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The Role Of Irrigation Methods Of Saline Water And The Chemical Effect Of Anti-Transpiration Materials In The Water Needs And Growth Of Wheat Crop.

Tareq K Masood*, Firas W Ahmed, Abdul Baqi D Salman,Kusay A Wheib, and Mazin Fadhil Khudhair.

Soil and Water Resource Department, College of Agricultural Engineering Sciences University of Baghdad, Iraq.

ABSTRACT

An experiment was carried out in one of the field south of Baghdad city, Iraq during the season 2014-2015 to assess the lack of water in shallow furrow, partial irrigation methods, and anti-transpiration materials in the water consumption and some properties of what crop growth and yield. Three different irrigation methods were used in this experiment including shallow furrow, partial and conventional (control) irrigation methods, and sprinkling with two kinds of anti-transpiration materials (ARMORAX and VAPOR GARD) in addition to the control treatment (without application). A factorial experiment was applied according to randomize complete block design with three replicates and differences were tested at $P<0.05$. Results showed the depth of irrigation water was varying due to irrigation method where irrigation water reached up to 428 $mm.season^{-1}$ for the conventional irrigation method. While in shallow furrow and partial irrigation, the applied quantity of water was decreased at 28% and 29% respectively, which means the increase of the horizontal expansion of agriculture for the same water resource, in another word, the increase in planted area at 0.426 and 0.390ha, and an increase in production at an additional 2.22 and 2.32 Mg in the shallow furrow and partial irrigation methods respectively. It also decreased the period of irrigation. Shallow irrigation treatment was superior in grain yield (5.96 $Mg.ha^{-1}$) at 21.8% off the conventional irrigation method. Partial irrigation method showed an increase in average flag leaf area where it reached up to 40.89 cm^2

INTRODUCTION

Arab regions are facing a severe water scarcity due to the increase of demands of water for water consumption whether for potable uses or for home uses in addition to the needs in agriculture, because of the population explosion and urbanization expansion witnessed in these areas. This will definitely lead, under the limited water resources, to decrease the water share for agricultural uses, which means the decrease of the agricultural areas and the increase of desertification opportunity in case no suitable procedures were taken for such purpose (Abou-Hadid 2010). As well as the increased demand of food, and as long as agriculture is the most consuming factor of water, where it consumes 85% of the total available water for human uses, and the losses in irrigation water may reach 50% as a result of bad irrigation efficiency (FAW 2004) with a decrease in the quality of irrigation water in Iraq (Mazin et al, 2018). Must be enhance this efficiency and water use yield in agriculture, new technologies and methods upgrades were used especially in surface irrigation. FAW has confirmed that the surface irrigation was and still, unconditionally, the most important procedure of irrigating crops, where it forms 95% of 250 million of hectares of the irrigated lands all over the world (93% of this lie in the closer east), and that will continue most likely in the near future. The changing in irrigation procedures and methods is not always correct. Also, it is not practical to convert most of current surface irrigation to the new technical irrigation methods. Where instead of giving up surface irrigation for being not efficient, it should be reconsidered those factors that led to it and finding the technical enhancement for it (FAW 2006). One of these methods is the shallow furrows (Masood 2017, Ati et al 2016, Nasood 2015) and the alternate partial irrigation (Mahdi and Masood 2017, 2014) and the interacted agriculture of the same water resource (Ali et al 2016).

To increase the efficiency of surface irrigation if strategic crops, such as wheat, there was a shallow furrow new procedure was invented for especially for wheat crop (Masood 2015) in addition to the use of anti-transpiration. This research aims to study the effect of shallow furrow and partial irrigation methods and the application of anti-transpiration materials on the growth and yield of crop and the productivity of irrigation water and water consumption.

MATERIALS AND METHODS

An experiment was conducted in one of the fields south of Baghdad through the agricultural season of 2014/2015 in a loamy texture alluvial soil classified to Typic Torrifluvent. Table 1 shows the physical and chemical characteristics of the soil before planting. Particle size distribution was measured due to pipette method (Day 1956), bulk density due to core sample (Blake and Hartage 1986). Also water holding capacity was measured at 33 and 1500 K Pascal tension.

