WATER RETAINER

TEST RESULTS, TESTIMONIALS

KEEPING THE SOIL MOIST FOR LONGER

Water&Soil Ltd. Lipthay u. 9. Budapest 1027 www.waterandsoil.eu Tel: +36309147134 E-mal: info@waterandsoil.eu

Contents:

1. Summary

1.1. National Institute of Agricultural Research, Morocco

1.1.1. Orange, Tadla (2018)

Conclusion

The results obtained showed that the compared combinations of water regimes and the Water Retainer doses have a significant effect on the growth and development of the "Morocco late". The evolution of the soil water reserve on the depth 0 -100 cm highlights the positive effect of Water Retainer by reducing the drawdown of the water reserve.

Material and methods

The study consists of comparing two doses of *Water Retainer* (d1 and d2) associated with two water regimes (R1 and R2). A control water regime (R0) without application of the product will be considered. The application of the product Water Retainer will be renewed every 45 days in citrus fruit and applied once before emergence in case of annual crops. Application of water regimes and doses of Water Retainer will be associated with observations on the soil and the plant in order to study the interaction of water regime and Water Retainer throughout the vegetative growth phase and fruit yield elaboration. The treatments studied are as follows:

a- doses of Water Retainer:

d1 : 2 ml/m^2

d2 : 4 ml/m^2

These two dosages will be applied at startup. From the second application the dosages become 1 and 2 ml / m^2 for d1 and d2 respectively.

b- Water regime:

R0 : 100% ETc (control), R1 : 70% ETc, R2 : 50% ETc

The experimental protocol is a split plot. The water regime factor will be assigned to the main units while the dosage of the Water Retainer is assigned to the secondary units.

Parameters to be monitored are:

Soil: soil moisture using PR2 probes. Access tubes are installed in the areas treated and not treated by the product.

Citrus tree: Marking of shoots at each treatment and monitoring of the following parameters:

- Flowering rate, fruit set and the physiological fall of fruits
- In early July, fruits will be marked to follow the diameter of the fruits.

At harvest, the yield per tree, the juice content, the size and the citric acid content are to be measured. (Harvest is expected in May 2019.)

Physical and chemical properties of the experimental field soil

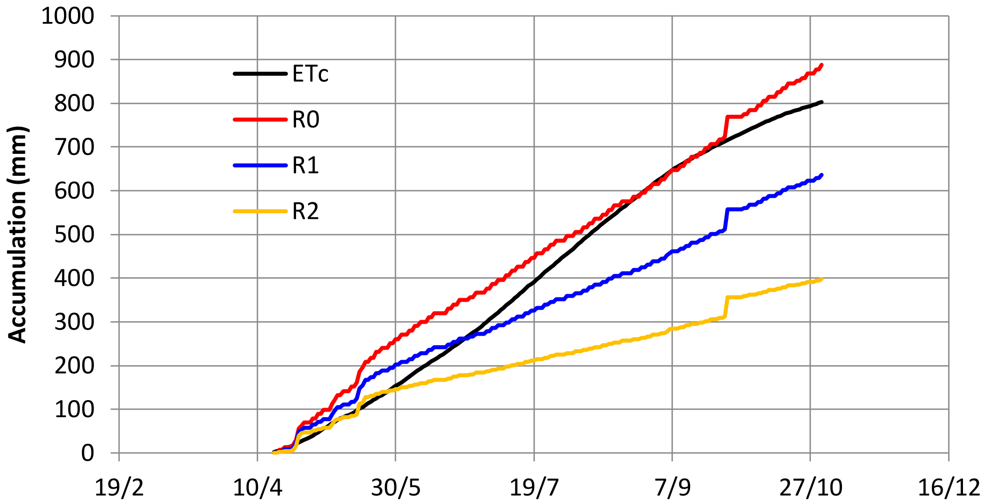
Properties	Soil layer (cm)		
	0 – 30	30 – 60	60 - 120
Clay (%)	27.7	43.3	47.4
Fine silt (%)	3.9	15.9	16.6
Coarse silt (%)	49.2	2.8	19.3
Fine sand (%)	12.3	11.2	11.3
Coarse sand (%)	5.7	27.6	6.1
Organic matter (%)	1.91	1.08	1.08
pH	7.97	8.22	8.43
Electrical conductivity (mS/cm)	1.03	0.45	0.53
Field capacity Fc (%)	27	28	27
Wilting point Wp (%)	16.	17	16.
Bulk density	1.38	1.46	1.57

3

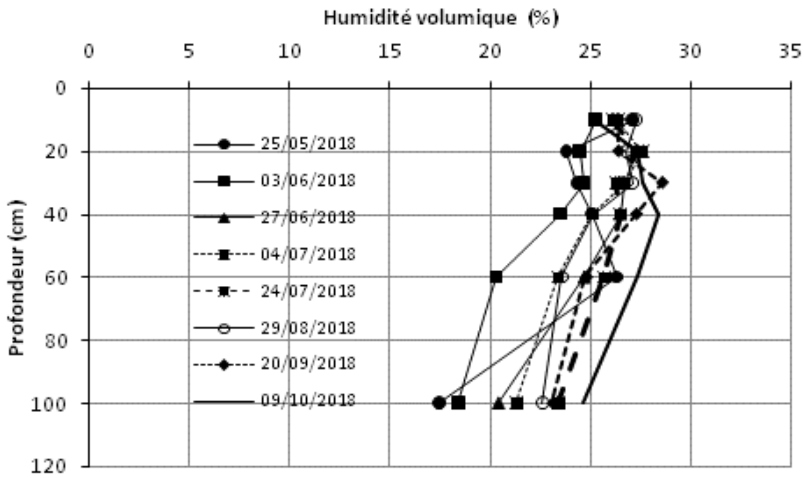
Irrigations number and water amount applied for each treatment

Stage	Duration of stage (day)	Irrigation number	Applied volume (mm)		
			R0	R1	R2
Flowering	17	2	13.3	8.8	4.6
Fruit set	22	10	89.6	59.7	31.3
physiological drop of fruits	47	18	178.7	118.9	62.4
Summer growth of fruit diameter	123	49	471.4	313.8	164.7

Cumulative values of ETc, and water supplies (irrigation+ rain) per water treatment

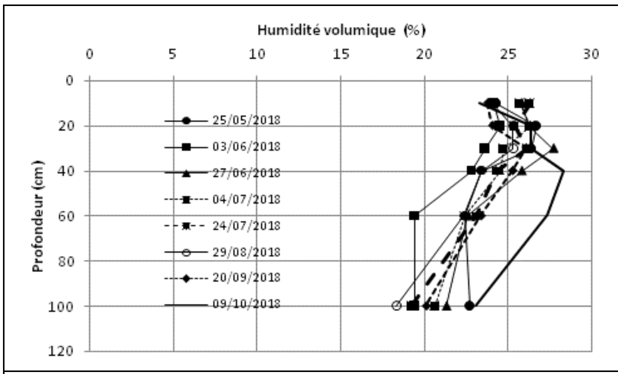


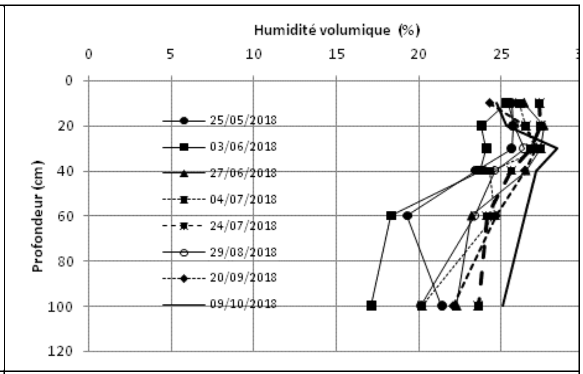
Soil moisture profile under different combinations of water regime and Water Retainer



Soil moisture profile under the control regime R0

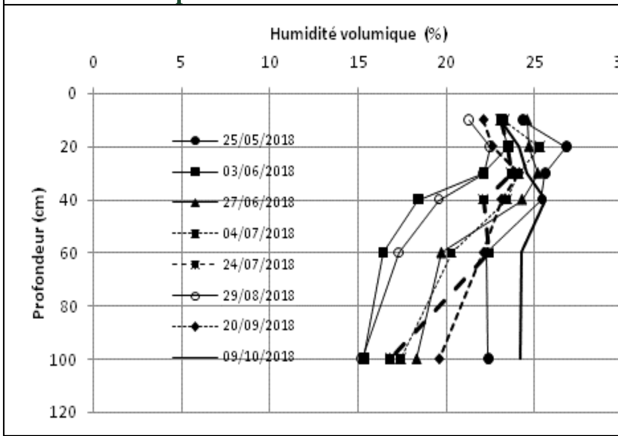
4

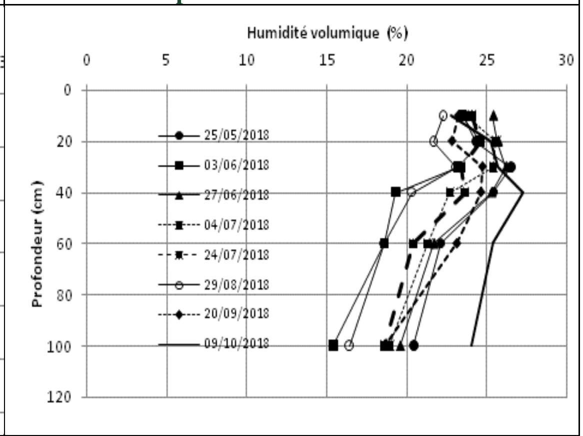




Soil moisture profile under R1d1

Soil moisture profile under R1d2

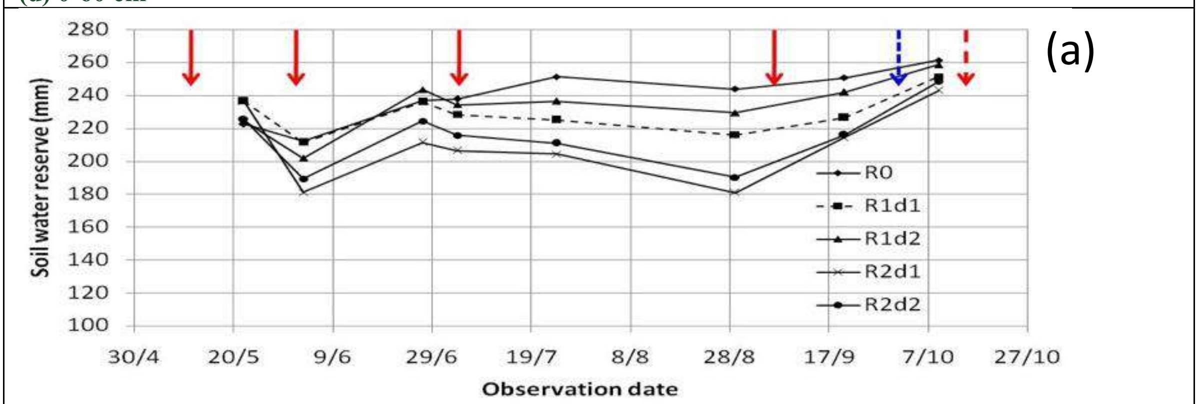


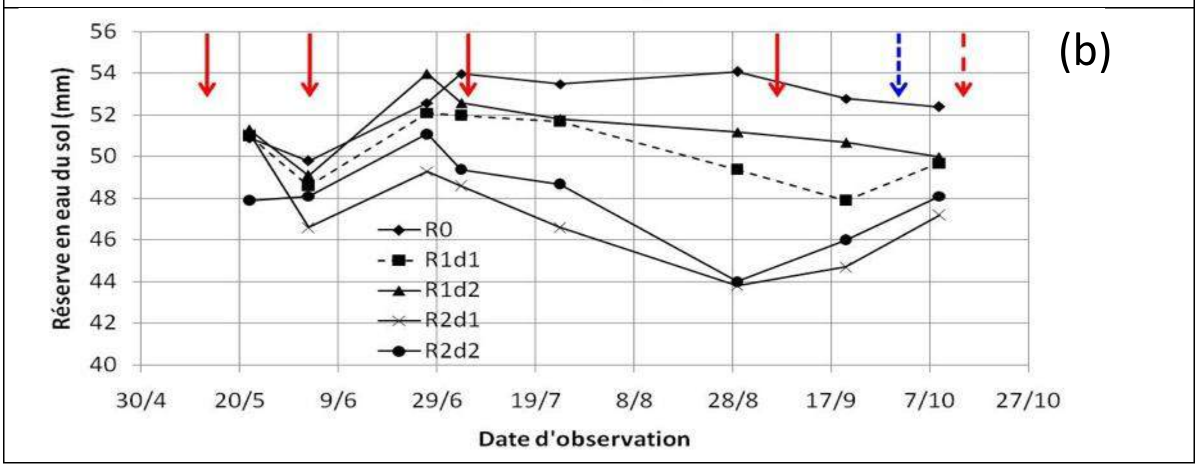


Soil moisture profile under R2d1

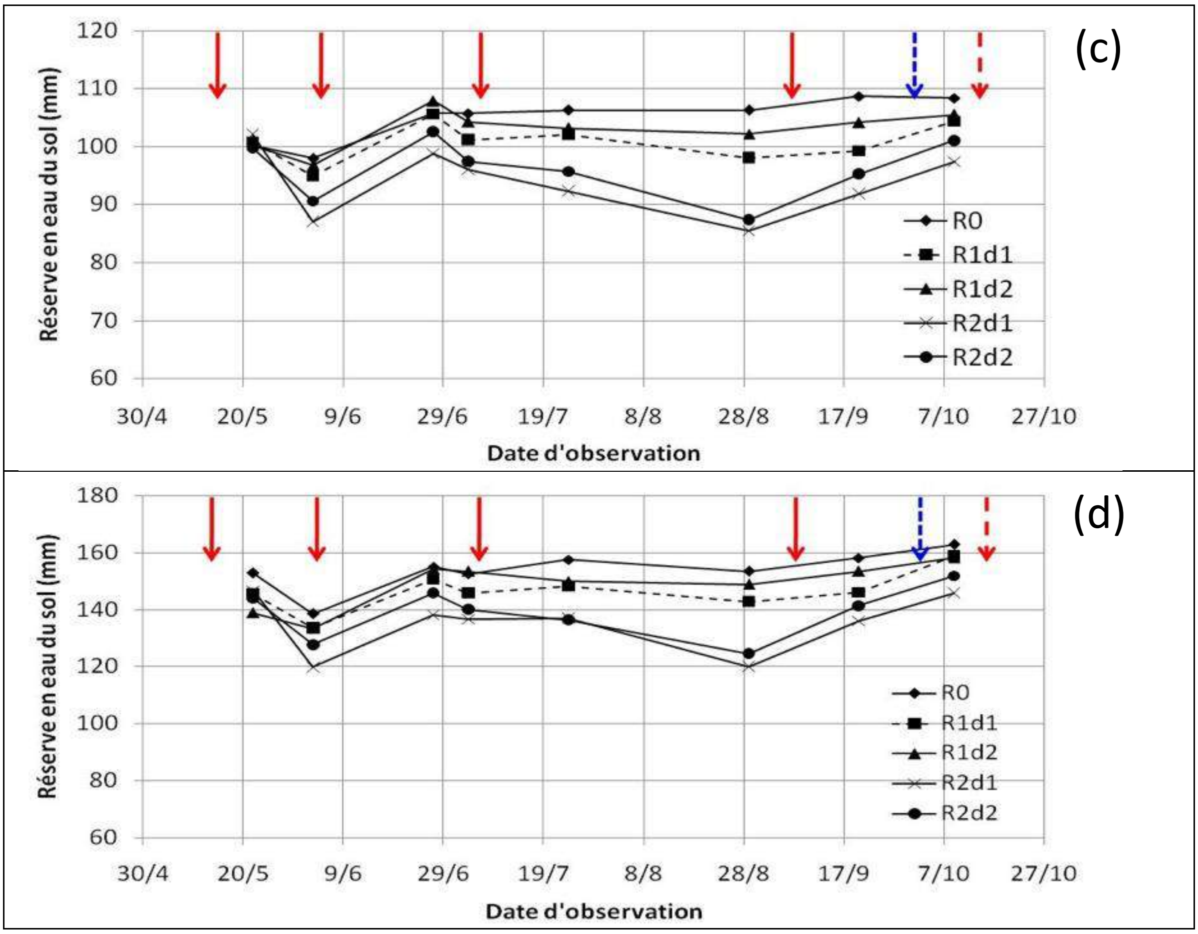
Soil moisture profile under R2d2

Soil water reserve evolution on (a) 0-100 cm, (b) 0-20 cm, (c) 0-40 cm and (d) 0-60 cm





