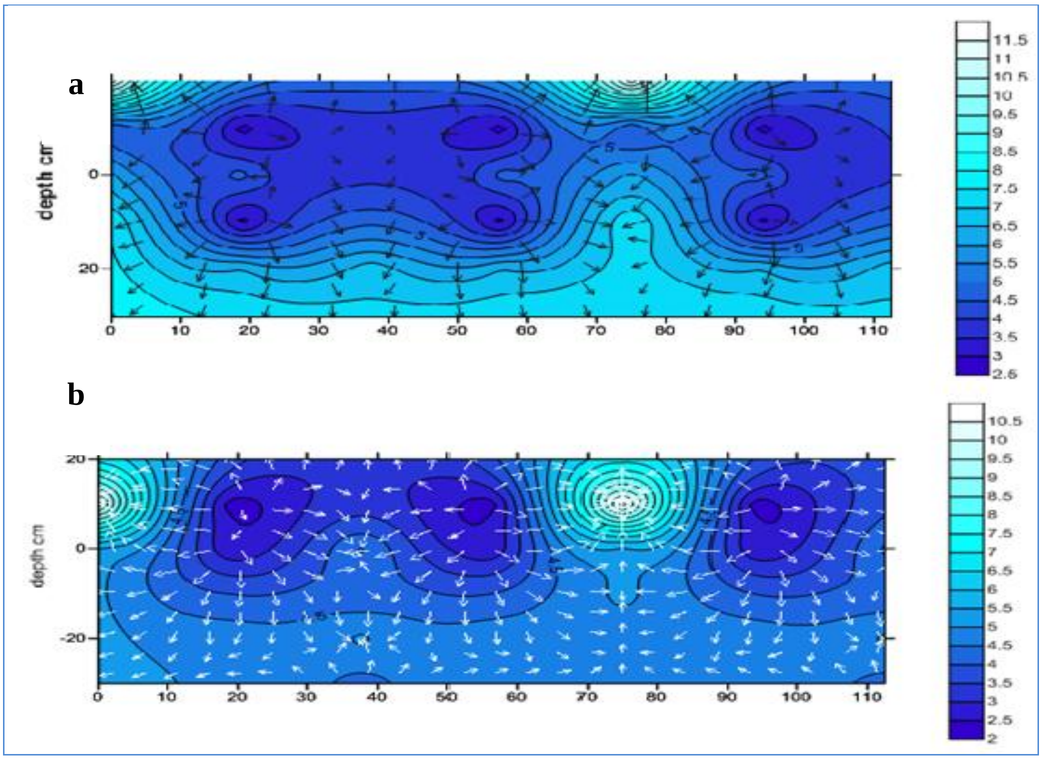


Fig. 3: Distribution of SAR under CBI treatment in middle season (a) and end season (b), and BPI treatment in middle season (c) and end season (d).



