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Application of SWRT Technique to Reduce Stress and Water supply

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Abstract. The increasing of temperature with reduction of rainfall in dry season led to reduce water areas which cause reduce the cultivation areas in Iraq and other countries. Effecting of drought causing negative action on crop productivity. The irrigation water shortage will impact on crops by stress of water as well water decreasing will increase salt concentration that will increase the salt stress cause influence on yield of crops. This research will study of stress by decreasing of water (deficit irrigation) on production of okra crops with both use subsurface water retention techniques (SWRT) and without use SWRT, then estimation differences after that calculate affection of salt on crop. The research was done in Babylon governorate in Al-Hindiya Barrage. The treatments A1 used drip irrigation system with SWRT technique and used deficit irrigation in some times, while A2 used trickle irrigation without SWRT and use deficit irrigation in some times. The results of treatment A1 showed the amount of applying water reduced to 7% than A2. Whereas the number of irrigations of A1 equal to A2. The yield of crop of A1 was more than of A2 by 15 %. The actual yield of A1 was impacted by water stress and salt were 0.01 kg/m2 and 0.011 kg/m2 respectively. The actual yield of A2 which impacted by water stress and salt were 0.079 kg/m2 and 0.085 kg/m2, respectively. The yield in A1 with SWRT and without stress and the yield of A2 without SWRT and without stress showed percent of increasing of 2.3%. The SWRT technique helps to stress resistance and drought resistance by using okra of loam soil.

Keywords. okra, deficit irrigation, SWRT Surface Water Retention technology, water stress, salt stress.

1. Introduction

Using technologies in agriculture via installing subsurface water retention technique (SWRT) under crop's root zone assisting to conserve irrigation water into the root zone. The researcher used in his study the SWRT technology under the root zone of zucchini crops in Babylon province region. He is Utilizing the Surface drip irrigation in watering process and measuring the discharge and water depth and in finishing harvest the crop to obtain on yields. The yield was calculated for two treatment T1 (with SWRT) and T2 (without SWRT). T1 yielded 6.04 kg/m2 while T2 yielded 4.64 kg/m3. The value of water conserving in plot T1 was 16.7% less than of T2 [1]. The reduction in number of irrigations at T1 was 12 % less of T2. The salt stress sensor candidates and the root structural fabric area as a tissue harboring salt stress components were suggested. Significance of sodium excluding and vacuolar sodium sequestration in crop overall salinity tolerance was highlighted. [6] studied the drought stress which was an abiotic factor influencing growth and productions of crops and one of the most enhancing determining factors for corn growing and yield in Iran. To estimate the influence of water deficit stress on production and some of traits related to production of maize types, this study conducted by 3 levels of moisture disability stress as first factor was 50, 100 and 150mm evaporation from class A pan.
[5] mentioned that salts effect on agricultural production understanding sodium sensing and transfer in crops below salt stress will be of usefulness for breeding strongly salt-tolerant plant types.[7] study the influencing of salinity on resource utilize efficiency of wheat yield in middle zone of Iraq utilizing database of 270 growers. Stochastic border analysis was suggested for analysis resources utilize efficiency in watered wheat yield system with respect to electric conductivity (ECe) of soil. The conclusions were explained for using fertilizer and water were underused. The production of wheat raising among 13.9%, 8.5%, and 5 % in low, middle and, large soil salt concentration, respectively. Soil salinity decreasing by reclamation, semi-reclamation but un-reclamation needs to raise resources use efficiency and yield in the Iraqi watered wheat regions.[8] research of dry stress through vary growing stages of soybean on development process and production. This research was conducted in China with different irrigation treatments for two seasons at 2015 – 2016, two scarcity stress levels were mild and severe application in four growing stages for the study (initial, development, mid of season, end stage, and finally the harvest stage). The influence of scarcity stress at various stages on growth and production were predicted and compared. The production were impacted via the water deficit through the sensitive mid of season. Compared to the other treatment, production components and reduced dramatically with water deficits through mid and harvest season. The seed production losses of 73% and 82% per crop were tested in the crops exposed to scarcity stress through midseason.[2] studied the water control in drought periods in Iraq, calculated the evaporation and water consumption of crops (ETc) and calculate the amount of water per each value of ETc. The water duty considered from main determinants in design and operation of irrigation projects, in best irrigation schedule of crops and represent less the amount of water was supposed to fill the shortage which was getting from ETc to various the crops and growing stages. In research obtain on increasing of ETc and water duty because of increasing in temperature through the 2018 years. The ETc and water duty in trickle irrigation was the best from traditional irrigation equal or less than 50% from quantity of irrigation supplied by traditional irrigation. The drip irrigation as the best method to rationing and fill the scarcity.[3] stated on the new technique (SWRT) was developed to enhance water saving below surface soil in root zone. This technology was high of reducing in water irrigation losses. The study use SWRT was set up within the root zone during planting season of 2017 inside the greenhouse. The study work was done in Babylon Governorate. The treatments were utilized for comparing by utilizing drip irrigation system. The first treatment was utilized SWRT in T1, without SWRT and controlled watering in T2 and uncontrolled watering in T3. The water use efficiency (WUE) in T1, T2, and T3 were 2.43, 1.94 and 0.98 kg/m3, respectively. In search the using SWRT under the soil surface give increasing in the value of okra crop yield. They give conserving water and decrease the water losses via deep percolation.[4] in research the researchers are used SWRT technique to increase production and saving water with hot pepper in greenhouse and three treatments are done, the first treatment used SWRT (T1), second used organic matter (T2) and third used tillage