5

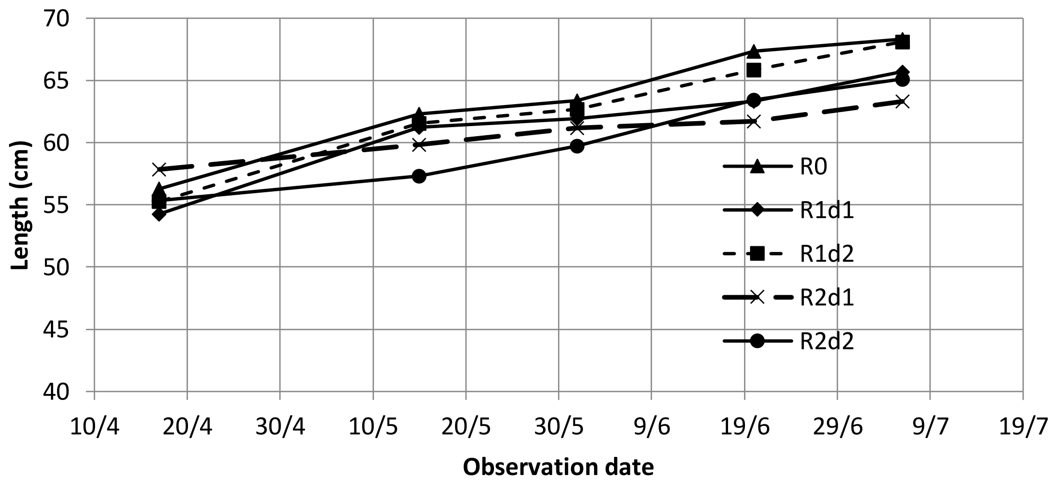


Flowering rate, fruit set rate, physiological drop rate of fruits per treatment

Water regime	*Water Retainer* dose	Flowering rate	Fruit set rate	Physiological drop rate
R0	-	0.78 ± 0.056 a*	0.74 ±0.12 a*	0.47 ±0.13 a*
R1	**d1**	0.75 ±0.078 a	0.80 ±0.08 a	0.59 ±0.15 b
	d2	0.76 ±0.051 a	0.77 ±0.16 a	0.48 ±0.12 a
R2	**d1**	0.77 ±0.070 a	0.80 ±0.19 a	0.72 ±0.14 c
	d2	0.75 ±0.067 a	0.71 ±0.14 a	0.61 ±0.19 b

***:** The averages of the same column followed by the same letter are not statistically different according to the Fisher test (threshold 5% or 1%)

Evolution of the length of shoots according to the water regime and the dose of Water Retainer



1.1.2. Silage corn, Garb (2018)

Conclusion

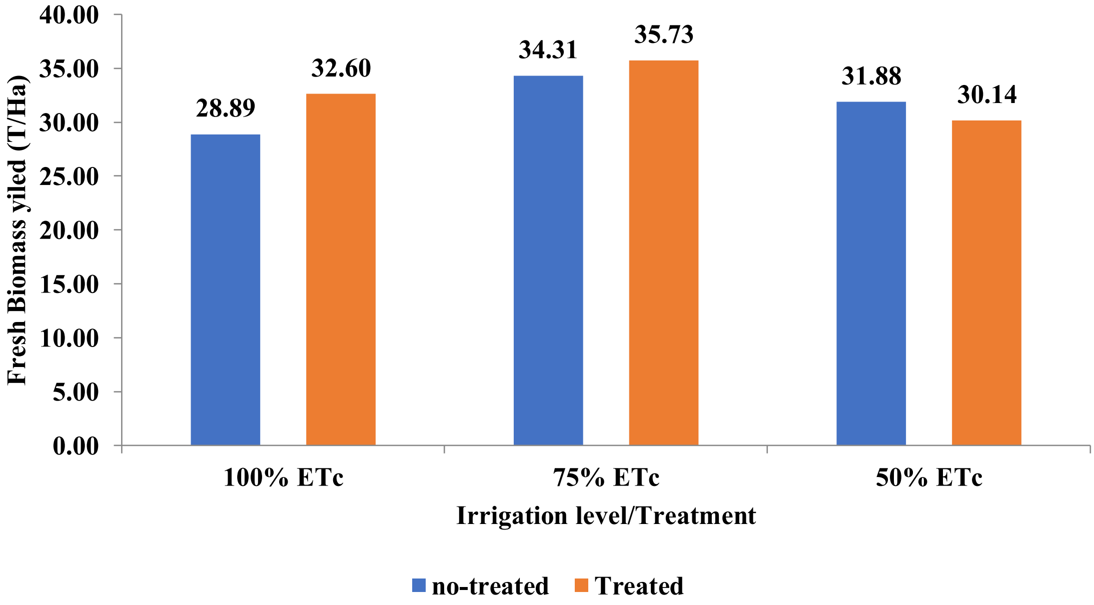
WSWR increased soil moisture, plant height, shoot and ears weight, ear to shoot ration fresh biomass yield and water use efficiency under different irrigation regimes. Thus suggested that using WSWR was recommended under deficit irrigation regime (75% ETc), for saving water and increasing corn silage production.

Overall, considering the water scarcity situation in Morocco and importance of silage corn as a forage plant, application of WSWR can be useful to save more water that leads to produce more yields.

Material and methods

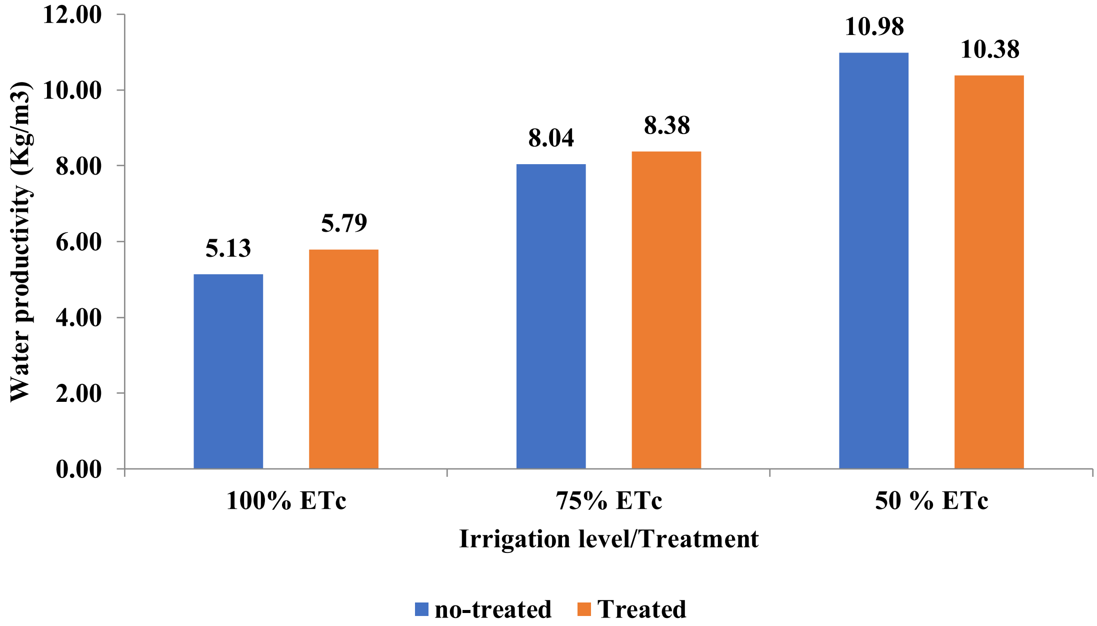
The experiment was carried out in in the experimental farm Sidi Allal Tazi of the Regional Agricultural Research Center (RARC of Kenitra (INRA Morocco) located north of Kenitra city, during Jun-October 2018. The silage corn hybrid "Monastir" was used in this study. The experiment was arranged in spilt-plot with 4 replicates by following randomized complete blocks (RCBD) design, with main factorial irrigation regime in main plots with three levels (well-irrigated control at 100% ET_c, deficit irrigated (DI) at 75% ETc and 50% ET_c, and the Water Retainer (WSWR) treatment is the second factor in sub-plot with two levels (Non-Treated 0ml/l and Treated 2ml of WSWR /m^2) applied to soil surface after seed sowing. Treated sub-plots have been received 4.8L of diluted WSWR per plot. Each sub-plot included 8 rows with spacing of 0.50 m and length of 6 m (24m). The experimental layout was presented in figure n°1. The soil was clay soil type locally named Dehs.

Fresh biomass yield (t/ha) of treated and no-treated plots under 100%, 75% and 50%ETc irrigation regimes.



7

Water productivity (fresh weight FW basis) of treated and no-treated plots under 100%, 75% and 50%ETc irrigation regimes



1.1.3. Olive and date palm, Marrakech (2018)

Conclusion

The obtained data shows that soil humidity increased with soil depth for all irrigation regimes. The Water Retainer has a great impact in retaining soil humidity in case of deficit irrigation. The effect of Water Retainer on the vegetative growth shows a significant positive impact of Water Retainer, used as soil spray, on the shoot growth in case of two deficit irrigations (75% ETc and 50% ETc). High shoot growth was obtained with dilutions of 2ml/m and 4ml/m under the first and the second irrigation regimes respectively.

Material and methods

The experiment was conducted in Sâada Research Station of INRA Marrakech. The characteristics of the experimental plot are as follow:

Olive:

- Plantation date: December 2010
- Plantation density: 156 trees per Ha (8m x 8 m);
- Variety: Menara
- Drip irrigation equipment: May 2018 (switched from flood irrigation which was applied since 2010). This causes extreme stress for the trees.

Date palm:

- Plantation date: December 2015
- Plantation density: 123 trees per Ha (9m x 9 m);
- Variety: Sedrate

Drip irrigation equipment: installed in 2017.

Drip irrigation is the irrigation technique used in this experiment and the amount of water applied is controlled by the number of drippers and duration of irrigation. We studied 3 irrigation regimes:

- Full irrigation: 100 % ETC (four drippers of 25 liters per hour per tree)

- Moderate deficit irrigation: 75 % ETC (three drippers of 25 liters per hour per tree)
- Severe deficit irrigation: 50 % ETC (two drippers of 25 liters per hour per tree)

The amount of applied water was calculated by estimating tree evaporation (ETc).
Two Water retainer's dilutions were tested and compared to the control:

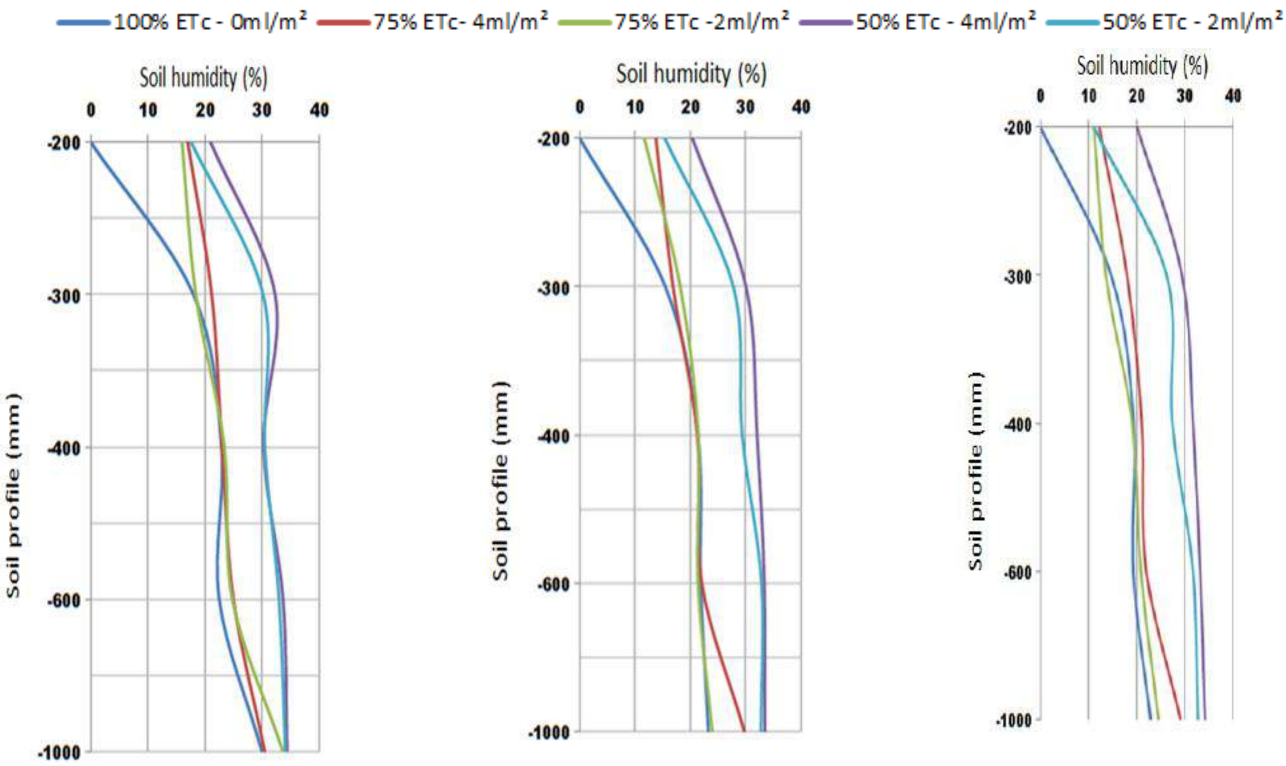
- 2 ml of the product per square meter
- 4 ml of product per square meter
- Control (only water= 0 ml/ m).

In Total 9 treatments were studied: Irrigation regimes (0%, 75% and 100% ETC) x Water Retainer dilutions (0, 2 and 4ml/m) = 3 x 3 =9. The frequency of renewal of the application of this product is 45 days.

Olive:

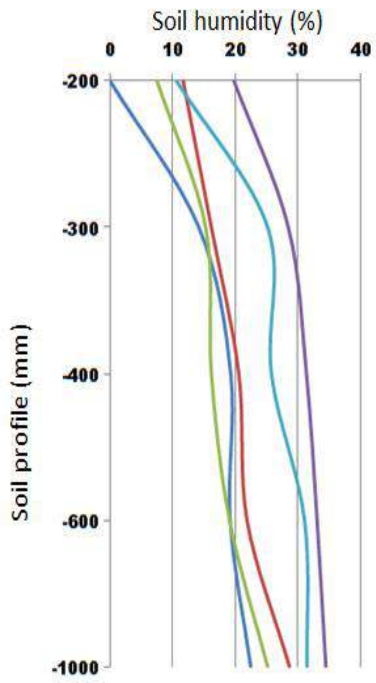
Parameters assessed:
Soil humidity, stomatal conductance, chlorophyll fluorescence, new shoot growth, olive fruit yield, olive fruit weight, maturity index, olive oil content.