EC and pH were measured for 1:1 soil extract, also, action's and anions were measured according to Richards 1954, and soil organic matter was also measured using potassium dichromate due to Walkely Black method. Carbonate and bicarbonate were measured according to Jackson 1958. Core sampler was used to determine soil bulk density (Blake and Hartage, 1986). Available phosphorous in soil was measured according to Olsen and Sommers1982, also, available nitrogen and potassium were measured. Calcium carbonate was measured using calcimeter as described in Hesse 1971. CEC was determined due to Savant 1994.

Table 1: Chemical and physical properties of soil before planting

	Properties		Values	Units
Chemical properties	EC 1:1		2.10	$dS.m^{-1}$
	pH		7.24	
	Cations and Anions	Na^{+}	7.00	$meq.l^{-1}$
		K^{+}	0.86	
		Ca^{++}	4.70	
		Mg^{++}	2.65	
		Cl^{-}	16.20	
		SO_4^{--}	2.31	
		HCO_3^{-}	2.00	

		CO_3^{--}	Nil	
	Available nutrients	N	21.00	$mg.kg^{-1}$ soil
		P	22.51	
		K	74.49	
	Carbonate minerals		2.4	$gm.kg^{-1}$ soil
	Organic matter		8.30	$gm.kg^{-1}$ soil
	CEC		17.35	$Cmolc.100gm^{-1}$ soil
Physical properties	Separates	Sand	442	$gm.kg^{-1}$ soil
		Silt	440	
		Clay	118	
	Soil Texture		Loam	-
	Total porosity		44	%
	Bulk density		1.48	$Mg.m^{-3}$
	Field capacity		0.30	$cm^3.cm^{-3}$
	Welting point		0.14	$cm^3.cm^{-1}$

Farming processes:

The field of study was plowed perpendicularly using reversible bottom plough, and soil surface was leveled, then the field was divided into three blocks where each block has 27 experimental units each was 6 m^2 $(3*2)m^2$. Units specified for furrow irrigation had 8 furrows 2 m, 0.25m width and 0.18 m deep each and there was a 0.35 m space between each two furrows while 2m were left between each block and another, and 1 m left between treatments to control water and salt movement. This experiment was designed to be a factorial RCBD in three replicates. Results were statistically analyzed and tested at $p<0.05$ LSD.

Class Ipaa 99 wheat seeds were planted on 20/10/2014 at 120 $kg.ha^{-1}$. Nitrogen fertilizers were applied at 114 $kg.ha^{-1}$ (Urea 46%N) and phosphate at 85 $kg.ha^{-1}$ (tri-super phosphate 21%P) and potassium fertilizers 111 $kg.ha^{-1}$ of potassium sulphate (K42%) at two doses, the first was at branching and the second before the stage of booting. Plants were harvested on 10/5/2015.

Experimental treatments:

Experiment included different treatments:

Irrigation treatments: conventional irrigation based on at 50% consumption of available water. Partial irrigation (adding 70% of water depth applied in conventional irrigation treatment), and shallow furrow irrigation, which means adding water depth across reducing the area of wetting (0.72 of the total area).

Anti-transpiration materials: two types of anti-transpiration materials were used ARMORAX and VAPOR GARD in addition to the control treatment of no sprinkling. These materials were sprinkled at 500 $cm^3.100L^{-1}$ water, in two stages, the first on booting stage 20/3 and the second 10 days later. Table 2 shows the chemical compound of these anti transpiration materials.

Table 2.Chemical compound of anti-transpiration materials

Anti-transpiration		Chemical compound
ARMORAX	8% SiO_2	3% free amino acids
VAPOR GARD	96% di- 1- p- Menthene , 4% Inert Ingredients.	

Irrigation was accomplished using an irrigation system that pumping water from a well close to field (table 3 shows well water properties) through tubes to spread water to the different units. Water discharge gauge was used to determine the volume of applied water in each treatment. Irrigation was applied as of 50% consumption of the available water due to:

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$$d = (\theta_{f.c}-\theta_w)\ D \quad (1)$$

Where d: applied water depth (mm)

θf.c: volumetric water content at field capacity ($cm^3.cm^{-3}$)
Θw: volumetric water content before irrigation
D: rhizosphere depth (mm)

Table 3: Properties of well water used in the experiment

EC dS m^{-1}	pH	meq.L^{-1}				Class
		Na^+	Ca^{++}	Mg^{++}	SAR	
2.6	7.23	1.36	9.0	32.0	0.30	C_3S_1

Plants heights were measured (from soil surface to the spike, and leaf area (cm^2) was done by measuring the widest width of flag leaf and longest length of it as:

$$LA = 0.95\ LW (2)$$

Total seeds yield and biological yield ($kg.ha^{-1}$) was measured from the average yield of 1 m^2 of the experimental unit then converted to $kg.ha^{-1}$.