(T3). The study carries out in Babylon governorate in 2016-2017. The research concluded yield for three treatments. In study obtain on yield of T1 more than T2 and T3 by 19.4 and 26.9 % respectively.in your study will do on calculating stress with using SWRT technique and without using technique to obtain on less water use of crops with increase productivity.

2. Materials and methods: Field and Site of the Study

This study was done in Al-Hindiya Barrage area near Barrage/Abu Gharek road, in Hilla city (76 Km south of Baghdad city). The latitude 32 º 40’ 47.6" north and longitude 44º 15'55" east, the altitude: 30 m. Figure (1) explains the map for the site of the search field study. The water source by pond contact with farm ditch from lateral canal that field from Al- Kifil channel. Test the texture of soil samples of field study by laboratories of the faculty of Agriculture in Baghdad University. The goal of the analysis was to find soil texture and physical analysis of soil which included bulk density, estimation the soil texture, field capacity (F.C.), as well as permanent wilting point (P.W.P). The soil texture class of the research area was loam for depth ranges 0 to 60 cm. The F.C. was 33.14% by volume and P.W.P was 13.23% by volume. The amount of sand in soil texture was 79.2%, silt was 10% and clay 10.8%. The effective root zone (R.Z.) was 50 cm.

Figure 1. Map of the study work area.

3. Treatments and Crop Material

Two treatments were used: A1 was utilizing SWRT installed below soil surface and second A2 plot was installed without SWRT but controlling in watering. The total area used for research purposes was 63.75 m2. The sheet of SWRT was 51 m length and width 47.1 cm width, shaped as U with aspect ratio 2:1 (width to height), set up under the soil surface and 45 cm under root zone of thickness 160 µm. The setup process of the SWRT was done by hand as explain in Figure (2). Okra (Abelmoschus esculentus L.) was seeded at 20 cm between each plant of plots A1 and A2. The distance between emitters was 20 cm in A1 and A2 plots. The growing date was begun in January and ended date was finish in July (seven-month time period). The length, width and height of greenhouse were 51 m, 9 m and 3 m, respectively.

The total area of greenhouses was 460 m2. The average flow rate of each dripper was 35 cm3/min for treatments(A1) and (A2).