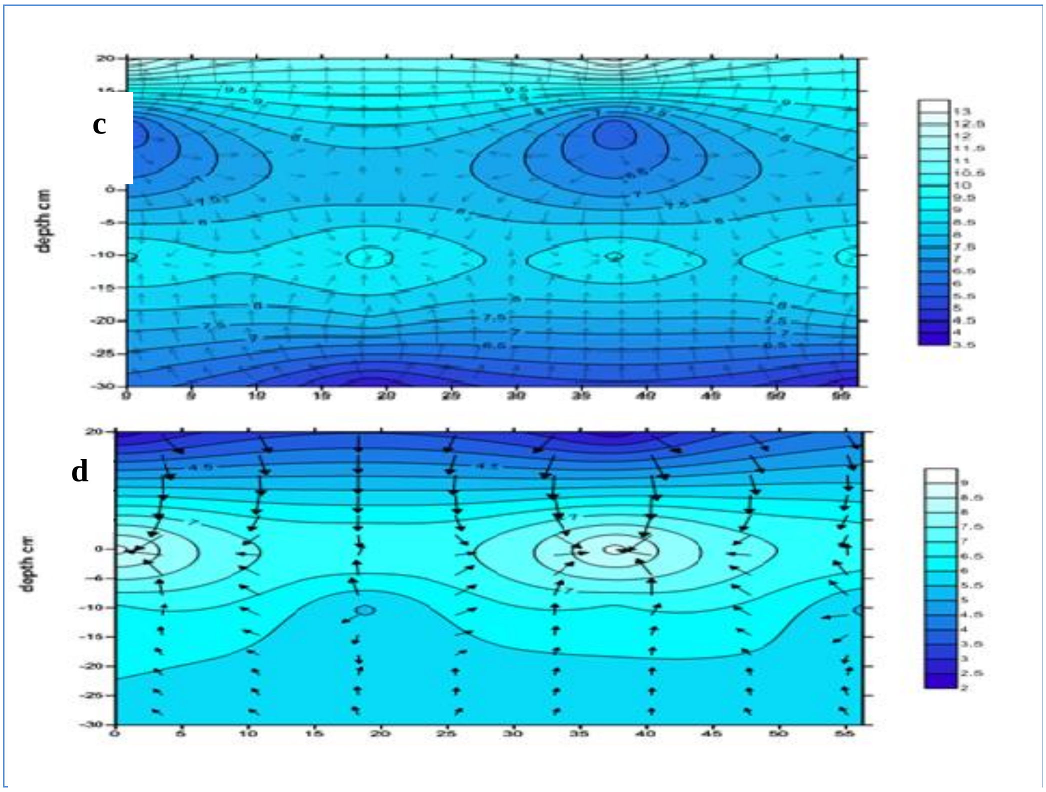
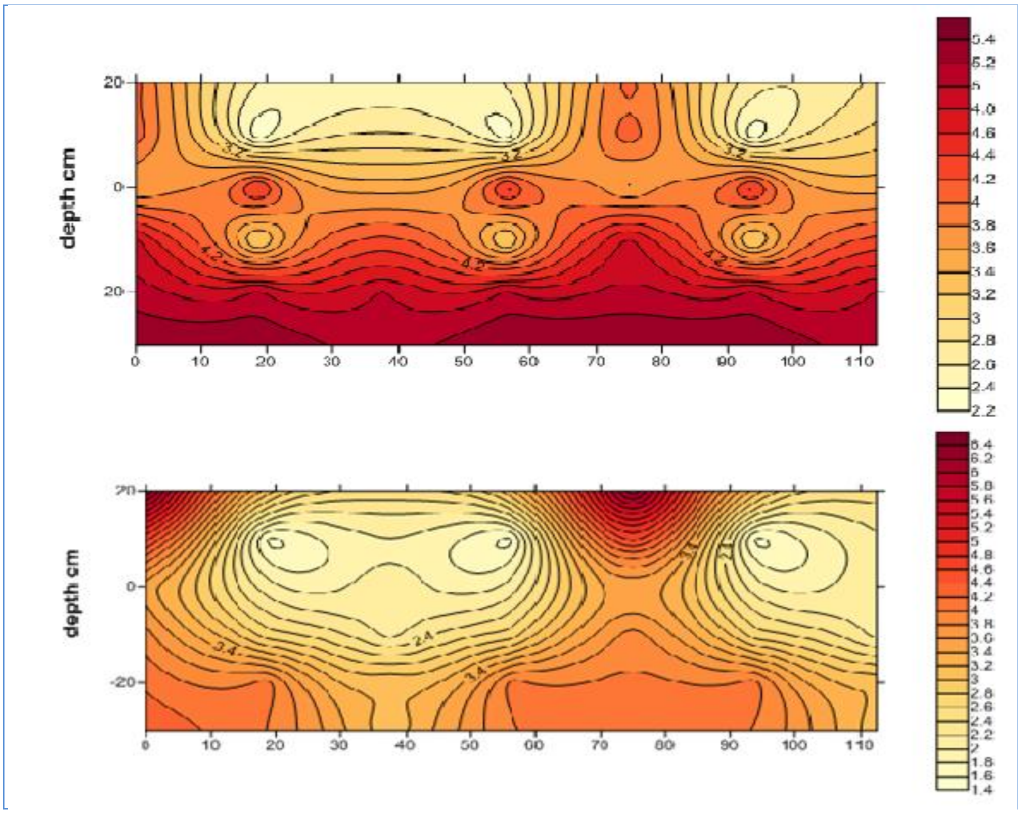