Average transpiration rate ($cm^3/100.cm^{-2}.hr^{-1}$) was calculated after cutting the flag leaf off the plant and weight recorded then 3 minutes later another weight is recorded using this equation:

$$\text{Transpiration rate} = \frac{\text{(first weight of leaf – second weight of leaf)}100*60}{\text{Time of measure* leaf area (cm2)}} \quad (3)$$

RESULT AND DISCUSSION

Result in figure 1 showed that the conventional irrigation treatment has consumed a higher quantity of water as compared to other irrigation treatment where it reached 4280 $m^3.ha^{-1}$ per season. The applied quantity of water has decreased to lower limits when partial irrigation was applied, the quantity of water was 3000 $m^3.ha^{-1}$ in the meanwhile the decrease rate of irrigation water depth was 29.9% as compared to the conventional irrigation. Shallow furrow irrigation treatments had an applied quantity of 3080 $m^3.ha^{-1}$ of water in a rate of decrease 28% of the conventional irrigation. The decrease of the partial irrigation or shallow furrows was related to the reduced water depth in partial irrigation, which means the decrease of deep perculation including leaching of nutrients in the root zone, while in the shallow furrow, the area of wetting of soil surface was reduced as well which also means the reduce of water loss and consumption.

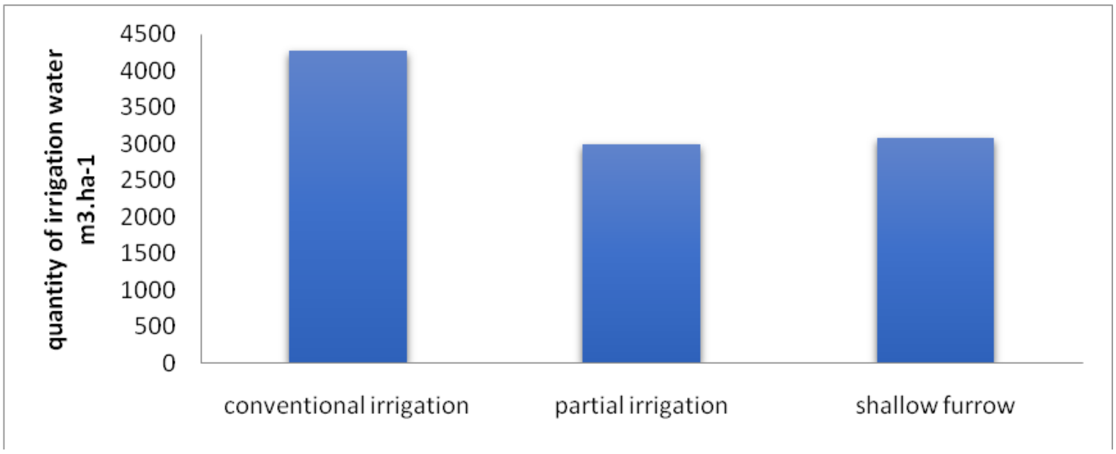

Figure 1: quantity of irrigation water $m^3.ha^{-1}$ of the partial, shallow furrow, and conventional irrigation.

The variation of applied water is noticed due to using different method or behavior, also the wetting area was varied. The partial irrigation shown saving irrigation water during the season of wheat growth at 1280 $m^3.ha^{-1}$ while it was 1200$m^3.ha^{-1}$ in shallow furrows irrigation.The calculations of invested area of water use saving was measured due to the equation:

$$\text{Additional invested area (ha)} = \frac{\text{Saved water quantity } (m^3.ha^{-1}) \times}{\text{Used quantity of non-conventional irrigation Treatment } (m^3.ha^{-1})}$$

Results of saving irrigation water showed that the use of shallow furrow irrigation has the capability of expansion in horizontal agriculture for the same water resource at an area of 0.390 ha (3896 m^3), while the application of partial irrigation can lead to an expansion of 0.427 ha (4266 m^3) in the horizontal area to know the additional grain yield in the invested additional area of the same water resource we applied the equation:

$$\text{Invested area grain yield } (Mg.ha^{-1}) = \frac{\text{Yield of non-conventional treatment } (Mg.ha^{-1}) \times \text{ Additional invested area (ha)}}{\text{Area (ha)}}$$

Figure 2 showed the increase in yield, due to the application of partial irrigation when the additional area was invested at 22.2 $Mg.ha^{-1}$ increases, while the increase of yield was 2.32 $Mg.ha^{-1}$ when shallow irrigation was conducted.