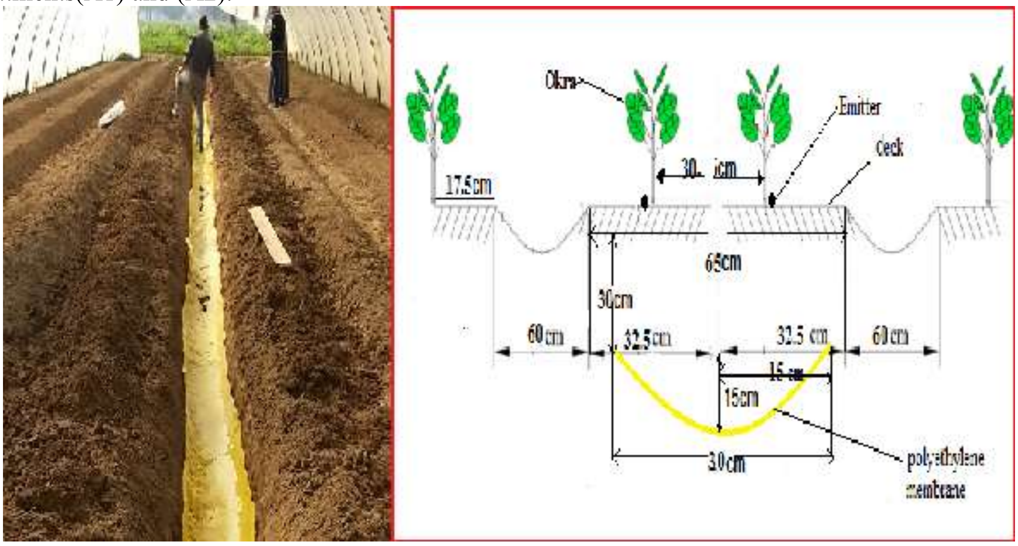

Figure 2. Set up process of the polyethylene membrane under the soil surface.

4. Yield index

The summation of production from started harvest till end the harvest pickings crop's production was utilize as a total production of fruit. The yield unit wrote as kg/m^2 according to the [10]:

$$\text{Yield} = \text{total weight of crops (kg)/ total area of crops (m}^2\text{)} \quad (1)$$

5. Coefficient of Water Stress (KS)

The influences of soil water stress on plant evapotranspiration are described via decreasing the value for the plant coefficient. This is accomplished via multiplying the crop coefficient by the coefficient of water stress symbolizes as Ks according to FAO 56. Moisture content in the root zone can be expressed via root zone depletion symbolized (Dr).

At field capacity (F.C), the root zone depletion is zero (Dr). When soil moisture (θ) is extracted via crop evapotranspiration, the depletion raises, and stress will be caused when Dr becomes equal to readily available water (RAW). After the root zone depletion rising more than RAW (the water moisture drops below the threshold θ), the root zone depletion is maximum, and the crop evapotranspiration begins to decrease as shown in Figure (3).

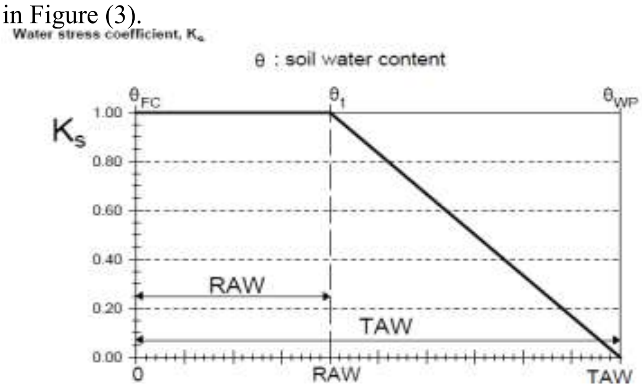

Figure 3. shows the Influence of water stress on crop evapotranspiration (ETc) as show in [9].

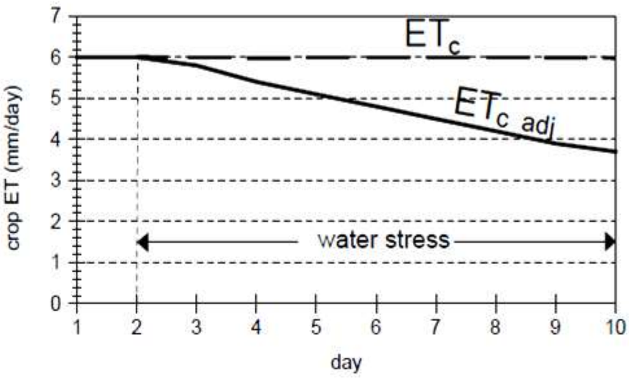

Figure 4. Influence of water stress on crop evapotranspiration (ETc).