Evolution of soil humidity measured in second day after suspending irrigation during 5 successive day according to water irrigation regimes and soil sprayed Water Retainer dilutions

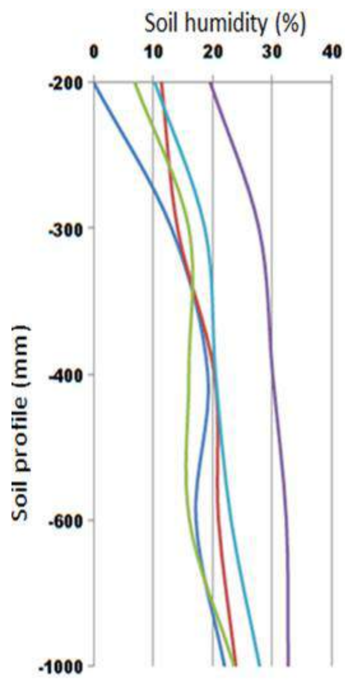


Day 1 Day 2 Day3

9



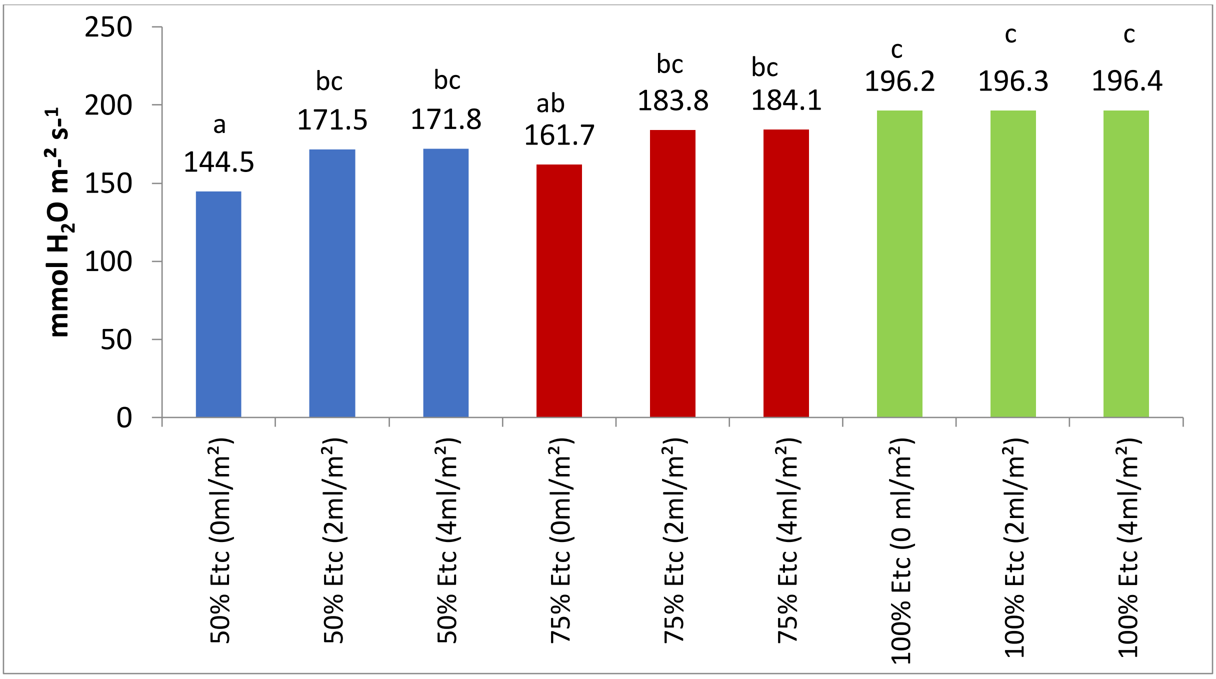
Day 4



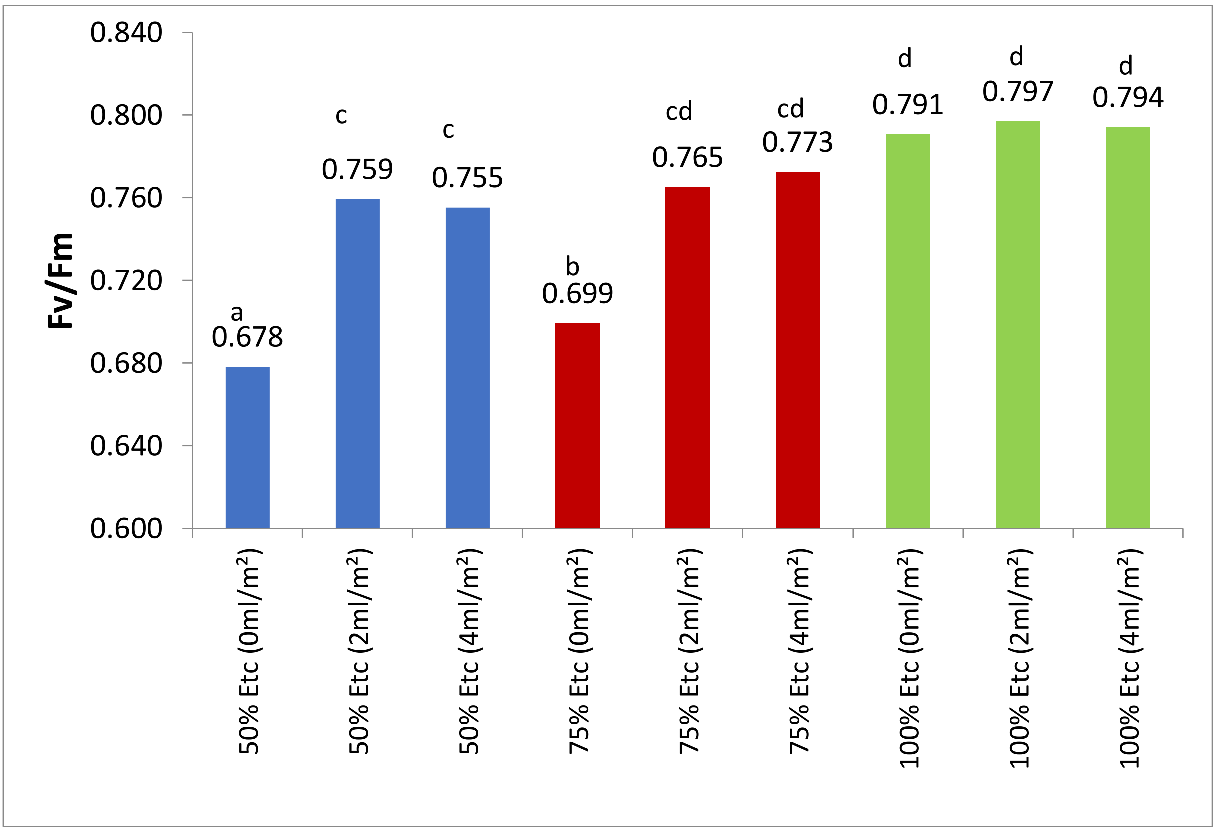
Day 5

We noted that in the absence of **Water Retainer**, the soil dries continuously from soil surface compared to the other treatments (figure 4). The difference between the five studied treatments is significant from the second day. However, Water Retainer dilution leading to a better soil water content depends on irrigation regime. In case of moderate deficit irrigation (75% ETc) only 2 ml/m is sufficient. But in case of server deficit irrigation, the concentration of the product must double (4 ml/m).

Stomatal conductance of olive trees measured under different studied treatments (Values with same letter did not differ significantly P (α=5%))

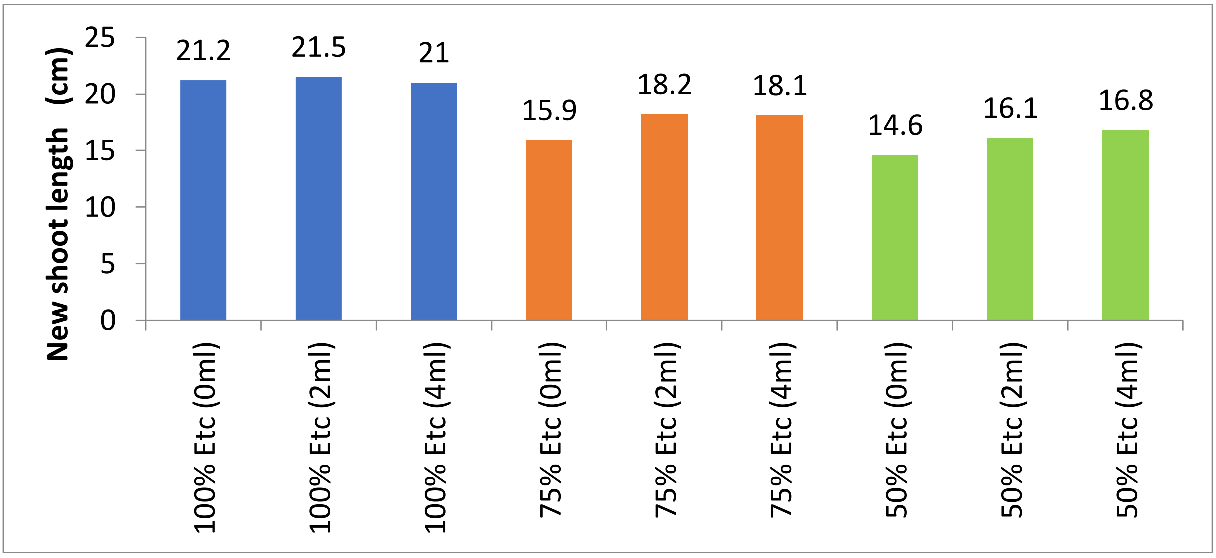


Chlorophyll fluorescence of olive trees measured under different studied treatments (Values with same letter did not differ significantly P (α=5%))

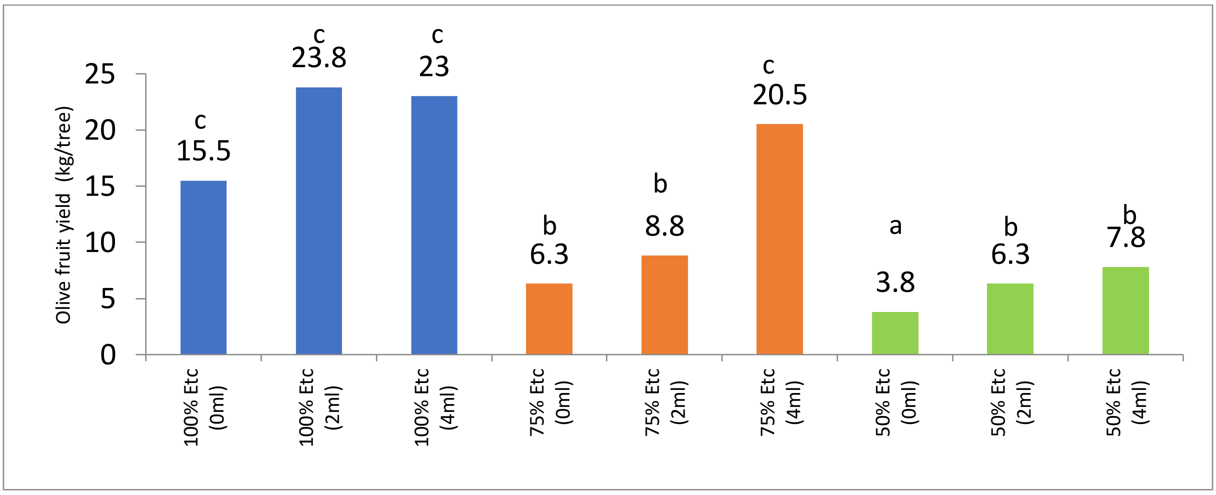

Fv/Fm
0.840
0.800
0.760
0.720
0.680
0.640
0.600
a
0.678
c
0.759
c
0.755
b
0.699
cd
0.765
cd
0.773
d
0.791
d
0.797
d
0.794
50% Etc (0ml/m²)
50% Etc (2ml/m²)
50% Etc (4ml/m²)
75% Etc (0ml/m²)
75% Etc (2ml/m²)
75% Etc (4ml/m²)
100% Etc (0ml/m²)
100% Etc (2ml/m²)
100% Etc (4ml/m²)

11

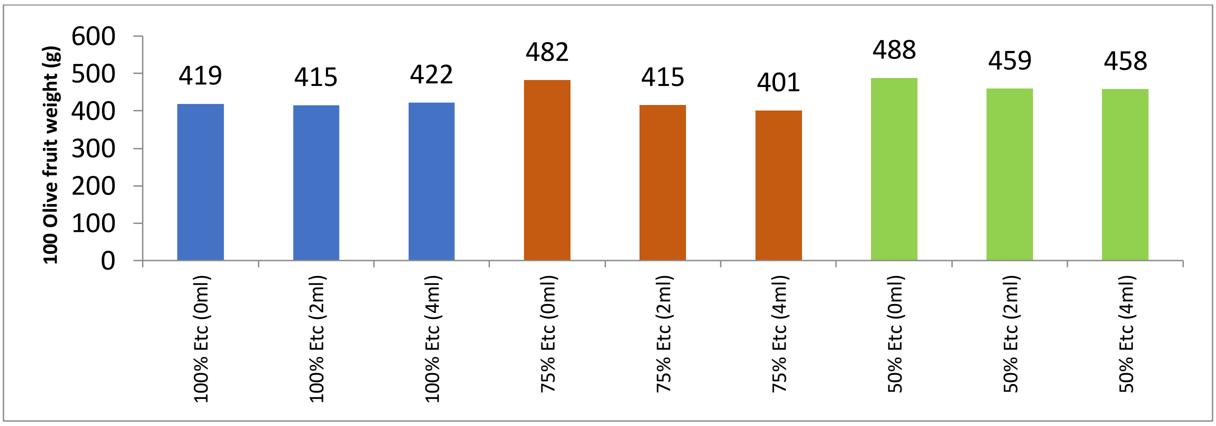
New Shoot length of olive trees measured under different studied treatments



Olive fruit yield estimated under different studied treatments (Values with same letter did not differ significantly P (α=5%))

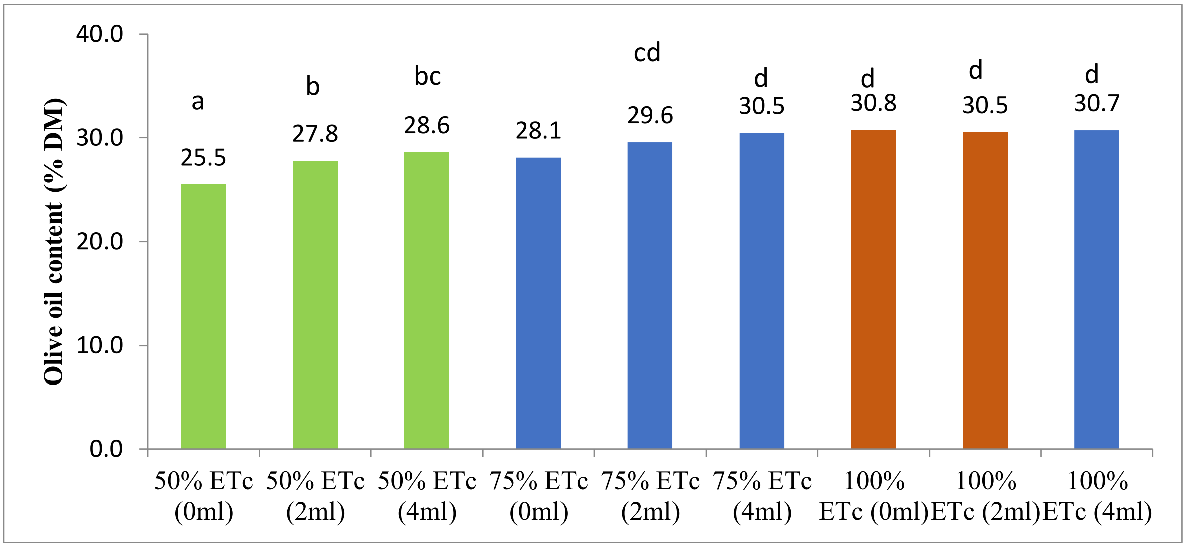


100 fruit weight harvested under different studied treatments



12

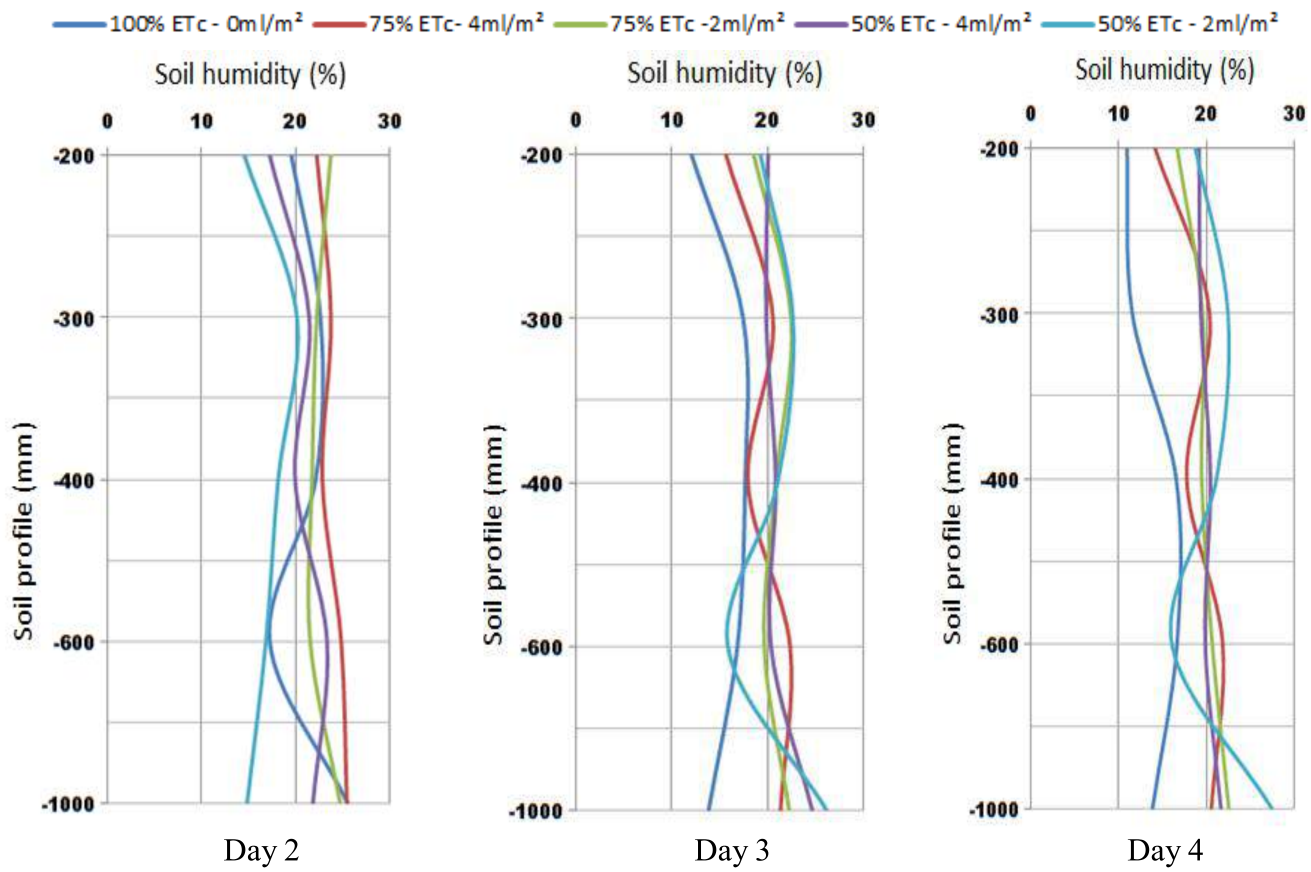
Olive oil content according to studied treatments