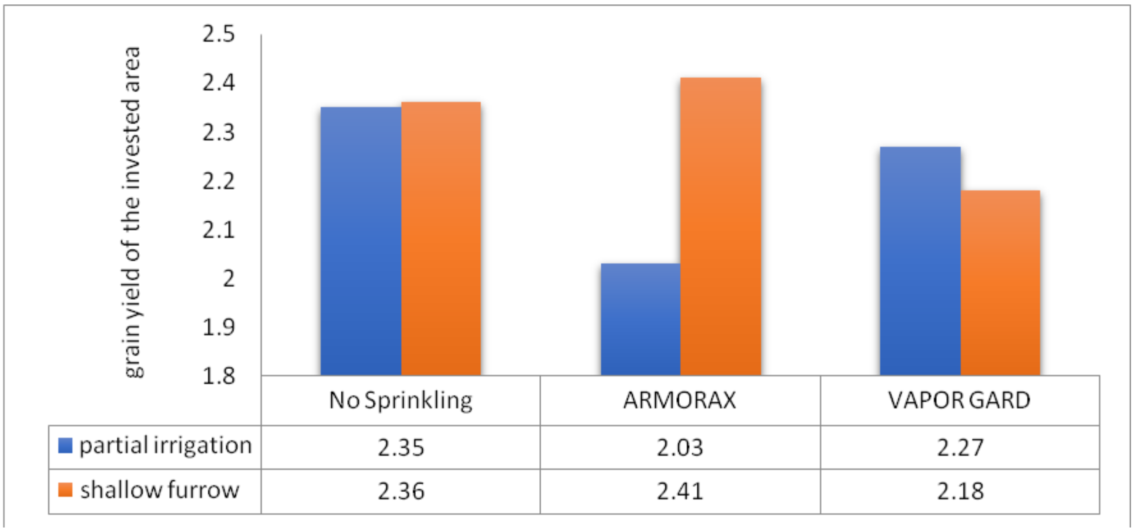

Figure 2: grain yield of the invested area due to the reduce of water quantity applied in partial, shallow furrows irrigation with the use of ant transpiration material.

Table 4 shows the effect of different irrigation and ant transpiration material on the grain yield, where the average of grain yield was 4.89, 5.21, 5.96 $Mg.ha^{-1}$of conventional, partial, and shallow furrows irrigation treatments respectively. The shallow furrows treatment was significantly superior at 22% when compared to conventional irrigation, while the partial irrigation treatment has given a non-signification increase 6% when compared to conventional irrigation. In the same behavior, the shallow furrows irrigation treatment has given a significant increase at 14% when compared to partial irrigation, that could be related to role of irrigation method of shallow irrigation in increasing yield, where it is considered as a root growth suitable method in addition to decreasing soil salinity through salt movement upward to the tip of the furrow. Results also showed that the highest yield at sprinkling with ARMORAX was 5.59 $Mg.ha^{-1}$ as compared to no sprinkling treatment, but this increase was not significant in yield. Grain yield has decreased insignificantly of the VAPOR GARD treatment where yield average was 4.94 $Mg.ha^{-1}$. The interactive effect of irrigation treatments and anti-transpiration materials, where interaction of shallow irrigation and ARMORAX and shallow irrigation without sprinkling were superior significantly while the conventional irrigation VAPOR GARD was 3.89 $Mg.ha^{-1}$ has significantly decreased other than all other treatments except partial irrigation ARMORAX. Interaction results of conventional irrigation with VAPOR GARD that gave lowest yield significantly might be related to the anti-transpiration material.