$$ks = \frac{TAW-Dr}{TAW-RAW} = \frac{TAW-Dr}{(1-P)TAW} \quad (2)$$

Ks: dimensionless transpiration reducing factor dependent on available soil moisture was between 0 – 1
Dr: root zone depletion measured by (mm)
TAW: total available soil moisture in the root zone measured by (mm).
P: percent of TAW that a crop can elicitation from the root zone without suffer of moisture stress. The calculation of Ks, the adjusted crop evapotranspiration symbolize ETc adj is calculate by:

$$ETc\ adj = (Ks\ Kcb + Ke)\ ETo \quad (3)$$

For soil moisture determine conditions, Ks < 1. If no soil water stress will Ks = 1.
Ks describe the influence of water stress on ETc. Where the single crop coefficient is utilized, the influence of water stress is incorporated into (Kcb+Ke) or Kc as:

$$ETc\ adj = Ks\ Kc\ ETo \quad (4)$$

When the root zone depletion is less than RAW, Ks = 1.

6. Soil salinity

Influence of salts in the soil water cause decreasing evapotranspiration by reducing the soil moisture than available of crops. The crops need to force to Soil salinity because of it has an attraction as additional force. The crops are required need to force to extract water from a salty soil. some salts cause toxic impacts to crops and can decrease crop metabolism and growing. The reducing in ET, crop growing and yield because of salt of soil water [10]. Salt concentration various as the soil water moisture changes, salt of soil is tested based on the electrical conductivity (EC) of the saturation extract of the soil (ECe). ECe is calculated by deci Siemens / meter symbolize dS /m. Below best conditions, plant productions remain at potential ranges until a special, threshold ECe of the saturating soil water extract is attain. If the ECe increasing the yield reducing linearly. Percent reducing in yield per dS/m raising in ECe [11].

7. The relation between yield and salinity

The predicting of reducing in crop yield because of salinity was described in the [9].
For conditions where ECe > ECe threshold where:

$$Ya/Ym = 1 - (ECe - ECe\ threshold) * b/100 \quad (5)$$

Ya: actual crop yield, Ym: maximum crop yield when ECe < ECe threshold, ECe: mean electrical conductivity of the saturation extract for the root zone (dS /m), ECe threshold electrical conductivity of the saturation extract at the threshold of ECe
When crop yield first reduces below Ym (dS /m), b: reduction in yield per increase in ECe [%/(dS/ m)]
Values for ECe threshold and b have been provided; Salinity-yield data in the [10] and [11]

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8. The relation between yield and moisture stress

A simple, linear crop-water production function was introduced in the Allen 1986, to predict the reduction in crop yield when crop stress was caused by scarcity of soil water [9]:

$$\left(1-\frac{\mathrm{Ya}}{\mathrm{Ym}}\right)=\mathrm{ky}\left(1-\frac{\mathrm{ETc\ adj}}{\mathrm{ETc}}\right) \quad (6)$$

Where: Ky a yield response factor [-].
ETc adj adjusted crop evapotranspiration [mm /day].
ETc crop evapotranspiration for standard conditions (no water stress) [mm /day].
Ky is a factor that describes the reduction in relative yield according to the reduction in ETc caused by soil water shortage. Values for Ky for individual growth periods and for the complete growth season have been included in the study of Allen 1986.

9. Combined Salinity-et Reduction Relationship

9.1. No water stress (Dr < RAW)

When salinity stress occurs without water stress, Eqs. 89 and 90 [9] can be combined and solved for an equivalent Ks, where Ks = ETc adj/ETc:

$$\mathrm{ks}=1-\frac{\mathrm{b}}{\mathrm{ky}*100}(\mathrm{ECe}-\mathrm{ECe\ threshold}) \quad (7)$$

9.2. With water stress (Dr > RAW)

When soil water stress occurs in addition to salinity stress, Eqs. 84 in Chapter 8 and eqs. 89 and 90[9] are combined to yield:

$$\mathrm{ks}=1-\frac{\mathrm{b}}{\mathrm{ky}*100}(\mathrm{ECe}-\mathrm{ECe\ threshold})\left(\frac{\mathrm{TAW}-\mathrm{Dr}}{TAW-RAW}\right) \quad (8)$$

For conditions when ECe > ECe threshold and Dr > RAW. Figure 44 shows the impact of salinity reduction on Ks as salinity increases. Note that the approach presumes that RAW (and p) does not change with increasing salinity. This may or may not be a good assumption for some crops.