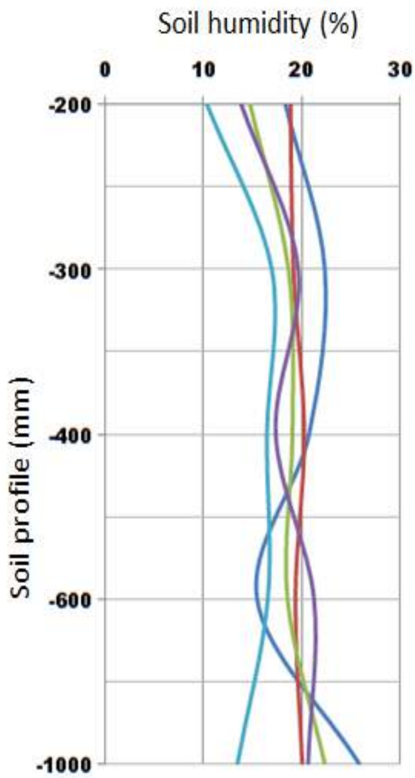
Date palm:

Parameters assessed:
Soil humidity, chlorophyll fluorescence.

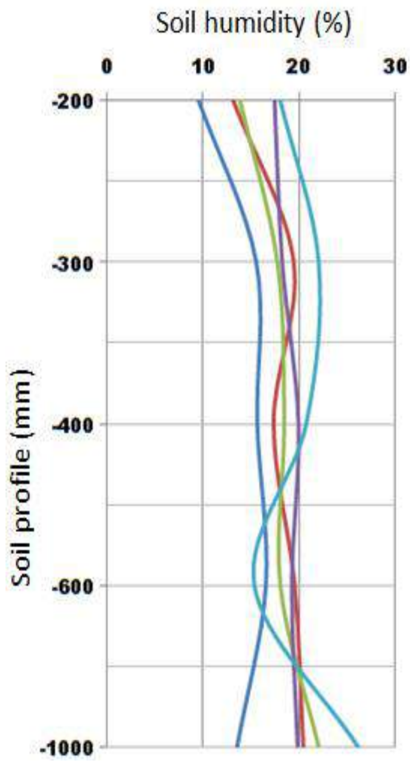
Evolution of soil humidity measured 5 successive days after suspending irrigation



13

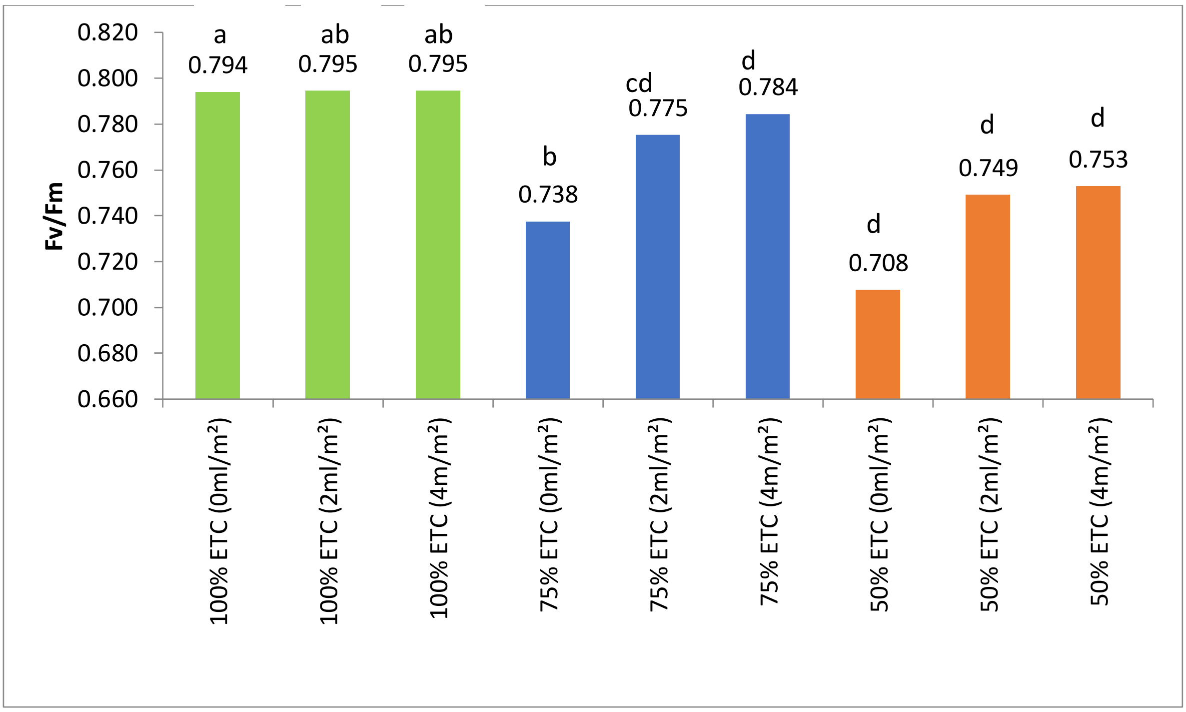


Day 5



Day 6

Chlorophyll fluorescence of olive trees measured under different studied treatments (Values with same letter did not differ significantly P (α=5%)).



14

1.2. HORTICROP Research Ltd., Nairobi, Kenya: Regulatory trials for product registration

1.2.1. French Beans, Mwea Trial Site, Kirinyaga County (2018)

Conclusion:

1. Water Retainer reduced the need for irrigation in French beans. Overall, Water Retainer treatments T2, T3 and T4 received 42%, 33%, and 24% less water respectively in the entire growing season of French beans compared to the untreated control. The effect of Water retainer on the need for irrigation was comparable to Stockosorb treatment T5 which received 44% less irrigation compared to the untreated control.

2. French bean in Water Retainer treatment T4 showed normal growth and development of shoots, plant height, roots and dry matter up to the flowering stage (40 DAE), which was comparable to the untreated control (T1) which received the optimal irrigation.

3. The marketable yield of French beans obtained in the Water Retainer treatment T4, was comparable to the yield that was obtained from the Untreated control (T1) and Stockosob treatment (T5)

Germination of French beans per treatment

Treatment	Germination (percent)
Untreated +100% Irrigation (T1)	77.1%
WR+50% Irrigation (T2)	72.6%
WR+60% Irrigation (T3)	71.3%
WR+70% Irrigation (T4)	74.9%
Stockosorb+50% Irrigation (T5)	65.9%

Yield of French beans at different treatment levels

Treatment	Yield in tons/ha	
Untreated+100% Irrigation (T1)	10.5	c
WR+50% Irrigation (T2)	3.6	a
WR+60% Irrigation (T3)	5.9	ab
WR+70% Irrigation (T4)	9.7	c
Stockosorb+50% Irrigation (T5)	8.3	bc
P-Value ESE	0.006 ±1.14	

1.2.2. French Beans, Timau Trial Site, Meru County

Conclusion:

1. Water Retainer reduced the need for irrigation in French beans. Overall, Water Retainer treatments T2, T3 and T4 received 24%, 26%, and 25% less water respectively in the entire growing season of French beans compared to the untreated control. The effect of Water retainer on the need for irrigation was comparable to Stockosorb treatment T5 which received 34% less irrigation compared to the untreated control.

2. French beans in Water Retainer treatment T4 showed normal growth and development of plant height and biomass, which was comparable to the untreated control (T1) which received the optimal irrigation.

3. The marketable yield of French beans obtained in the Water Retainer treatment T4, was comparable to the yield that was obtained from the Untreated control (T1) and Stockosob treatment (T5)

Germination of French beans per treatment

Treatment	Germination (percent)
Untreated +100% Irrigation (T1)	87.5%
WR+50% Irrigation (T2)	83.8%
WR+60% Irrigation (T3)	76.3%
WR+70% Irrigation (T4)	89.4%
Stockosorb+50% Irrigation (T5)	86.3%

Marketable yield of French beans at different treatment levels

Treatment	**Yield in tons/ha**	
Untreated +100% Irrigation (T1)	**37.7**	**ab**
WR+50% Irrigation (T2)	**30.3**	**a**
WR+60% Irrigation (T3)	**32.2**	**a**
WR+70% Irrigation (T4)	**42.4**	**b**
Stockosorb+50% Irrigation (T5)	**46.1**	**b**
P-Value	**0.014**	
SE	**±3.01**	

1.3. Greenhouse Trial and Research Centre, Centurion, South Africa

Regulatory trials for product registration

Conclusion :

Greenhouse Trial:

• The maize wet biomass yield was statistically significantly higher than the control on all the application rates.
• The beans biomass yield did not show any benefit when this product was applied on the surface of the soil, probably due to lower water demand compared to the maize.
• The nutrient content of the plants were not significantly influenced due to the surface application of the product.

Laboratory Trial:

• When evaluating the evaporation from the surface of the treated and untreated soil the treated soil lost considerably less water due to evaporation.

Material and methods:

16

Soil:
A loamy sand (Babsfontein) soil was used.

Test product:
Water Retainer product

Treatments and application rates:
Pot trial:
Based on the recommended application rate as prescribed for the product, it was used in combination with a standard fertilizer, together with half, full and double the recommended application rates. This is in accordance with the requirements of the Registrar of Act 36 of 1947 to be able to register the product as a group 3 fertilizer. Together with these treatments a reference treatment which received only fertilizer was included (Treatment 1).
The different application rates are as set out in Table1.
The product was diluted 1000 times in order to get the equivalent volumes below into the pots (1liter dissolved in 100liters of water for each 1000m2) and applied onto the soil surface after seeds were planted and band placement of the fertilizer.

Table 1. Treatments

1 Soil +3:2:2(35) Control
2 Soil +3:2:2(35) + 0.5x (15 ml/pot)rec rate
3 Soil +3:2:2(35) + 1 x (30 ml/pot)
4 Soil +3:2:2(35) +2 x (60 ml/pot)

Crop:
Maize and beans

Trial layout:
Pots containing 6 kg of soil were treated as follows:
At planting 2g/pot of a 3:2:2(35) bulk blended mixture was applied as a band in the middle of the pot. This reference 3:2:2(35) was compiled with MAP, LAN and KCl. After planting the a diluted product was applied as set out in table 1 During the trial period the daily irrigation was interrupted from time to time to stress the plants and then the water content measured and expressed as % water content.
Treatments were replicated 4 times.
At harvest the plants of the different replicates were cut above the soil, weighed (wet mass), oven dried at 65°C and weighed again (dry mass). The replicates were then combined and sent to the laboratory for chemical analysis. At the same time soil samples from the different replicates were taken in the middle and side of the pot. The replicate samples were then pooled and send to the lab for chemical analysis.

Laboratory trial:
Soil columns were prepared by filling up two perplex tubes with soil. After adding water to the columns, one column receive the product while the second column were not treated with the product. They were weighed daily and the water loss due to evaporation noted.

Statistics:
A SAS program was used to calculate the ANOVA's, LSD (Fisher unprotected t-test) and CV.

Data collected:

Plant biomass of maize as influenced by variable application rates of product

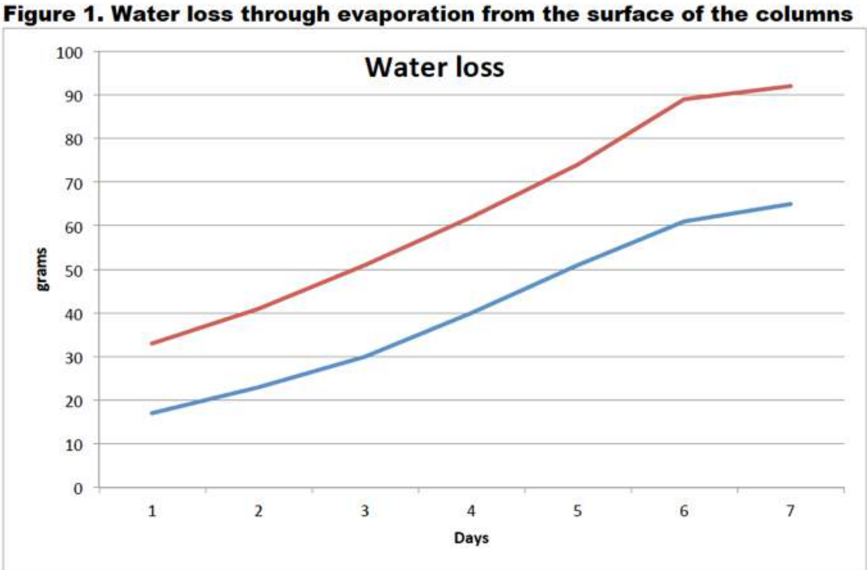
No.	TREATMENTS	WET	DRY
1	Soil +3:2:2(35) Control	25.82 b	14.95 ab
2	Soil +3:2:2(35) + 0.5x (15 ml/pot)	30.02 a	15.14 a
3	Soil +3:2:2(35) + 1 x (30 ml/pot)	29.32 a	14.82 b
4	Soil +3:2:2(35) +2 x (60 ml/pot)	29.48 a	14.96 ab
	LSD (p= 0.05)	2.95	0.318

17

Biomass of beans as influenced by variable application rates of the product

No.	TREATMENTS	WET	DRY
1	Soil +3:2:2(35) Control	21.14 a	14.64 a
2	Soil +3:2:2(35) + 0.5x (15 ml/pot)	21.52 a	15.08 a
3	Soil +3:2:2(35) + 1 x (30 ml/pot)	21.14 a	14.79 a
4	Soil +3:2:2(35) +2 x (60 ml/pot)	22.44 a	15.08a
	LSD (p= 0.05)	2.83	0.536

Figure 1. Water loss through evaporation from the surface of the columns



SOIL WITH WATER RETAINER **SOIL WITHOUT WATER RETAINER**

1.4. Jafer Agro Services (Pvt.) Ltd., Karachi, Pakistan

Conclusion

Cotton:

The Water Retainer treatment resulted 4-5 % yield surplus with the skip of 1/3 of the number of the irrigations. Flooding irrigation was applied. The test was run on two different sites.