Table 4: effect of irrigation methods and anti-transpiration materials on grain on yield $Mg.ha^{-1}$

Treatments	anti-transpiration			Means
	No Sprinkling	ARMORAX	VAPOR GARD	
Conventional Irrigation	4.98	5.80	3.89	4.89
Partial Irrigation	5.52	4.78	5.34	5.21
Shallow Furrow	6.07	6.20	5.60	5.96
$LSD_{0.05}$	1.29			0.74
Means	5.52	5.59	4.94	5.35
$LSD_{0.05}$	0.74			

Table 5 shows that significant increase among irrigation methods and plant heights. Anti-transpiration materials have not given a significant increase where they were 96.5, 99.4, 99.4 cm of No sprinkling treatments, ARMORAX, and VAPOR GARD respectively. In spite of the matter that following the shallow furrows and partial irrigation did not decrease heights of plants because of the role of partial irrigation and shallow furrow in increasing the depth of group to replenish the water deficiency and eventually increasing the uptake of nutrients that positively reflects on growth. Also, plant height run down when anti-transpiration material is used might delay the time of sprinkling, the same table shows the interaction effect between irrigation methods and anti-transpiration material, where the application of anti-transpiration material in the partial irrigation treatment led to an increase in plant heights at 100.8 cm in ARMOR AX and 100.7 cm in VAPOR GARD that significantly exceeded at 8.6% and 8.5% respectively as compared to without sprinkling partial irrigation treatment. And that could be related to the role of anti-transpiration materials and their content of nitrites especially amino acids when plant faces water deficit.

Table 5: plant heights at different irrigation methods treatments and anti-transpiration material

Treatments	anti-transpiration			Means
	No Sprinkling	ARMORAX	VAPOR GARD	
Conventional Irrigation	99.8	99.3	97.9	99.0
Partial Irrigation	92.8	100.8	100.7	98.1
Shallow Furrow	97.0	98.2	99.8	98.3
$LSD_{0.05}$	7.6			4.4
Means	96.5	99.4	99.4	98.4
$LSD_{0.05}$	4.4			

Table 6. refers to that the partial irrigation method led to an increase in average area of flag leaf in plant was 40.89 cm^2 in area (not considering anti-transpiration materials) which significantly exceeded the shallow furrows irrigation (36.95 cm^2) at 10.7% increase rate, in the mean while latest has not differ from conventional irrigation method that average flag area reached up to 40.48 cm^2. Partial irrigation method superiority may be related to increase of flag leaf area when VAPOR GRAD anti-transpiration material was used and gave highest value of the measure, due to the important role in conserving water in leaf to be reflected in flag leaf area, also, applications of anti-transpiration materials have given the highest leaf area average at 41.82 cm^2 in VAPOR GARD treatment in a significant increase at 12.7% as compared to no sprinkling treatment that gave an average leaf area of 37.12 cm^2 while sprinkling with ARMORAX had no different in average leaf area where it was 37.12, but sprinkling with ARMORAX has no significant differences then control treatment. The same table shows the effect of interaction between types of anti-transpiration material and irrigation methods where sprinkling with VAPOR GARD in partial and conventional irrigation have given highest flag area at 43.20, 42.02 cm^2 in a significant increase of 29.84 and 26.3% as compared to no sprinkling shallow furrows treatment. When VAPOR GARD with shallow furrows irrigation method, it had significantly exceeded

the no sprinkling shallow furrows. When VAPOR GARD was applied with shallow furrow irrigation method, it was significantly exceeded the same irrigation method with no sprinkling at an increase 20.92% and that could be related to the fact that flag leaf increase was to the use of anti-transpiration materials that work positively on enhancing the water status of leaf and increasing the swallowing pressure of cells these enhancing the vegetative growth.

Table 6: effect of irrigation methods and anti-transpiration materials on flag leaf area cm^2

Treatments	anti-transpiration			Means
	No Sprinkling	ARMORAX	VAPOR GARD	
Conventional Irrigation	39.67	39.76	42.02	40.48
Partial Irrigation	38.41	41.05	43.20	40.89
Shallow Furrow	33.27	37.36	40.23	36.95
$LSD_{0.05}$	6.61			3.81
Means	37.12	39.39	41.82	39.44
$LSD_{0.05}$	3.81			