10. The Results and The Discussions : Irrigation interval and Depth of supplying Water

The irrigation schedule was carrying out for treatments A1 and A2 during the season of growth when the soil moisture depletion (smd) was 50 percent from the available water (AW) [9]. The applied water depth in month and number of irrigations at month (irrigation interval) of okra crop through the growing season for treatments A1 and A2 were shown in Table 1.

Table1. Month, depth of supplying water and irrigation interval of okra in treatment A1 and A2.

Month	Depth of supplying water A1 (mm)	Irrigation interval A1 (day)	Depth of supplying water A2 (mm)	Irrigation interval A2 (day)
Jan.	22	2	24	2
Feb.	11	2	18	2
Mar.	65	5	76	5
April	59	4	60	4
May	92	4	92	4
June	147	4	157	4
July	48	2	51	2
Total	444	23	478	23

11. Yield and reduction of yield by water stress and salt stress of okra Crop

The yield of okra crops was calculating by the Eq. 1 for treatments A1 (use SWRT) and A2 (without SWRT):1.08 kg/m2 and 0.92 kg/m2, respectively. The computing of the yield for A1 was larger than that in A2 by 15 %. This increasing in yield of okra crop in A1 was due to the water and nutrient were retention in root zone by SWRT that used by the plant by capillary rise way in water soil. Fig.5 explain the yield of okra crops for A1 and A2.

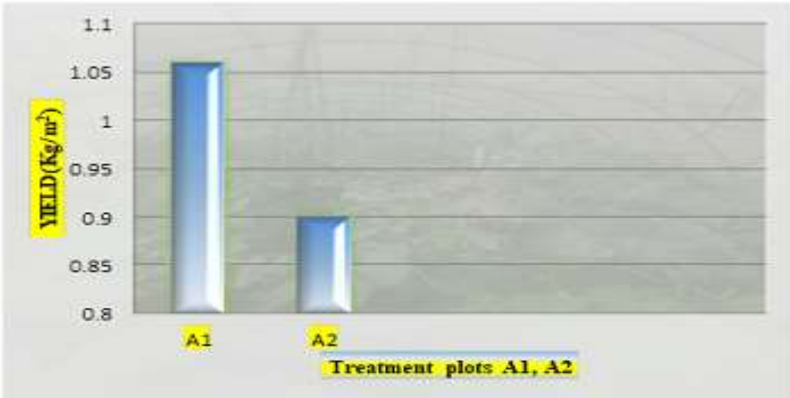

Figure 5. Yield values for treatments plots A1and A2 of okra in the growing season.

12. The Stress

The stress from water shortage and salt affection depending on eqs.5-8, Allen, 1998. as shown below:
The using SWRT treatment plot (A1) the SWRT sheet membrane was enhanced the plant strength to drought and salinity by conservation of water under surface soil through root zone.
When Ks (stress A1)= 0.77, Ks (salt A1)= 0.99, and Ks total= Ks from stress A1* Ks from salt or 0.76. from Eq. 6 result
1-0.025/ym=1.26 (1-0.76) Ym=0.036
The delta Y= 0.01 kg/m2 by influence of water stress.
Difference ym= 0.011kg/m2 by influence of salt stress.
The yield at optimal condition must =1.08+0.01 from water stress + 0.011 from salt stress = 1.11kg/m2
Ks from salt A2=0.99 ds/m as the same the A1 because the soil same in two treatment, But the water stress of A2 more than A1 because do not use SWRT to save water.
Yield (Ya) = 0.92 kg/m2
d Y from affection of water stress =0.079 kg/m2 , d Y from affection of salt stress =0.085 kg/m2
The optimal yield without stress of water and salinity =0.92+0.079+0.085=1.084 kg/m2
Table (2), Table (3) and Table (4) show the relationships among the stress coefficient with yield and crop evaporation (ETc).
Table.2 shows effect the yield production from the stress of water and stress of salt as relation by coefficient of stress of water and coefficient of stress from salinity with actual yield (Ya) and maximum yield (Ym).