Chilies:

The Water Retainer treatment resulted 4-5 % yield surplus with the skip of 1/3 of the number of the irrigations. Flooding irrigation was applied.

Groundnut:

The Water Retainer treatment resulted 5.1-8.3 % yield surplus. Cultivation was rain-fed.

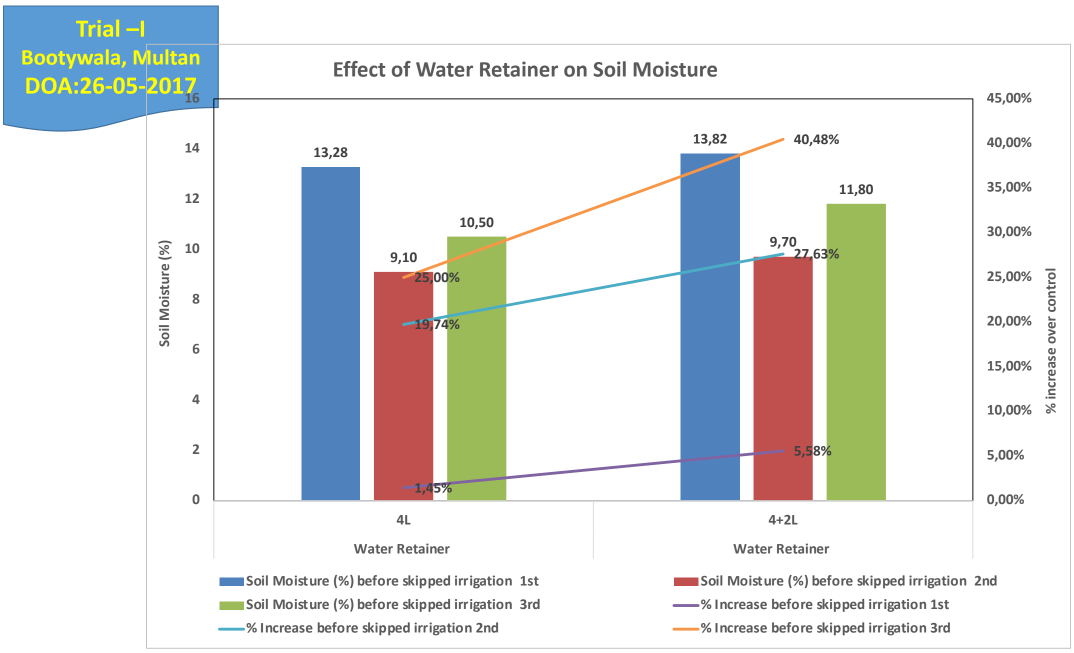
Treatments, methods and data collected:

Cotton:

18

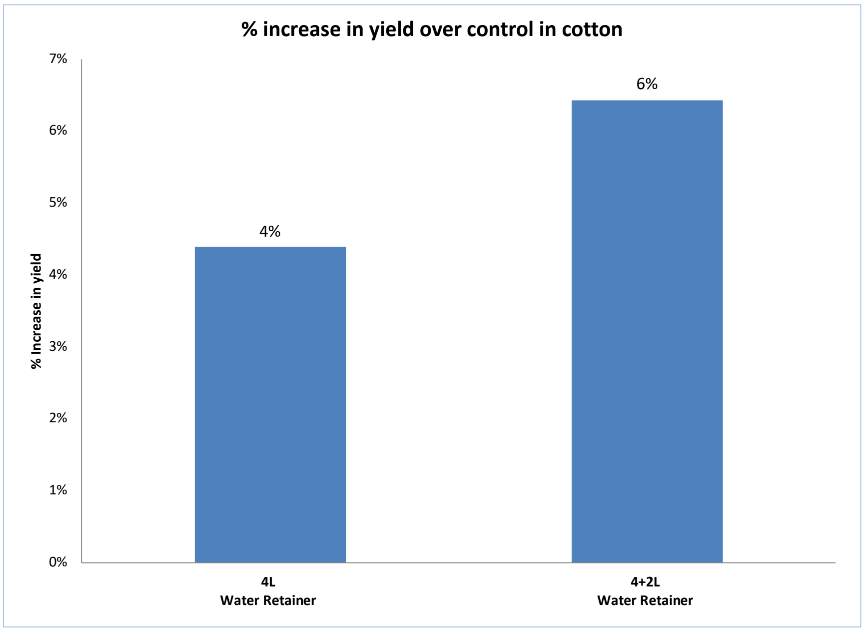
Irrigation and treatments applied

Treatments	Trial-1		Trial -2	
	Applied	Skipped	Applied	Skipped
T1 = Control	9	Nil	10	Nil
T2 = Water Retainer @ 4L (Single Application)	6	3	7	3
T3= Water Retainer @ 4L + 2L (Repeated application)	6	3	7	3

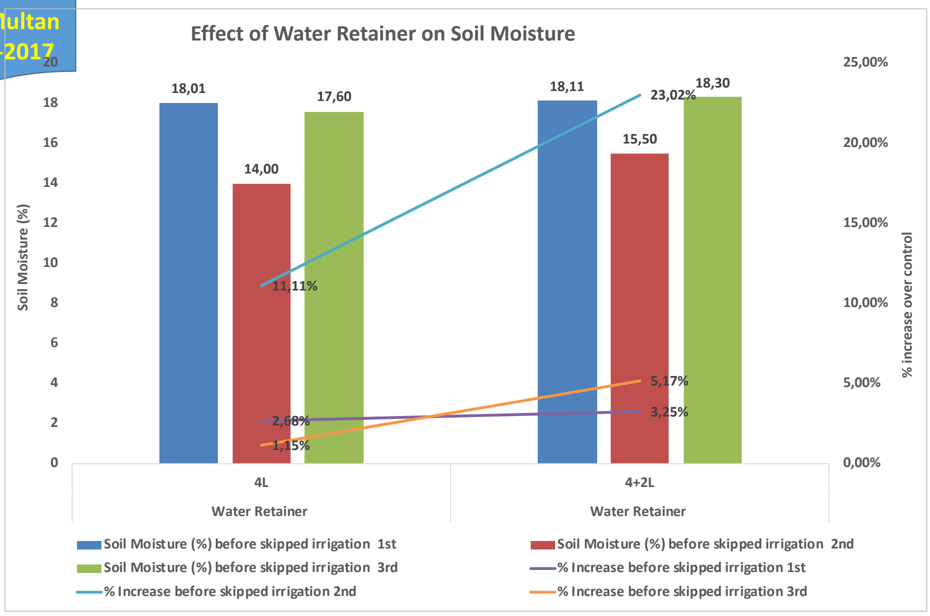


19

Trial –I
Bootywala, Multan
DOA:26-05-2017

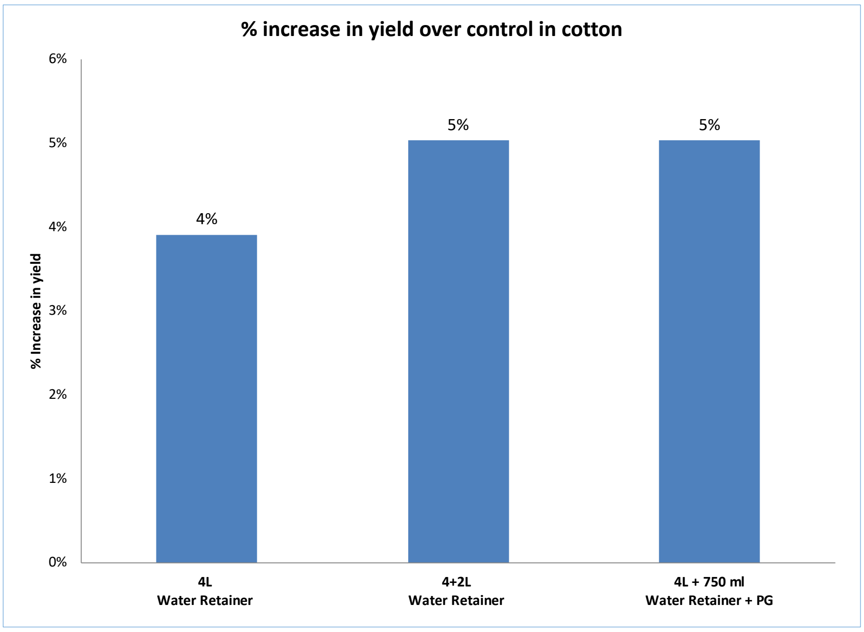


Trial –II
06 Tarpai, Multan
DOA:01-06-2017



20

Trial –II
06 Tarpai, Multan
DOA:01-06-2017



Chilies:

Water Retainer in Chilies
In-house Trial Review-2018

JAFFER

Trial Protocol :

Objective	"To study the impact of using ***"Water Retainer"*** on water retention, crop growth, development and yield in Chilies (under irrigated conditions)"

Trial Locations	**Kunri (Sind)**
Layout Design	RCBD
Plot Size	255 sq. meter
Replicates	Three

Treatments:

S.#	Treatment / Product	Dose / sq. meter (ml)		Remarks
		1st Appli	2nd Appli	
T1	Control / UTC	-	-	Follow farmer practice for irrigations
T2	Water Retainer – (application with sprayer)	**1.0**	-	**Chilies (Irrigated):** 1st application at "wattar" after first irrigation to crop. 2nd application 45 days after 1st application (spray in between lines, preventing crop. If spray drift falls on crop then wash with water just after application)
T3	Water Retainer – (application with sprayer)	**1.5**	-	
T4	Water Retainer – (application with sprayer)	**2.0**	-	
T5	Water Retainer – (application with sprayer)	**1.0**	**0.5**	
T6	Water Retainer – (application with sprayer)	**1.5**	**0.5**	
T7	Water Retainer – (application with sprayer)	**2.0**	**0.5**	

Project Summary:

JAFFER

Project	*Water Retainer*
Supplier	Water & Soil - Budapest, Hungary
Target Crop	Chilies (irrigated conditions), Groundnut (Rainfed conditions)
Target	Water retention, saving in irrigations, crop growth & development, yield
Trial Season	Kharif 2018
Total Trial Conducted	2

Trial Details :

Trial #.	Crop	Location	Trial Design / Replicates	D. O. Appli.	No. of Appli.
Trial-1	Chilies (irrigated)	Kunri - Sind	RCBD / Three	01-05-2018	One vs Two
Trial-2	Peanut (Rainfed)	Tala Gang – Punjab	RCBD / Three	14-05-2018	One vs Two

Water Retainer in Chilies
In-house Trial Review-2018

Irrigation schedule :

Treatments	Date of Transplanting	1st Irrigation 30/4/2018	2nd Irrigation 5/5/2018	3rd Irrigation 14/5/2018	4th Irrigation 29/5/2018	5th Irrigation 14/6/2018	6th Irrigation 20/6/2018	7th Irrigation 26/6/2018	8th Irrigation 01/08/2018	9th Irrigation 11/08/18	10th Irrigation 26/08/18
T1 : Control / UTC	30/04/2018	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
T2 : Water Retainer 1 ml/Sqm.		Yes +	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes
T3 : Water Retainer 1.5 ml/Sqm.		Yes +	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes
T4 : Water Retainer 2 ml/Sqm.		Yes +	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes
T5 : Water Retainer 1+0.5 ml/Sqm.		Yes +	Yes	No	Yes	Yes +	No	Yes	Yes	No	Yes
T6 : Water Retainer 1.5+0.5 ml/Sqm.		Yes +	Yes	No	Yes	Yes +	No	Yes	Yes	No	Yes
T7 : Water Retainer 2+0.5 ml/Sqm.		Yes +	Yes	No	Yes	Yes +	No	Yes	Yes	No	Yes

Yes	Irrigation
Yes +	Irrigation+Application
No	No irrigation

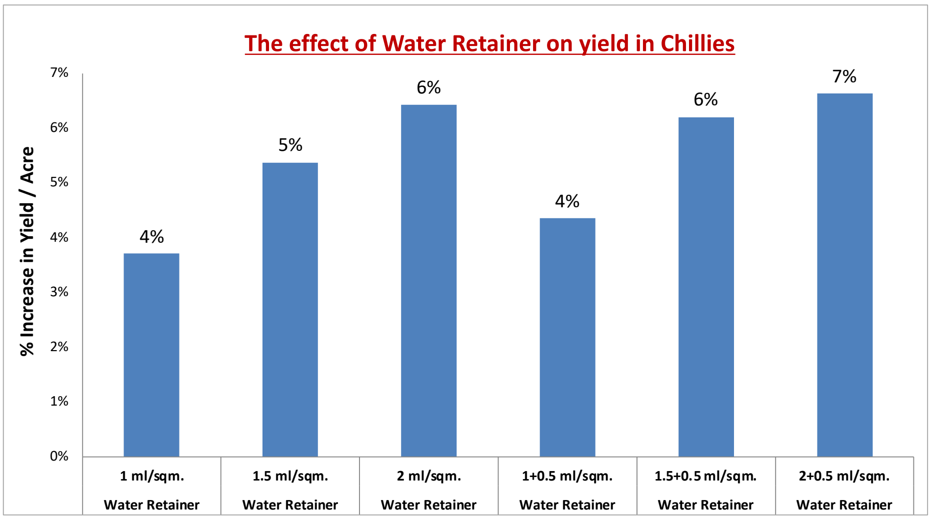
Water Retainer in Chilies
In-house Trial Review-2018

Trial-1
Crop : Chilies
D.O. Application : 1st : 01-May-2018 2nd : 13-June-2018

S.#	Treatment / Product	Dose / sq. meter (ml)		Soil Moisture Content (%)					
		1st Appli	2nd Appli	Before Application (01-05-2018)		4 WAA (29-05-2018)		8 WAA (26-06-2018)	
				A (0-12 inch)	B (12-18 inch)	A (0-12 inch)	B (12-18 inch)	A (0-12 inch)	B (12-18 inch)
T1	Control / UTC	-	-	18.3	16.5	25.0	23.4	26.4	24.6
T2	Water Retainer – (application with sprayer)	1.0	-	23.4	21.6	28.3	26.8	30.3	28.4
T3	Water Retainer – (application with sprayer)	1.5	-	24.0	21.4	32.9	30.1	34.9	32.3
T4	Water Retainer – (application with sprayer)	2.0	-	23.6	21.9	34.3	32.1	36.2	33.9
T5	Water Retainer – (application with sprayer)	1.0	0.5	23.8	21.8	27.6	27.5	32.5	29.7
T6	Water Retainer – (application with sprayer)	1.5	0.5	25.4	21.2	33.7	31.6	36.2	33.1
T7	Water Retainer – (application with sprayer)	2.0	0.5	24.4	19.9	36.4	34.8	37.9	36.4

23

Water Retainer in Chilies
In-house Trial Review-2018



Groundnut:

Water Retainer in Groundnut
In-house Trial Review-2018

Trial Protocol :

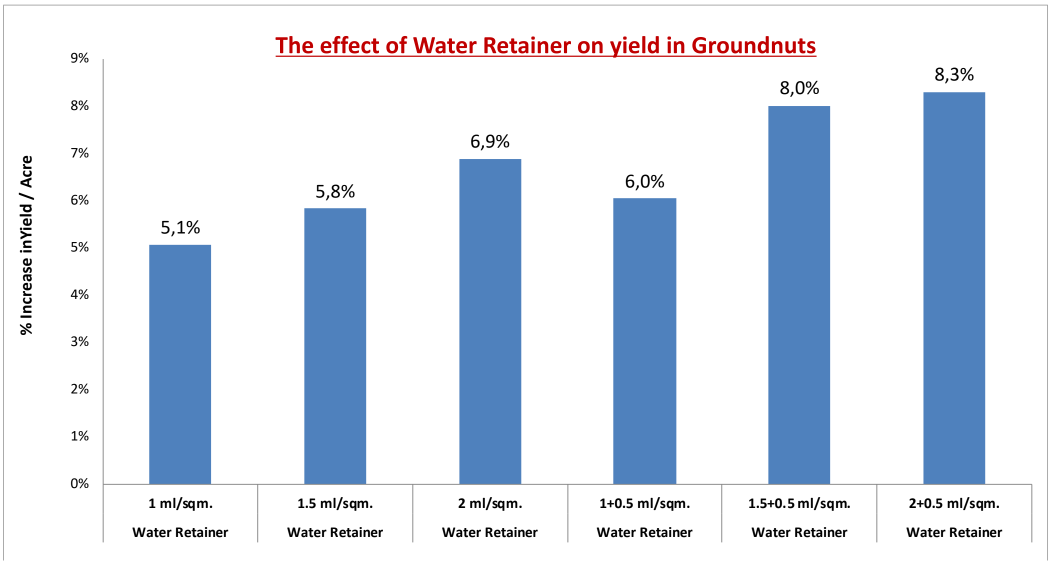
Objective	"To study the impact of using ***"Water Retainer"*** on water retention, crop growth, development and yield in Groundnut (under rainfed conditions)"
Trial Locations	**Talagang (Punjab)**
Layout Design	RCBD
Plot Size	150 sq. meter
Replicates	Three