Table 7 shows that irrigation methods led to increase straw yield, where shallow furrows irrigation method has given straw yield of 11.84 $Mg.ha^{-1}$ at an increase rate of 13.19% as compared to conventional irrigation method (10.46 $Mg.ha^{-1}$) while partial irrigation has given a non-significant increase in straw yield at 4.11%. as well as, the highest straw yield when anti-transpiration materials were it reach up to 11.32 $Mg.ha^{-1}$ at a rate of 2.35% of the average in sprinkling with VAPOR GARD that reached up to 11.06 $Mg.ha^{-1}$, but this increase was non-significant. In the meanwhile, there were no significant between sprinkling treatment with no sprinkling ones. The same table shows the interaction effect between anti-transpiration materials and irrigation methods on the straw yield where the shallow furrows method with ARMORAX has given highest straw yield at 12.44 $Mg.ha^{-1}$ with a significant increase as compared to conventional irrigation method with VAPOR GARD at 25.78% rate of increase, while the latest has not differed from the other treatments.

Table 8 showed that shallow furrows irrigation method has led to a decrease in transpiration rate (0.705cm^3.100cm^2hr^{-1}) regardless to any kind of anti-transpiration materials, in a rate of decrease at 27% from the conventional irrigation, in the meanwhile transpiration rate has decreased in partial irrigation treatment 0.755cm^3.100cm^2hr^{-1} at a decrease rate 21.84% of the conventional irrigation, but that decrease was non-significant. Also, the application of anti-transpiration materials gas given lowest transpiration rate in sprinkling with VAPORE GARD (0.642cm^3.100cm^2hr^{-1}) as compared to no sprinkling treatment in a non-significant way. The no decrease in transpiration rate when anti-transpiration material used caused and increase in flag leaf area as compared to control treatment, where there is an universal relationship between transpiration rate and area of leaf. Sprinkling with ARMORAX has not significantly differed from control. The same table shows the effect of interaction among anti-transpiration materials and irrigation methods where sprinkling with ARMORAX has given lowest transpiration rate in a significant decrease from interaction with the no sprinkling. In the same time. Other treatments have not differed from each other.

Table 7 : effect of irrigation method and anti-transpiration materials in straw yield ($Mg.ha^{-1}$)

Treatments	anti-transpiration			Means
	No Sprinkling	ARMORAX	VAPOR GARD	
Conventional Irrigation	10.00	11.48	9.89	10.46
Partial Irrigation	11.32	10.05	11.31	10.89
Shallow Furrow	11.11	12.44	11.98	11.84
$LSD_{0.05}$	3.24			1.87
Means	10.81	11.32	11.06	11.07
$LSD_{0.05}$	1.87			

Table 8: effect of irrigation methods and anti-transpiration materials in transpiration rate (cm^3.100$cm^{-1}.hr^{-1}$)

Treatments	anti-transpiration			Means
	No Sprinkling	ARMORAX	VAPOR GARD	

Conventional Irrigation	0.917	1.352	0.630	0.966
Partial Irrigation	1.067	0.563	0.633	0.755
Shallow Furrow	0.685	0.769	0.662	0.705
$LSD_{0.05}$	0.463			0.267
Means	0.889	0.895	0.642	0.809
$LSD_{0.05}$	0.268			

Table 9 shows the effect of different irrigation methods and anti-transpiration materials in prolyn. Prolyn averages were 24.94, 23.69, 23.85 $mmol.gm^{-1}$ in conventional, partial, and shallow furrow irrigation methods respectively. Results referred to an increase in prolyn concentration in conventional irrigation method that exceeded the partial and the shallow furrow irrigation methods significantly at 5.27% and 4.57% respectively, while there were no significant differences between partial and shallow furrow irrigation methods. Prolyn decreased in partial and shallow furrow irrigation methods which might be related to the absence of water stress when these two irrigation methods were applied in spite of the decrease in water depth added to plants in partial and shallow furrow irrigation methods. Also, the increase in prolyn in conventional method may be related to the salt accumulation in soil profile due to the increase in irrigation water depth which means the increase in salt accumulation that reflected in increasing prolyn content. These results were matching what Alshahwani et al 2007 and Aboud and Abbas 2013 found. This confirms that the partial and shallow furrow irrigation methods had a role in increasing the yield of wheat grains, in addition to the increase of water use efficiency and saving water for other uses. Results also showed that sprinkling with ARMORAX has revealed least concentration of prolyn in leaves (23.85 $mmol.gm^{-1}$) with a decrease rate of 1.2% as compared to no sprinkling treatment. The decrease in prolyn with sprinkling with ARMORAX might be related to the content of this anti-respiration material of the free amino acids and their role in decreasing the stress effects. The interaction among irrigation treatments and anti-respiration materials we can see the decrease of prolyn in shallow furrow treatment and sprinkling with ARMORAX (23.03 $mmol.gm^{-1}$) off the conventional no ARMORAX and VAPOR GARD sprinkling irrigation treatment, where prolyn has significantly decreased, while there was no significant differences in interacted treatments.