Table 2. coefficient of stress of water and coefficient of stress from salinity

Ks stress	Ks salt	Ks total	Ya	Ym	d Y
1.00	0.99	0.99	0.024	0.024	0.000
0.83	0.99	0.82	0.024	0.031	0.007
1.00	0.99	0.99	0.032	0.032	0.000
0.83	0.99	0.82	0.025	0.032	0.007
1.00	0.99	0.99	0.038	0.038	0.000
1.00	0.99	0.99	0.038	0.038	0.000
0.77	0.99	0.76	0.053	0.076	0.023
1.00	0.99	0.99	0.034	0.034	0.000
1.00	0.99	0.99	0.055	0.056	0.001
0.96	0.99	0.95	0.037	0.039	0.002
0.71	0.99	0.70	0.023	0.037	0.014
1.00	0.99	0.99	0.031	0.031	0.000
1.00	0.99	0.99	0.031	0.031	0.000
0.81	0.99	0.80	0.036	0.048	0.012
0.64	0.99	0.634	0.016	0.030	0.014
1.00	0.99	0.99	0.038	0.038	0.000
0.93	0.99	0.92	0.019	0.021	0.002
0.78	0.99	0.99	0.008	0.024	0.000
				Sum	0.085

Table 3. Stress and variation yield due to reducing irrigation of okra of treatment plot A1.

Date	ETc (mm/day)	R.Z (mm)	F.C (%) by vol.	P.W.P (%) by vol.	F.C (mm)	P.W.P (mm)	TAW (mm)	RAW (mm)	Dri (mm)	TAW-Dri	TAW-RAW	KS	ETc adj.	ky	N*	-1N	Ky* (N-1)	Z**	Ya (Kg/m2)	Ym (Kg/m2)
Jun -12	4.62	305	33.14	13.23	101.08	40.35	60.73	39.47	24.89	35.84	21.25	1	4.62	1.26	1	0	0	1	0.06	0.06
Jun -14	6.43	305	33.14	13.23	101.08	40.35	60.73	39.47	37.76	22.97	21.25	1	6.43	1.26	1	0	0	1	0.045	0.045
Jun -16	3.36	310	33.14	13.23	102.73	41.01	61.72	40.12	45.02	16.7	21.6	0.77	2.6	1.26	0.77	0.23	0.28	0.71	0.025	0.035
Jun -18	3.69	310	33.14	13.23	102.73	41.01	61.72	40.12	24.1	37.62	21.6	1	3.69	1.26	1	0	0	1	0.04	0.04

*N=ETc adj./ETc **Z=1-(Ky*(1-N)), *** Ym=Ya/z from Eq. $(1-\frac{Ya}{Ym}) = Ky(1-\frac{ETc}{ETc})$ Δy =0.01, Old yield =1.08
New yield =1.08+0.01=1.09kg/m2 , With salt effect became New yield =1.08+0.011=1.091kg/m2
The yield no effect of T1 there the reduction was 0.01 kg/m2 but in T2 was reduction in yield more than T1 there the reduction was 0.079kg/m2. The SWRT membrane helped on save water and endured the plant to stress in treatment plot T1 longer than treatment plot T1. This notes added to SWRT new point to use in light and medium desert soil.
Table (4) show stress and variation yield due to reduction irrigation of okra of plot A2
*N=ETc adj. /ETc **Z=1-(Ky*(1-N)), *** Ym=Ya/z from Eq. $(1-\frac{Ya}{Ym}) = Ky(1-\frac{ETc}{ETc})$ Ky=1.26 Δy =0.079 Old yield =0.92 kg/m2
New yield =0.92+0.079=0.999=1kg/m2 With salt effect New yield =0.92+0.085=1.005=1kg/m2

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Table 4. Stress and variation yield due to reducing irrigation of okra of treatment plot A2.