Fig. 4: Distribution of soil salinity EC under CFI treatment in middle season (a) and end season (b), and SFI treatment in middle season (c) and end season (d).



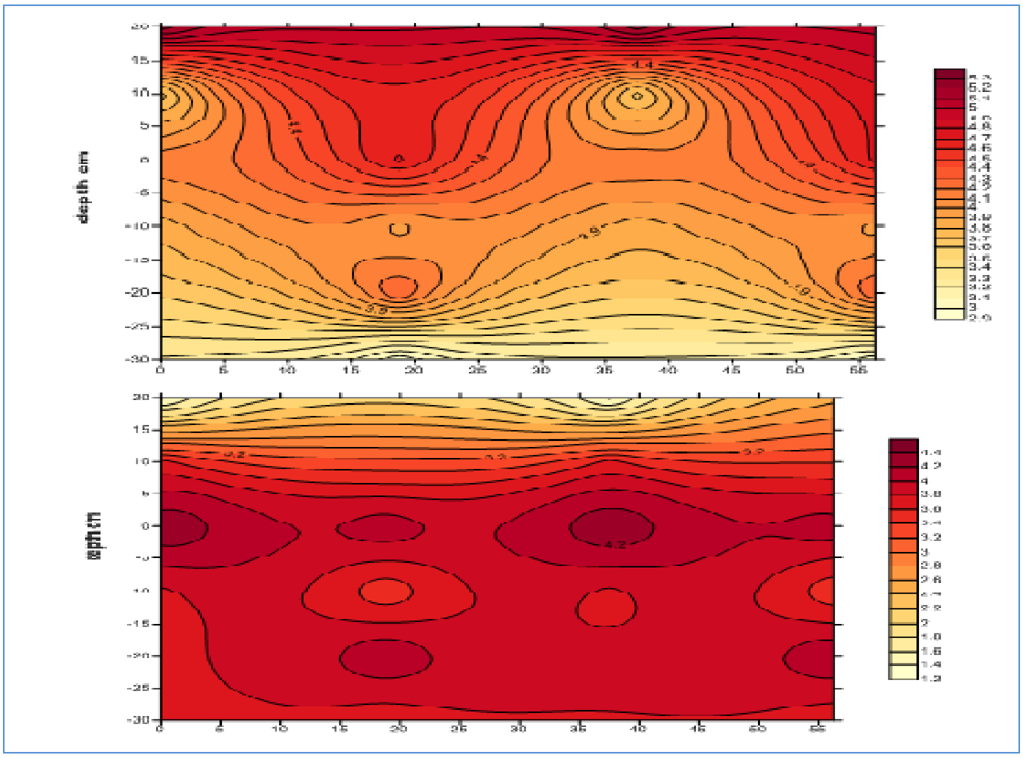


Fig.5: Distribution of SAR under CFI treatment in middle season (a) and end season (b), and SFI treatment in middle season (c) and end season (d).