Table 9: effect of different irrigation methods and anti-transpiration materials in prolyn

Treatments	anti-transpiration			Means
	No Sprinkling	ARMORAX	VAPOR GARD	
Conventional Irrigation	24.49	24.97	25.35	24.94
Partial Irrigation	23.46	23.56	24.07	23.69
Shallow Furrow	24.48	23.03	24.03	23.85
$LSD_{0.05}$	1.90			0.52
Means	24.14	23.85	24.48	24.16
$LSD_{0.05}$	0.52			

Table 10 shows that there was no significant effect of the partial and shallow furrows irrigation methods when compared to conventional irrigation method to study the total content of chlorophyll in leaves of wheat. Also results showed the interaction effects of irrigation methods and anti-transpiration materials where the ARMORAX has given the highest content of chlorophyll at 80.1 $mg.gm^{-1}$ at a simple increase off the significance level as compared to shallow furrow with VAPOR GARD treatment at an increase of of 21.91%.

Table 10: effect of different irrigation methods and anti-transpiration materials inchlorophyll total.

Treatments	anti-transpiration			Means
	No Sprinkling	ARMORAX	VAPOR GARD	
Conventional Irrigation	73.2	75.0	75.7	74.6
Partial Irrigation	79.0	74.0	75.2	76.1
Shallow Furrow	73.7	80.1	65.7	73.2
$LSD_{0.05}$	14.30			8.26
Means	75.3	76.3	72.2	74.6
$LSD_{0.05}$	8.26			

REFERENCES

[1] Abu Dhahi, YosifMuhammed, Muayed Ahmed Al-Younis.1988. Guide of Plant nutrition. House of books publisher, University of Baghdad, ministry of higher education and scientific research.

[2] Abood, M.A. and Ahmed K. Abbas. 2013. Use of Certain Treatments in the Salt Stress Relief in the Growth and production of Wheat Varity Sham 6 (*Triticumaestivum* L.). EJAS. 5(3):245-259.

[3] Abou_Hadid, A.F.(2010). Agricultural water management. In Arab environment: water sustainable management of scarce resource (Eds.Mohamed El-Ashry, Najibsaab and Bashar Zeitoon.) Arab Forum for Environment and Development (AFED) Beirut, Lebanon.

[4] Abou_Hadid, A.F.(2010). Agricultural water management. In Arab environment: water sustainable management of scarce resource (Eds.Mohamed El-Ashry, Najibsaab and Bashar Zeitoon.) Arab Forum for Environment and Development (AFED) Beirut, Lebanon.

[5] Ali, NooreldeenShawqi. 2012. Techniques of fertilizers and their uses. Universal house of publication and translation, University of Baghdad, ministry of higher education and scientific research.

[6] Ali, N.S., A.S.Atee and T.K. Masood. 2016. Effect of nitrogen application and amount of water on yield of intercropped Maize –Mung bean and water productivity. Journal of Agricultural Research and Innovative Technologies. 1(1):1-16.

[7] Ati, A.S., K. Makey and T.K. Masood. 2016. Effect of irrigation system basin and furrow in saline distributions patterns and productivity corn (Zea mays L.) Journal of Agriculture and Veterinary Science. 9(5):31-38.

[8] Blake, B.R. and K.H. Hartge. 1986. Bulk density. In A. Klute (Ed.).Methods of Soil Analysis, Part 1, 2nd edn.Agron.Monogr.No. 9.ASA and SSSA. Madison, WI. p. 363-375.

[9] Day, P.R. 1965. Particle fractionation and particle size analysis. In C.A. Black (ed.). Methods of soil analysis part 1, Agron. Ser. No. 9, Am. Soc. Agron: Madison, WI. Pp. 545-567.