Date	ETc mm/day	R.Z mm	F.C % by vol.	P.W.P % by vol.	F.C mm	P.W.P mm	TAW mm	RAW mm	Dri mm	TAW-Dri	TAW -RAW	KS	ETc adj.	N *	1-N	Ky* (1-N)	Z**	Ya Kg/m2	Ym ***Kg/m2
7-May	3.82	235	33.14	13.23	77.88	31.09	46.79	30.41	27.83	18.96	16.38	1	3.82	1	0	0	1	0.024	0.024
9-May	2.82	245	33.14	13.23	81.19	32.41	48.78	31.71	34.6	14.18	17.07	0.83	2.34	0.83	0.17	0.21	0.79	0.024	0.031
12-May	4.17	250	33.14	13.23	82.85	33.08	49.78	32.35	19.47	30.31	17.42	1	4.17	1	0	0	1	0.032	0.032
15-May	5.52	260	33.14	13.23	86.16	34.4	51.77	33.65	36.77	15	18.12	0.83	4.57	0.83	0.17	0.22	0.78	0.025	0.031
19-May	4.23	270	33.14	13.23	89.48	35.72	53.76	34.94	19.82	33.94	18.81	1	4.23	1	0	0	1	0.038	0.038
5-Jun	6.52	285	33.14	13.23	94.45	37.71	56.74	36.88	37.14	19.6	19.86	1	6.52	1	0	0	1	0.038	0.038
7-Jun	2.15	285	33.14	13.23	94.45	37.71	56.74	36.88	41.43	15.31	19.86	0.77	1.66	0.77	0.23	0.29	0.71	0.053	0.075
10-Jun	4.62	285	33.14	13.23	94.45	37.71	56.74	36.88	17.81	38.93	19.86	1	4.62	1	0	0	1	0.034	0.034
12-Jun	5.15	305	33.14	13.23	101.08	40.35	60.73	39.47	28.85	31.88	21.25	1	5.15	1	0	0	1	0.055	0.055
14-Jun	5.83	305	33.14	13.23	101.08	40.35	60.73	39.47	40.33	20.4	21.25	0.96	5.59	0.96	0.04	0.05	0.95	0.037	0.039
16-Jun	2.76	310	33.14	13.23	102.73	41.01	61.72	40.12	46.49	15.23	21.6	0.71	1.95	0.71	0.29	0.37	0.63	0.023	0.037
18-Jun	3.34	310	33.14	13.23	102.73	41.01	61.72	40.12	28.85	32.87	21.6	1	3.34	1	0	0	1	0.031	0.031
20-Jun	3.91	315	33.14	13.23	104.39	41.67	62.72	40.77	37.13	25.59	21.95	1	3.91	1	0	0	1	0.031	0.031
22-Jun	3.96	320	33.14	13.23	106.05	42.34	63.71	41.41	45.59	18.12	22.3	0.81	3.22	0.81	0.19	0.24	0.76	0.036	0.047
24-Jun	1.91	320	33.14	13.23	106.05	42.34	63.71	41.41	49.42	14.29	22.3	0.64	1.22	0.64	0.36	0.45	0.55	0.016	0.029
26-Jun	4.26	325	33.14	13.23	107.71	43	64.71	42.06	8.86	55.85	22.65	1	4.26	1	0	0	1	0.038	0.038
4-Jul	3.27	330	33.14	13.23	109.36	43.66	65.7	42.71	44.3	21.4	23	0.93	3.04	0.93	0.07	0.09	0.91	0.019	0.021
7-Jul	1.12	330	33.14	13.23	109.36	43.66	65.7	42.71	47.66	18.04	23	0.78	0.88	0.78	0.22	0.27	0.73	0.008	0.011

Figure 6 shows Stress from affection of deficit water and Fig.7 shows Stress from affection of salt.