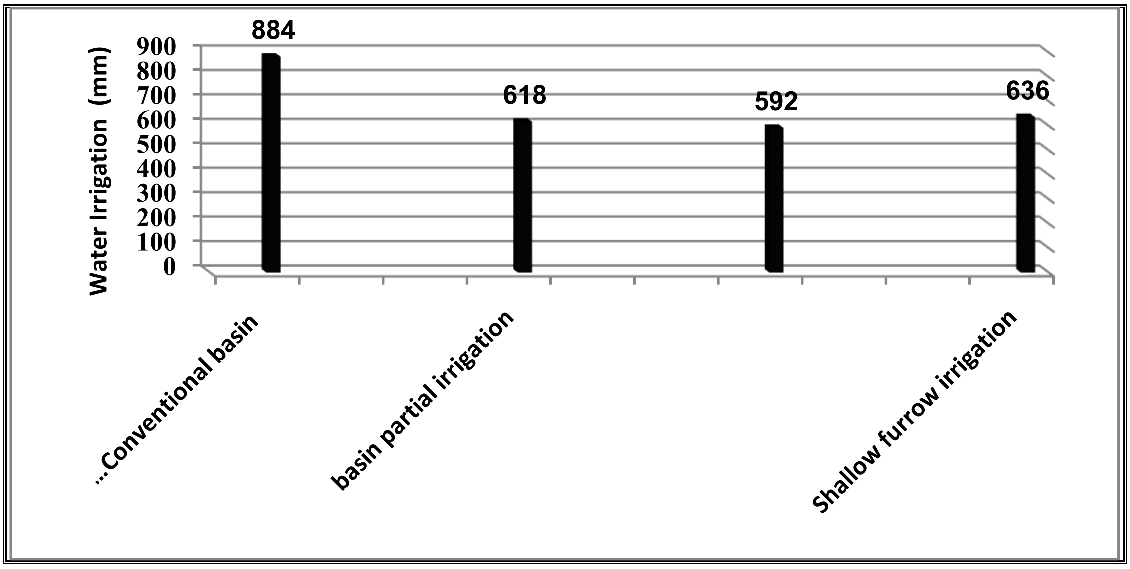


Fig.6: Water irrigation amount for all treatments.

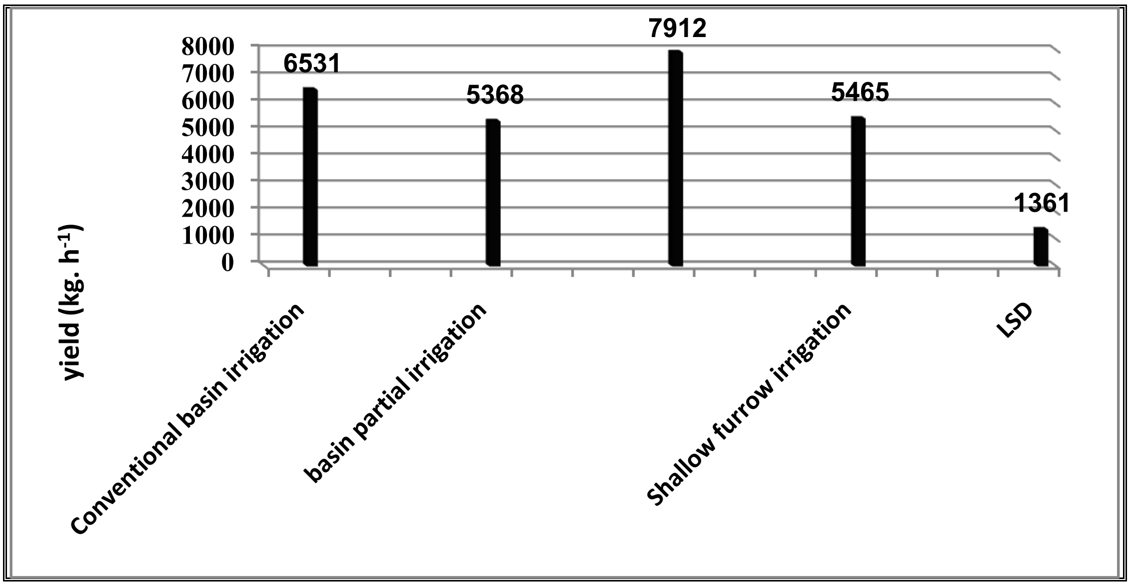


Fig.7: Corn productivity for all treatments.

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