[10] Demir ,A.O., A.T. Göksoy, H. Büyükcangaz, Z.M. Turan and E.S. Köksal. 2006. Deficit irrigation of sunflower (Helianthus annuus L.) in a sub-humid climate. Irrig. Sci. 24: 279–289.

[11] English, M.J. and S.J. Raja. 1996. Perspectives on deficit irrigation. Agric. Water Manage. 32: 1 –14.

[12] FAO.2004. Towards Improved Water Demand Management in the Near East. Twenty-Seventh FAO Regional Conference for the Near East Doha, Qatar, 13-17 March 2004.

[13] FAO.2006.Adopting Drought Mitigation Strategies in the Near East Region.Twenty-EighthFAO Regional Conference for the Near EastSana'a, Republic of Yemen, 12 -16 March 2006.

[14] Göksoy, A.T., A.O.Demir, Z.M. Turan and N. Dağüstü. 2004. Responses of sunflower (Helianthus annuus L.) to full and limited irrigation at different growth stages. Field Crops Res. 87: 167–178.

[15] Hesse, P.R. 1971. A textbook of soil chemical analysis. John Murray. London.

[16] Jackson, M.L. 1958. Soil chemical analysis prentice hall.Inc. Englewood Cliffs. N.J.

[17] Jalilian, J., S.A.M. Modarres-Sanavy, S.F. Saberali and K. Sadat-Asilan. 2012. Effects of the combination of beneficial microbes and nitrogen on sunflower seed yields and seed quality traits under different irrigation regimes. Field Crops Res. 127: 26–34.

[18] Khalaf, balasem jmaeel.2014.Importance of Agricultural investment in revealing food security. Baghdad college journal of extensive economical sciences, special issue of fifth scientific conference 2014-1-20.

[19] Mahdi,N.T. and T.K. Masood. 2017. Water Productivity Under Alternate Partial Furrow Irrigation And Organic Fertilization For Sunflower. Journal of Agriculture and Veterinary Science (IOSR-JAVS) Volume 10, Issue 8 Ver. II (August 2017), PP 01-06.

[20] Mahdi,N.T. and T.K. Masood. 2014.Effect of alternate partial furrow irrigation and organic matter on applid water depth and yield of sunflower .Diyala Agricultural Sciences Journal. 6(1):140-151 .PP 01-06.

[21] Masood, T.K. 2015. Irrigation methods and anti-transpiration as related to wheat and water productivity. The Iraqi J. Agric. Sci. 46(6):1016-1022

[22] Masood, T.K. 2017.Effect of irrigation methods on eater content distribution, water and corn productivity. The Iraqi J. Agric. Sci. 48(1): 178-184

[23] Mazin,F.Kh., Firas,W.A., A.Baqi,D.S,andWisam,M. 2018. Evaluation of Irrigation Water Quality Index for Tigris River and Pollution Levels of Heavy Metals in Baghdad.RJPBCS. 9(6):993.

[24] Olsen, S.R. and L.E. Sommers. 1982. Phosphorus in A.L Page, (Ed). Methods of Soil Analysis. Part2. Chemical and Microbiological Properties 2nd edition, Amer. Soc. of Agron.Inc. Soil Sci. Soc. Am. Inc. Madision. Wis. U.S.A.

[25] Richards, A. 1954.Diagnosis and improvement of saline and alkali soils agriculture. Hand book No.60.USDA Washington.

[26] Sanchez, M.C., R. Domingo and J.R. Castel. 2010. Review. Deficit irrigation in fruit trees and vines in Spain. Spanish J. Agric. Res. 8(S2): S5-S20.
[27] Savant, N.K. 1994.Simplified methelene blue method for rapid determination of Cation exchange capacity of mineral soils.Commum soil Sci. Plant Anal. 25(19-20): 3357-3364.
[28] Sepaskhah, A.R. and A.R. Parand. 2006. Effects of alternate furrow irrigation with supplemental every-furrow irrigation at different growth stages on the yield of maize (Zea mays L.). Plant prod. Sci. 9(4): 415-421 .
[29] Vazifedoust, M., J.C. Dam, R.A. Feddes and Feizi. 2008. Increasing water productivity of irrigated crops under limited water supply at field scale. Agric. Water Manag. 95: 89-102.