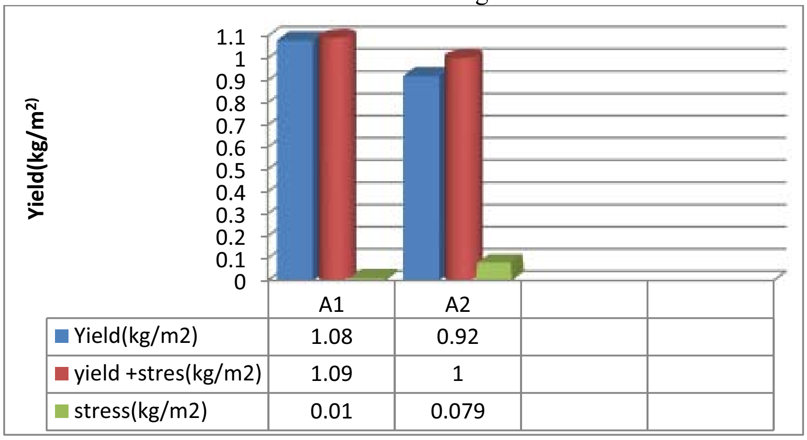

Figure 6. Stress of water in treatment plots A1and A2

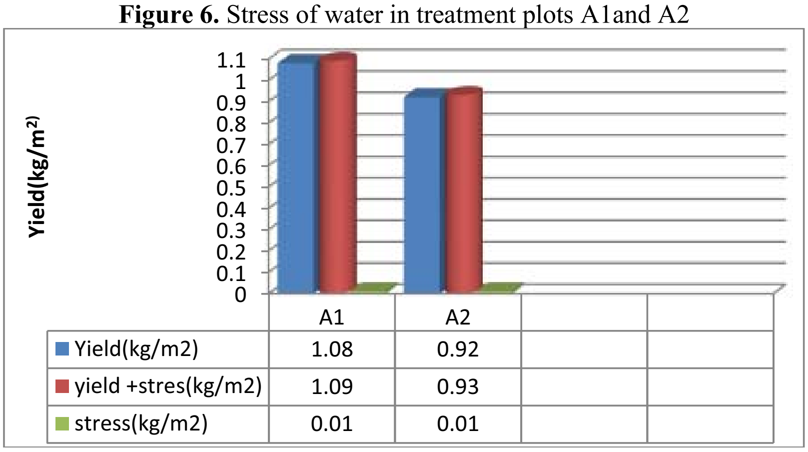

Figure 7. Stress of salt in treatment plots A1and A2

Stress from affection of salt. Eq.7 [9]
Ks= (1-9/(1.26*100) ×(3.14 ds/m-3ds/m))=0.99
Ks = ETc/Eta, when the ETc = evapotranspiration without effect, Eta= evapotranspiration with effect [9]
From eq. 6 obtain on Ym=1.09
Difference of yield will be 0.01kg/m2 was Reducing in in yield but is little [9]

13. Conclusions

Using the SWRT technology under the root zone of okra helped on conserving the water and nutrient and helped on reducing the number of irrigation and quantity of applied water and it is giving maximum of okra crop yield values:

- In treatment A1 the quantity of applying water reducing to 7% from A2. Whereas the number of irrigations of A1 equal to A2.
- The yield of okra crop in treatment A1 was larger than treatment plot A2 by 15%.
- The SWRT technique was conserved water and assisted on raising the yield of crop.
- impacting of water stress on yield which was 0.01 kg/m^2 and impacting of yield by salt was 0.011 kg/m^2 which reducing The yield of A1 was 1.08 kg/m^2 while it is yield with difference of stress must be 1.11 kg/m^2 from sum yield was effect with stress of water and stress of salt. impacting of water stress on yield which was 0.079 kg/m^2 and impacting of yield by salt was 0.085 kg/m^2 which reducing

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The yield of A2 was 0.92 kg/m^2 while it is yield with difference of stress must be 1.084 kg/m^2 from sum yield was effect with stress of water and stress of salt. 1.084 kg/m^2.

- The percent of increasing of yield with using SWRT technology of A1 with A2 which without SWRT under effecting stress of water and salt was 15%.
- The percent of increasing of yield with using SWRT technology of A1 with A2 which without SWRT without stress was 2.3%.

The utilization of SWRT technique assists to stress resistance and dry resistance by using okra crop in loam and medium soil.

14. Recommendations
For further studies, the following recommendations were suggested
- Utilization SWRT in light texture soils in fields region with all season for improving the yield and water conservation to strength of drought.
- Using deficit irrigation with SWRT to control drought
- Utilizing the SWRT technology with wheat, barley and rice crops.

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Nomenclature
SWRT= subsurface water retention technology.
A1, A2 = treatment plots.

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