Treatments:

S.#	Treatment / Product	Dose / sq. meter (ml)		Remarks
		1st Appli	2nd Appli	
T1	Control / UTC	-	-	Follow farmer practice for irrigations
T2	Water Retainer – (application with sprayer)	**1.0**	-	**Groundnut (rainfed):** 1st application just after sowing 2nd application 30-40 days after 1st appli. (spray in between lines, preventing crop. If spray drift falls on crop then wash with clean water using sprayer, just after application)
T3	Water Retainer – (application with sprayer)	**1.5**	-	
T4	Water Retainer – (application with sprayer)	**2.0**	-	
T5	Water Retainer – (application with sprayer)	**1.0**	**0.5**	
T6	Water Retainer – (application with sprayer)	**1.5**	**0.5**	
T7	Water Retainer – (application with sprayer)	**2.0**	**0.5**	

24

Water Retainer in Groundnut
In-house Trial Review-2018



1.5. Pak Rost Neshan®/Razi University, Kermanshah, Iran

Corn and sugar beet

Conclusion:

Water scarcity and water stress as its subsequent is a vital issue in worldwide especially in Iran. Iran with about 80 m population is placed in semi-arid region and protecting water reservoirs is really crucial because it has a direct role in agriculture and feeding people. By results which observed in this experiment, our research team is strongly advise farmers and anyone who engaged with agriculture to use Water Retainer in cropping systems. As it revealed, using Water Retainer can protect crops (Corn and Sugar Beet in this experiment) against water stress negative effects. The final yield of corn and sugar beet in 15 lit/ha of Water Retainer treatment showed no significant difference with control condition. On the other hand, water stress without Water Retainer treatments sharply decreased corn and sugar beet yield.
It's highly recommended to use 15 lit/ha Water Retainer with cropping system in West of Iran.

25

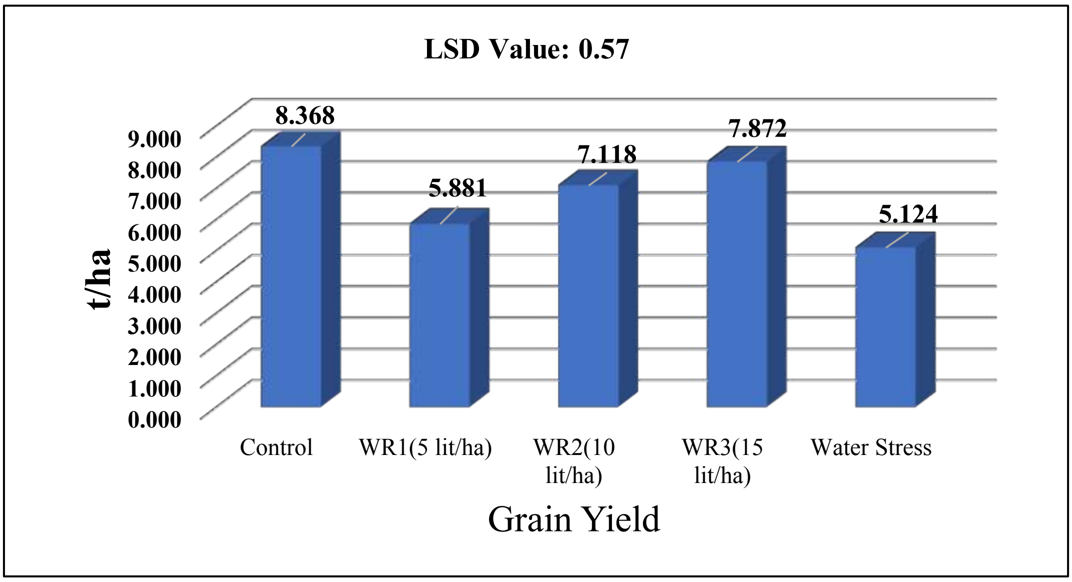
Treatments, methods and data collected:

Soil characteristics

Sand (%)	**Silt (%)**	**Clay (%)**	**Ca^{+2} (ppm)**	**Mg^{+2} (ppm)**	**Na^{+1} (ppm)**	**K^{+1} (ppm)**	**N (%)**	**Organic Matter (%)**	**Lime (%)**	**pH of Saturated Extract**	**ECe ($ds.m^{-1}$)**
83	9	8	3.2	1.4	2.1	230	0.059	0.56	9	8	0.98

Corn:

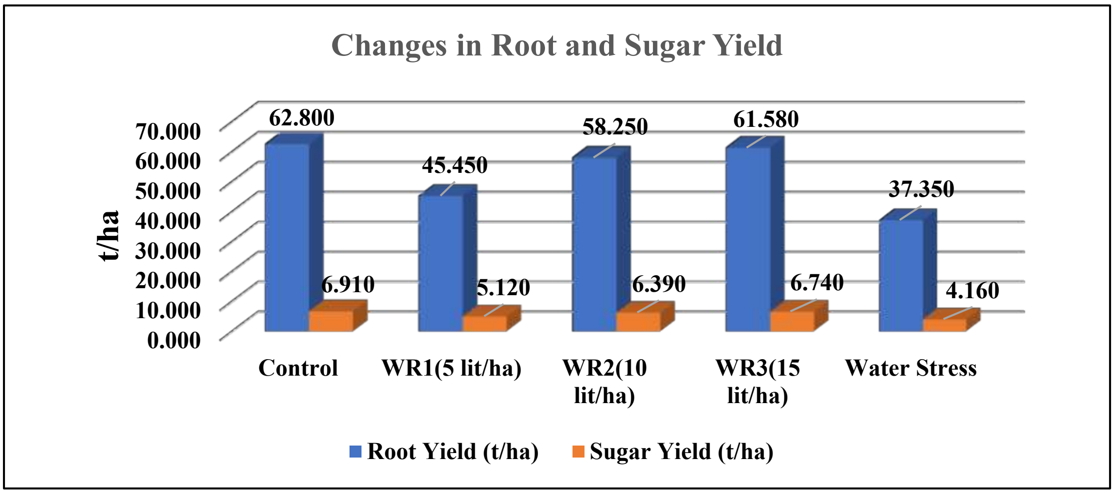
Irrigation	
Treatments	Water volume m^3
Control	10,200
WR_1, WR_2 and WR_3	5,950



Sugar beet:

Irrigation	
Treatments	Water volume m^3
Control	11,400
WR_1, WR_2 and WR_3	6,650

26



1.6. National Agricultural Research and Innovation Centre, Hungary

Spicy Pepper

Conclusion:

NAIK ZŐKO, Szeged:
The spicy pepper crop was harvested on 28 and 29 of September in the traditional way, selecting the peppers by hand into raschell bags, separating the crop from the treated and untreated area. After picking the peppers were taken to be prepared for sale, where they were measured by the quintal.
On the treated parcel 13.7 q (quintal) raw spicy peppers were harvested, whereas on the untreated area it was 11.3 q.
We can definitely confirm that the difference between the parcels can be attributed to the application of the substance 'Water Retainer' produced by Water&Soil.

NAIK ZÖKO, Kalocsa:
Based on phenological measurements and the resulting data shown in the tables, it can be ascertained that within the same varieties there are no significant differences between the main quality parameters and yields of the treated and the control, field or under plastic crops.

The results of our 2017 experiment also show exceptionally high germinating capacities of the seed samples.

The treatment is deemed effective both applied before the preparation of ridges and under plastic, and applied on the surface by means of other cultivator machinery.

Thus, by applying the Water Retainer, even half of the irrigation water used during the vegetation period and the other costs of irrigation application can be saved.

Treatments, methods and data collected:

Harvest results (yield)

Treatment	Kaldóm (field) kg/section (150 m^2)	Szegedi -178 (under plastic) kg/section (150 m^2)
Treatment (50% irrigation water)	183	189
Control	175	200

28

Quality parameter results

Treatment	variety/examined part	pcs	moist weight (g	dry weigh (g)	dry content %	ASTA color valu	raw see sprout %
Water Retainer - 50% less irrigation water	Kaldóm exocarp	14	317.7	56.5	17.8	198	99
	Kaldóm powder	15	342.9	56.2	16.4	152	
Control Crops	Kaldóm exocarp	15	325.5	57.5	17.7	200	95
	Kaldóm powder	15	347.1	61.2	17.6	166	
Water Retainer - 50% les irrigation water	Sz-178 exocarp	15	278.2	44.3	15.9	187	96
	Sz-178 powder	15	278.2	44.9	16.1	161	
Control Crops	Sz-178 exocarp	16	302.1	49.9	16.5	190	97
	Sz-178 powder	16	331.2	53.0	16.0	141	

1.7. Forest Research Center, Morocco

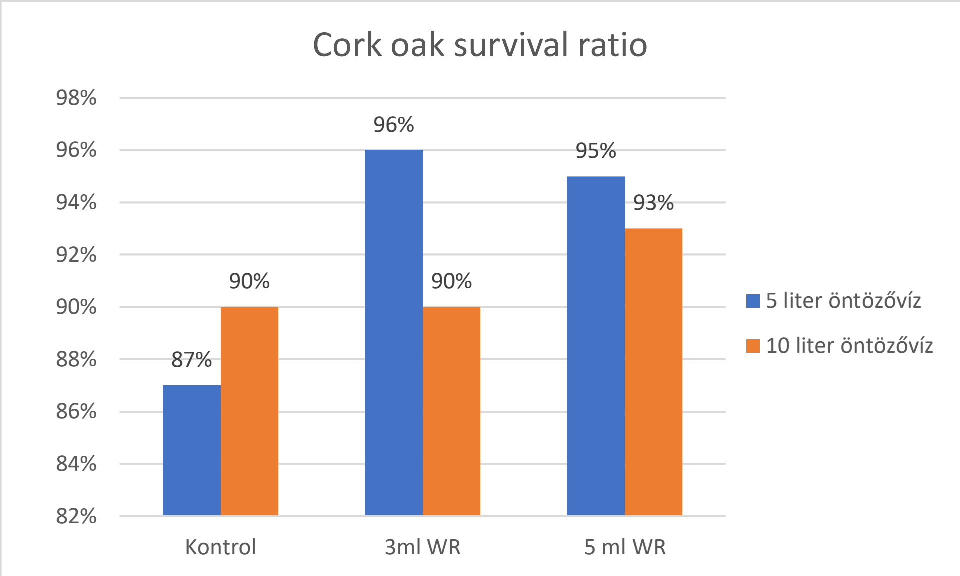
Conclusion:

The Water retainer treatment resulted 10 % survival ratio increase in a newly planted cork oak plantation. Cork oak is irrigated only in the first year. They experienced exceptional good evolution in both in height and collar diameter.
The survival ratio increase was similar in newly planted argan tree plantation in the first year. The argan must be irrigated for two years therefore the test continues.

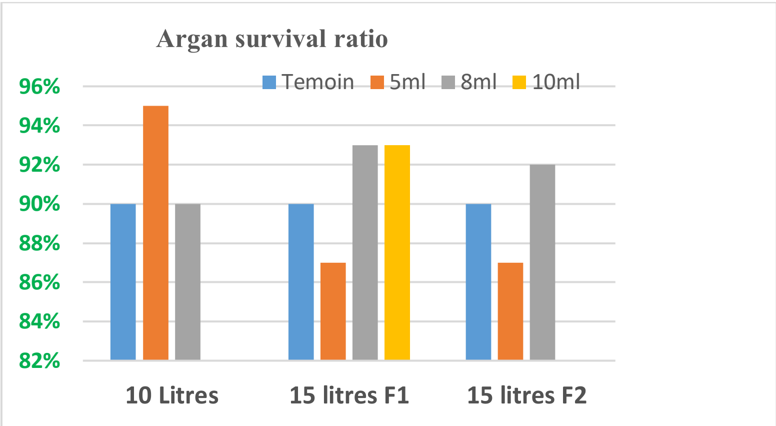
Treatments, methods and data collected:

Cork oak:

Survival ratio / Dosage	**Control**	**3ml WR**	**5 ml WR**
5 liter irrigation	87%	**96%**	**95%**
10 liter irrigation	90%	90%	**93%**


Cork oak survival ratio
98%
96%
94%
92%
90%
88%
86%
84%
82%
96%
95%
93%
90%
90%
87%
Kontrol
3ml WR
5 ml WR
5 liter öntözővíz
10 liter öntözővíz

Argan:


Argan survival ratio
Temoin
5ml
8ml
10ml
96%
94%
92%
90%
88%
86%
84%
82%
10 Litres
15 litres F1
15 litres F2

30

2. Test reports (full documents) from scientific/testing institutions and companies:

31

water&soil

المعهد الوطني للبحث الزراعي
Institut National de la Recherche Agronomique

National Institute for Agricultural Research

Scientific report

Use of Water Retainer to save water irrigation and to improve crop productivity In Morocco:

Case study: Citrus crop

Tadla region

Prepared by INRA scientific team

le Chef du Département
Environnement et Ressources
Naturelles

MOUSSADEK Rachid

Edition. Dec. 2018

Introduction

In arid climate areas of Morocco such as Tadla where water resources are very limited, the use of new irrigation techniques such as micro-irrigation and methods of controlling irrigation on the field are increasingly mastered to ensure agricultural production. Other methods based on the reduction of water losses by direct evaporation from the soil are being evaluated. Among the proposed methods to reduce direct evaporation of water is the use of *Water Retainer*. In many countries, encouraging results have been achieved. The present work is part of the convention between INRA and the company Hungarian "water and soil" and proposes to study the effectiveness of *Water Retainer* and its effect on the evolution of soil moisture and citrus productivity under the edaphic and climatic conditions of Tadla.

I. Objectives of study

To study the effectiveness of Water Retainer and its effect on soil moisture evolution and citrus productivity under the soil and climatic conditions of Tadla.

II. Material and methods

The study consists of comparing two doses of *Water Retainer* (d1 and d2) associated with two water regimes (R1 and R2). A control water regime (R0) without application of the product will be considered. The application of the product Water Retainer will be renewed every 45 days in citrus fruit and applied once before emergence in case of annual crops. Application of water regimes and doses of Water Retainer will be associated with observations on the soil and the plant in order to study the interaction of water regime and Water Retainer throughout the vegetative growth phase and fruit yield elaboration. The treatments studied are as follows:

a- doses of Water Retainer

d1 : 2 ml/m^2

d2 : 4 ml/m^2

These two dosages will be applied at startup. From the second application the dosages become 1 and 2 ml / m^2 for d1 and d2 respectively.

b- Régime hydrique

R0 : 100% ETc (control), R1 : 70% ETc, R2 : 50% ETc

The experimental protocol is a split plot. The water regime factor will be assigned to the main units while the dosage of the Water Retainer is assigned to the secondary units.

Visit of the Beni Mellal site on April 2018: choice of the experimental plot

Parameters to be monitoring are:

Soil: soil moisture using PR2 probes. Access tubes are installed in the areas treated and not treated by the product.

Citrus tree: Marking of shoots at each treatment and monitoring of the following parameters:

- Flowering rate, fruit set and the physiological fall of fruits
- In early July, fruits will be marked to follow the diameter of the fruits.
- At harvest, the yield per tree, the juice content, the size and the citric acid content are measured.

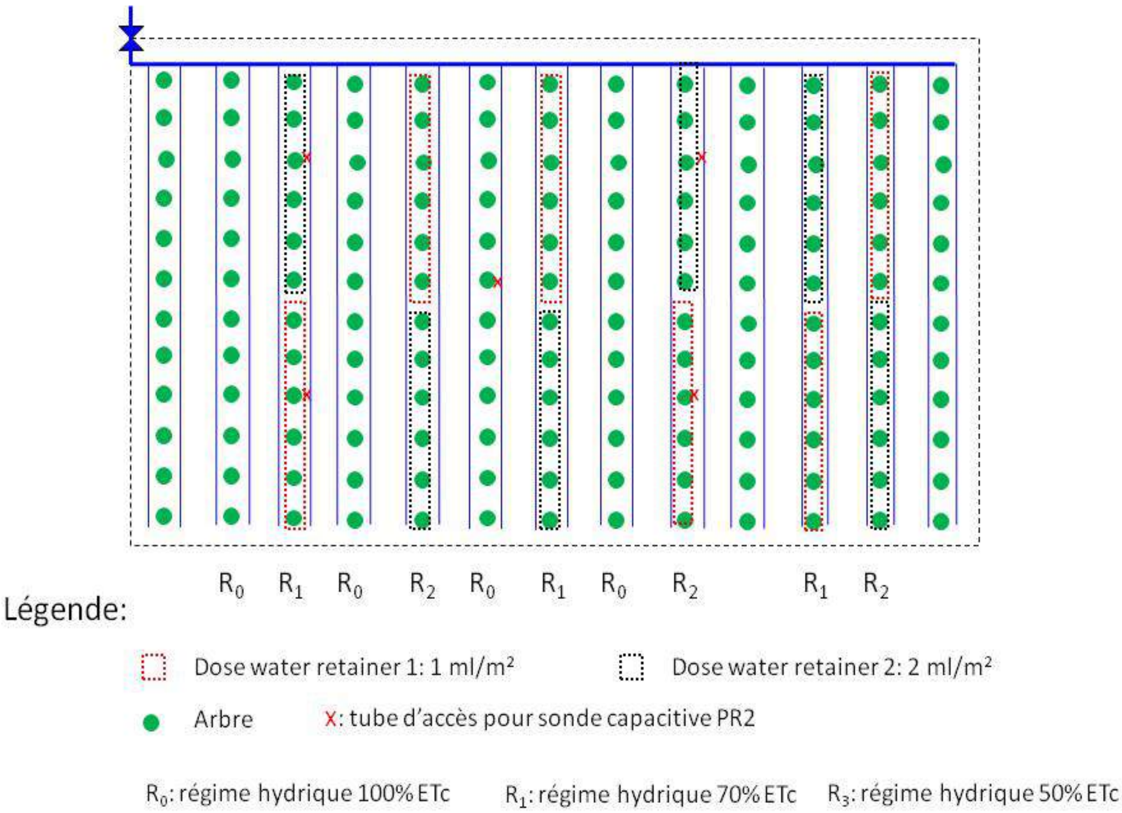


Figure 1. Scheme of the experimental plot

All trees lines are equipped with two 13/16 diameter PEHD laterals. The drippers are of PC Junior type, self-regulating with a nominal flow rate of 8 l / h under a nominal pressure of 1 bar.

The application of water treatments is made easy by acting on the number of emitters per tree to ensure the required proportions compared to the non-stressing regime. Trees under the regime R0 are equipped with 6 emitters. The regimes R1 and R2 are equipped with 4 and 3 drippers respectively. The following diagram illustrates the arrangement of the drippers.

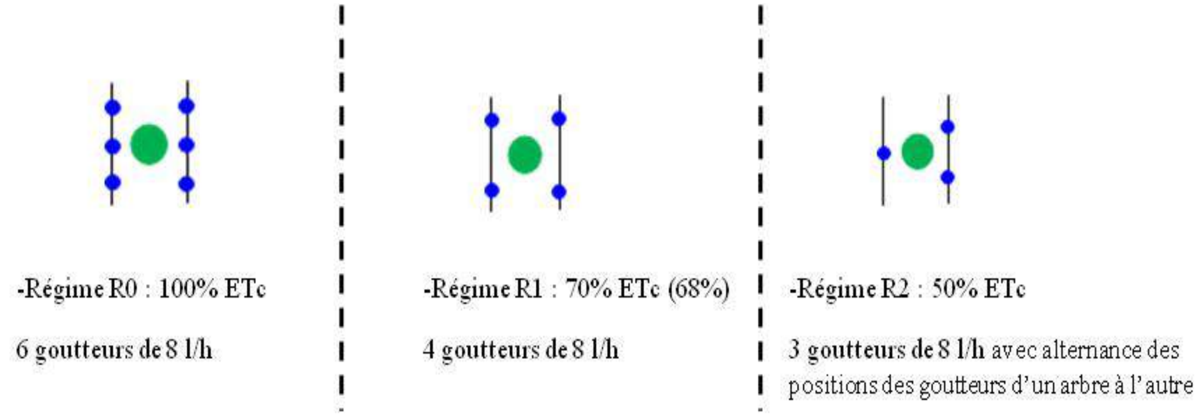


Figure 2. Arrangement of drippers for applying water regimes

The choice of tree lines and the application of Water Retainer treatments took into account the existence of heterogeneity of water distribution, due to pressure losses in the direction of the submain pipe and within the same ramp.

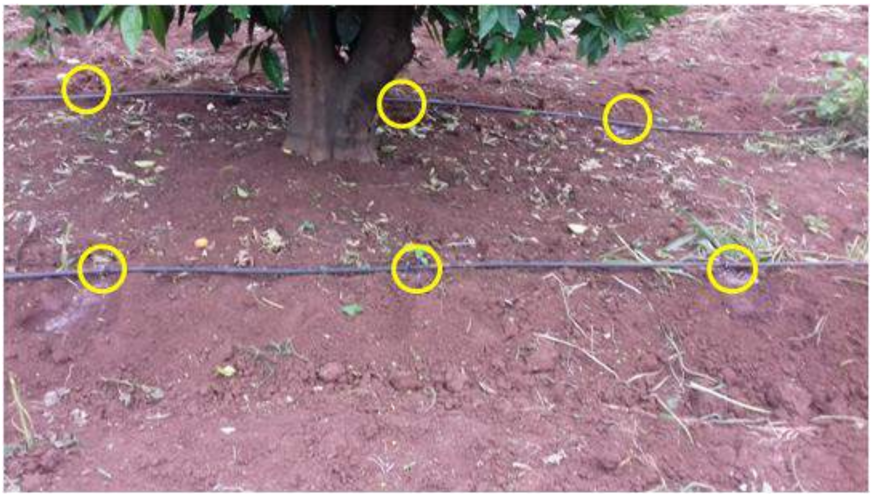
The modifications made to the number of emitters per tree allow having water amount for the same irrigation period representing 67% (≈ 70%) and 50% of the non-stressed regime R0 under R1 and R2 respectively.

2. Application of *Water Retainer*

The application of the Water Retainer must be preceded by a field maintenance operation and the removal of weeds to allow the product to reach the soil surface under the entire foliage of the tree.

Preparation of Water Retainer doses to apply

Application of Water Retainer under citrus tree



Regime R0 : six drippers per tree

Regime R1 : four drippers per tree

Régime R2 : three drippers per tree

Arrangement of drippers around trees for each water regime

3. Observations on the citrus tree and the soil

In parallel with the application of water regimes and *Water Retainer*, periodic observations on the plant were started after the marking of spring shoots. Similarly, PR2 capacitive probe access tubes were installed to monitor soil moisture under the various combinations of water regime and *Water Retainer* dose.

Measuring shoot lengths spring

Measuring soil moisture using the PR2 probe

Table 1. Chronogram of observations

Designation	Realization date
Application of *Water Retainer*	16/04/18, 30/05/18, 04/07/18, 05/09/18, 25/10/18
Observations on citrus tree	- Flowering rate, fruit set rate, physiological drop rate of fruits: 17/04/18, 27/04/18 and 26/06/18 - Spring shoot growth: from 17/04/18 to 06/07/18 - Counting summer shoots: 15/08/18 - Measure diameter of the fruit: from 02/07/18 to 09/10/18
Measure of soil moisture	From 22/05/18 to 09/10/18
Application of water regimes	Every two days (three times per week) and stop after a heavy rain

III. Results and discussion

3. 1. Climatic characterization of the season

The climatic variables for growing period are given in Table 2. The climatic data were collected from a local meteorological station. According to Table 2, the growing period is characterized by relatively high temperature with values that can exceed 40°C in July and August. The same period was completely dry from June to September.

Table 2. Climatic data of the experimental station in the growing period

Year/Month	Mean Tmax (°C)	Mean Tmin (°C)	Total precipitation (mm)	ET_0 (mm)
- Avril	23.5	11.6	75.0	110.7
- Mai	22.9	13.3	49.0	147.5
- Juin	31.6	18.8	0.0	165.2
- Juillet	40.1	26.1	0.0	189.3
- Août	42.3	29.1	0.0	180.7
- Septembre	33.8	18.4	5.0	125.6
- Octobre	26.1	13.3	45.0	88.0

Before the experiment started, soil samples were collected from soil layers 0-30, 30-60 and 60-120 cm for analyses. Some physical and chemical properties of the soil were determined. They are presented in Table 3.

Table 3. Some physical and chemical properties of the experimental field soil

Properties	Soil layer (cm)		
	0 – 30	30 – 60	60 - 120
Clay (%)	27.7	43.3	47.4
Fine silt (%)	3.9	15.9	16.6
Coarse silt (%)	49.2	2.8	19.3
Fine sand (%)	12.3	11.2	11.3
Coarse sand (%)	5.7	27.6	6.1
Organic matter (%)	1.91	1.08	1.08
pH	7.97	8.22	8.43
Electrical conductivity (mS/cm)	1.03	0.45	0.53
Field capacity Fc (%)	27	28	27
Wilting point Wp (%)	16.	17	16.
Bulk density	1.38	1.46	1.57

3. 2. Evaluation of the micro irrigation system

The determination of uniformity coefficient (UC) on a new installation of drip irrigation allows assessing the relevance of the original design and quality of materials used. For an already operating installation, the calculation of this coefficient can appreciate in addition to the effect of the two factors mentioned, the efficiency of maintenance measures including treatment of emitter clogging. The results obtained are summarized in Table 4.

Table 4. Mean values of drip irrigation system performance indicators

UC (%)	Q_{mean} (l/h)	Mean Pressure downstream (bar)	Fictive pluviometry (mm/h)		
			R0	R1	R2
93.2	7.89 ± 0.92	0.65 ± 0.05	0.97	0.64	0.48

According to the standards of drip irrigation systems diagnosis, the water distribution uniformity in the plot is excellent. The average flow per emitter is 7.9 l / h with low variability between drippers.

Measuring the drippers flow

3. 3. Water Supplies for each water regime

The water supplies under the R0 control regime were applied in accordance with the water requirements of citrus genotype studied. Calculations are made based on the daily values of the ET0 calculated according to the Penman Montheith FAO equation using the climatic data of the INRA automatic station and the local crop coefficients specific to the variety studied.

At the beginning of the experimentation, which coincided with the end of the flowering stage, and during the months of April and May, irrigations were interrupted several times following the abundant rains recorded during this period. Only two irrigations were applied. The differentiation of water supplies between regimes started towards the end of May. Irrigation is applied every two days by application of water requirements cumulative of the two previous days. The differentiation of the number of drippers per water regime makes it possible to apply variable irrigation doses.

Table 1 summarizes the number of irrigations and the volumes provided by regimes according to the phenological stages. According to the results given in the table, the summer growth of fruit diameter stage and the physiological drop of fruits stage are the strongest water demands with contributions of 471 and 179 mm respectively. Based on R0 water application from the beginning of the experimentation (753 mm), the water supplies were 67.5 and 49.1% under the R1 and R2 regimes, respectively.

Table 5. Irrigations number and water amount applied for each treatment

Stage	Duration of stage (day)	Irrigation number	Applied volume (mm)		
			R0	R1	R2
Flowering	17	2	13.3	8.8	4.6
Fruit set	22	10	89.6	59.7	31.3
physiological drop of fruits	47	18	178.7	118.9	62.4
Summer growth of fruit diameter	123	49	471.4	313.8	164.7

Figure 3 shows the cumulative values of crop water requirements (ETc), sum of rain and irrigation amount doses applied under three water regimes. Les apports en eau réellement appliqués sous le régime R0 dépassent légèrement les besoins en raison des majorations faites pour tenir compte de l'efficience de l'irrigation localisée prise égale à 90%.

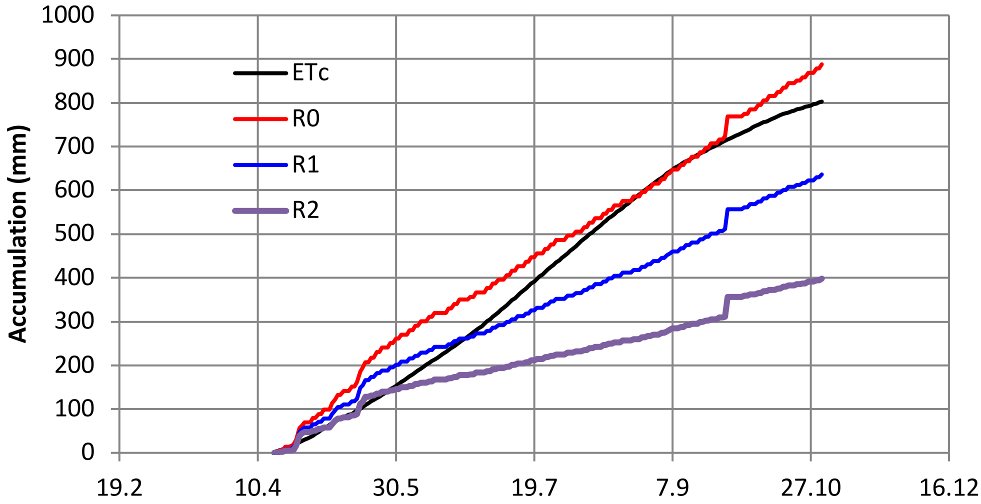


Figure 3. Cumulative values of ETc, and water supplies (irrigation+ rain) per water treatment

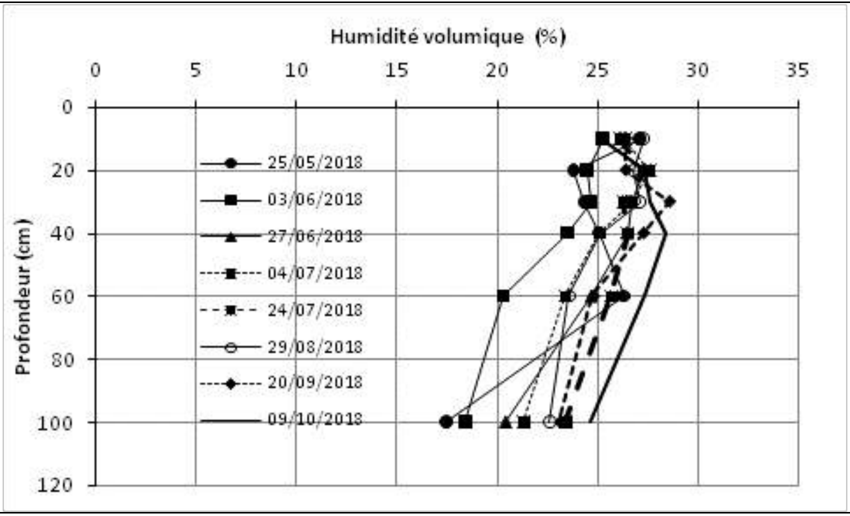
3. 4. Evolution of soil moisture profiles

A regular monitoring of moisture under water regimes compared started after the first application of *Water Retainer* in order to detect the possible effect of this product on the water content over the entire soil profile. The access tubes of the PR2 probe were installed at each regime at midway between two drippers. The installed tubes have a depth of 100 cm.

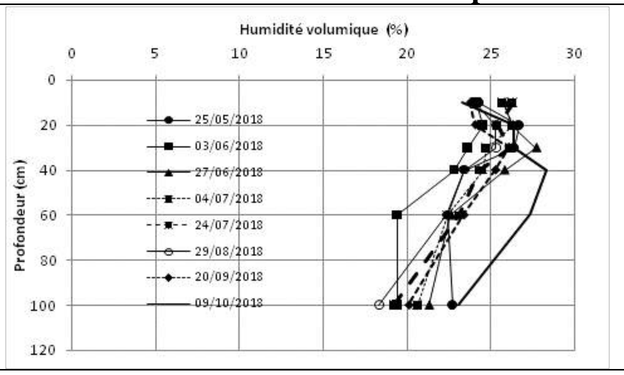
The profiles obtained under each regime are illustrated by the figures from 1 to 5. The analysis of the profile obviously shows that the humidity values decrease with the depth and vary between a maximum of 28.5% to 17% without falling below the moisture at the wilting point which is 15%. Considering the profiles established during the summer (June, July, August) we can see remarkable nuances between compared regimes. The humidity under R0 exceeds that under R1 followed by R2.

Considering the water regimes that have received *Water Retainer*, it can be seen that soil moisture is higher under the *Water Retainer* d2 dose (2 ml / m^2) compared to the d1 dose (1 ml / m2). The abundant rain homogenizes the distribution of moisture and hides the effect of the *Water Retainer* dose, as is the case of the 09/10/18 profile established after a rainfall of 45 mm.

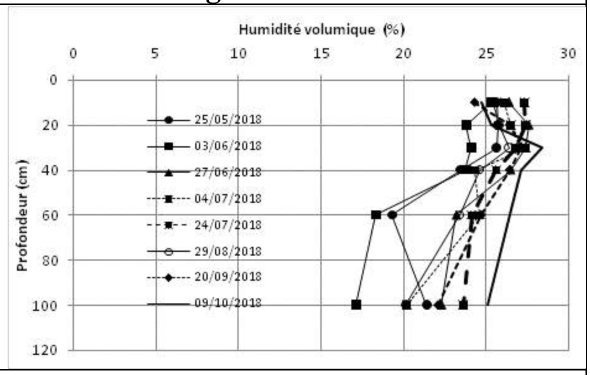
The assessment of the effect of compared water regimes and Water Retainer doses becomes remarkable by realizing the evolution graph of soil water reserve (SWR) on the depth 100 cm as illustrated by figure 5. The graph shows clearly that the water reserve on the period from 27 June to 19 September is higher under the R0 regime, followed by the combination R1d2 and R1d1 in this order. Under regime R2, the soil water reserve under *Water Retainer* dose d2 is greater than that under d1. The differences between the different combinations are reduced by the heavy rainfall recorded in early October as shown by stocks calculated on 09 October.



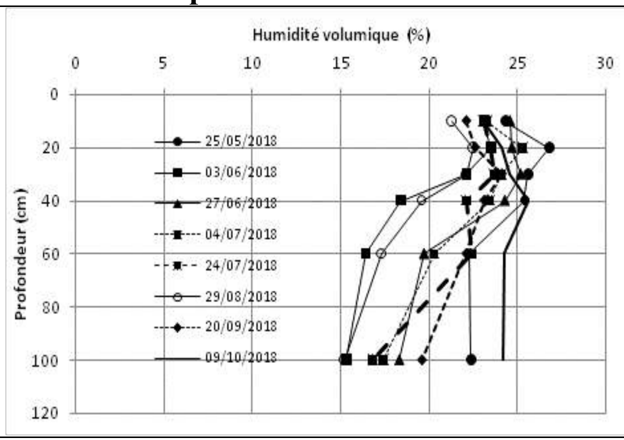
Soil moisture profile under the control regime R0



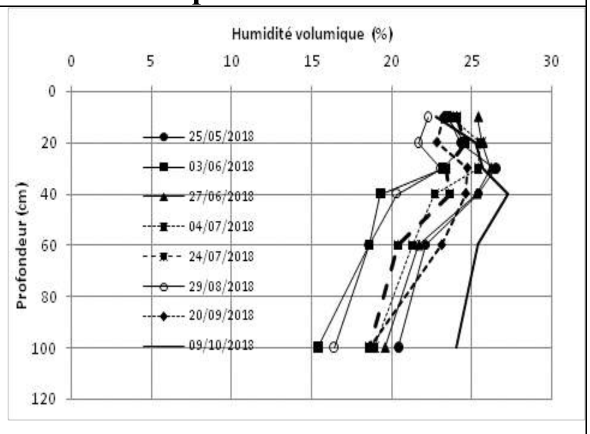
Soil moisture profile under R1d1



Soil moisture profile under R1d2



Soil moisture profile under R2d1



Soil moisture profile under R2d2

Figure 4. Soil moisture profile under different combinations of water regime and Water Retainer

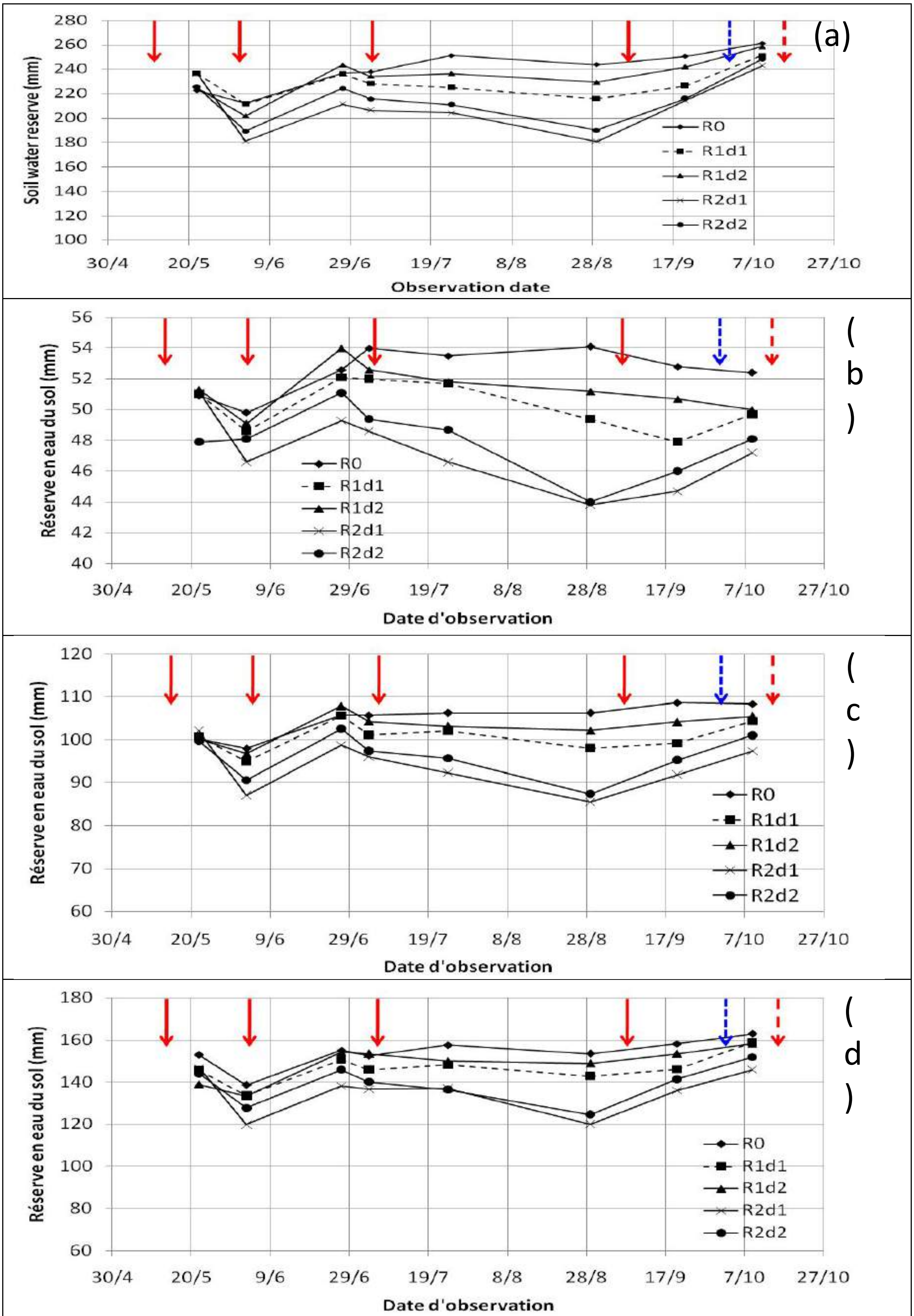


Figure 5. Soil water reserve evolution on (a) 0-100 cm, (b) 0-20 cm, (c) 0-40 cm and (d) 0 60 cm

3. 5. Flowering rate, fruit set and physiological drop rate of fruits

The first application of Water Retainer was made on April 16, 2018. This date coincides with the last week of the flowering stage. The rains following the first application of the Water Retainer forced the stoppage of irrigations and homogenized soil moisture in the field. The measured values of the flowering rate and subsequently of the setting rate of fruits were not influenced by either the water regime or the Water Retainer dose. Analysis of the variance showed that the effect of these two parameters on the flowering rate and the setting rate is not significant at the 5% threshold. The average values obtained are summarized in Table 5.

However, the physiological drop rate of fruits measured towards the end of June was affected by both factors. The effects of the irrigation regime and the Water Retainer dose are significant at the 5% threshold. The interaction between the two parameters is insignificant (5%). The physiological drop of fruits increases with water stress and decreases by increasing the Water Retainer dose. The average values vary between 0.47 under the control regime R0 and 0.72 under the R2 regime with the dose d1 of Water Retainer.

Table 6. Flowering rate, fruit set rate, physiological drop rate of fruits per treatment

Water regime	*water retainer* dose	Flowering rate	fruit set rate	physiological drop rate
R0	**-**	0.78 ± 0.056 a*	0.74 ±0.12 a*	0.47 ±0.13 a*
R1	**d1**	0.75 ±0.078 a	0.80 ±0.08 a	0.59 ±0.15 b
	d2	0.76 ±0.051 a	0.77 ±0.16 a	0.48 ±0.12 a
R2	**d1**	0.77 ±0.070 a	0.80 ±0.19 a	0.72 ±0.14 c
	d2	0.75 ±0.067 a	0.71 ±0.14 a	0.61 ±0.19 b

***:** The averages of the same column followed by the same letter are not statistically different according to the Fisher test (threshold 5% or 1%)

3. 6. Evolution of the length of spring shoots

Vegetative growth monitoring is limited to spring shoot. At the beginning of the experiment, six spring shoots were marked and numbered to monitor growth in length. To ensure more homogeneity between selected shoots and limit the effect of other factors not studied (orientation, location on the tree ...), spring shoots were chosen at the height of an adult on the south face of trees. They must also come from the median area of the twigs aged 1 year. The measurements are done every two weeks by means of calipers.

The analysis of the graph shows that shoots under the R0 regime followed by those under the R1d1 combination are consistently longer than the others from the measurements taken on May 15. For the same water regime, the shoots are shorter under the dose of 1 ml / m^2 of *Water Retainer* compared to the dose 2 ml / m^2. The shoots under the R2d1 combination are the shortest. This shows that the growth in spring shoot length is affected by the water regime and the Water Retainer dose.

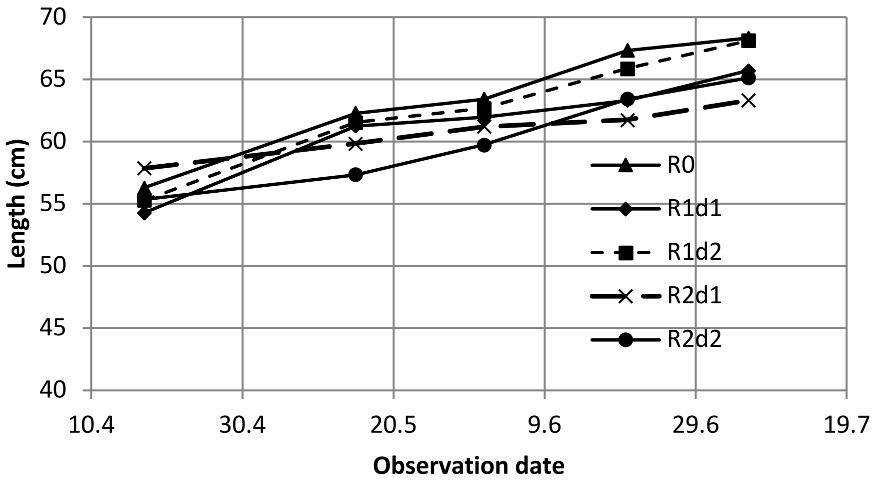


Figure 6. Evolution of the length of shoots according to the water regime and the dose of Water Retainer

3. 7. Number of summer shoots issued

Under normal conditions of temperature and humidity, three waves of vegetative emission are to be noted in citrus tree. They are characterized by young branches carrying leaves in light green. These are spring, summer and autumn shoots. The summer shoots are spread over two months between July and August. The number of summer shoots elaborated depends very much on the level of water supply of the tree. As a result, the number of shoots emitted by the tree is used as indicators of the level of satisfaction of the water requirements. Thus, a count of number of shoots was carried out on August 28th. The table summarizes the number of shoots per water regime and per dose of Water Retainer.

Table 7. Number of summer shoots

Water regime	Water Retainer dose	Number of shoots
R0	-	21,7 ± 2,6
R1	d1	17,5 ± 1,7
	d2	19,3 ± 3,1
R2	d1	11,5 ± 1,5
	d2	12,4 ± 1,4

The results obtained show a decrease in the number of shoots with water stress. The average values are 21.7, 19.4 and 11.9 under the regimes R0, R1 and R2 respectively. For the same water regime, the number of shoot is higher under the doses of Water Retainer d2 of 2 ml / m2.

3. 8. Evolution of fruit diameter

At the beginning of July, which coincides with the end of physiological drop stage of fruits, six fruits were chosen at the level of each treatment to follow the evolution of their diameters. The results obtained were translated in the form of a graph (figure).

The analysis of the graphs of fruits diameter evolution (Figure 5) shows a marked upward trend since the beginning of the measurements under all the combinations of water regime and dose of Water Retainer. Differences in fruit diameter between different treatments become visible from mid-August. The diameters of the fruits from trees under regimes R0 and R1d2 are comparable and exceed those of R1d1 combination. The diameters of the fruits from the trees under the R2 regimes are constantly lower than the previous ones. It can be confirmed that the diameter of fruit decreases with water stress. This decrease is limited by more dose of Water Retainer.

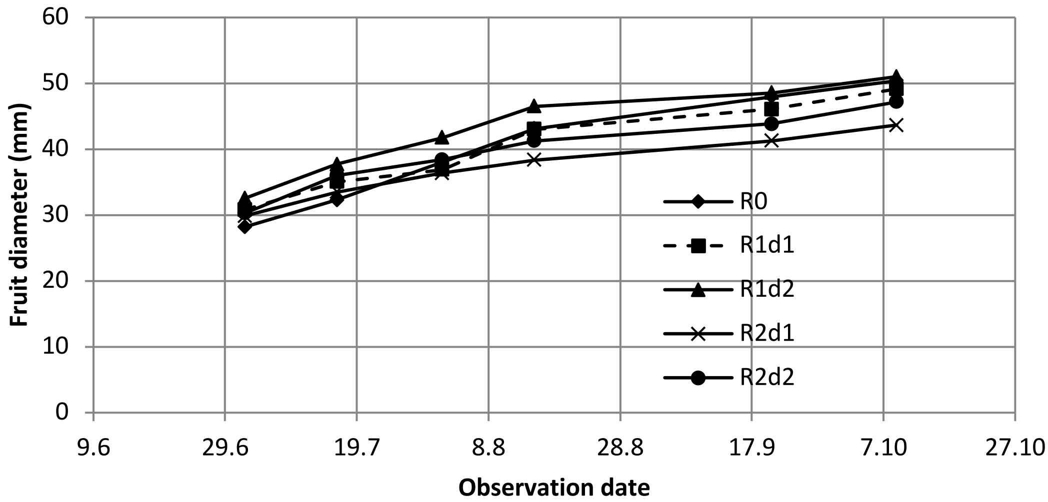


Figure 7. Evolution of average diameter of fruits

Marked fruit for measuring diameter

Count of the number of summer shoots issued

IV. Conclusion

The results obtained showed that the compared combinations of water regimes and the Water Retainer doses have a significant effect on the growth and development of the "Morocco late". Late application of water regimes and Water Retainer doses towards the end of the flowering stage did not affect flowering or fruit set rate. The physiological drop of fruits was accentuated by more water stress and attenuated by Water Retainer. The diameter of fruit and the emission of spring shoots are disadvantaged by water stress and improved by more Water Retainer. The evolution of the soil water reserve on the depth 0 -100 cm highlights the positive effect of Water Retainer by reducing the drawdown of the water reserve.

Acknowledgement

This work was carried out in collaboration with the Water&Soil® Ltd. (Hungary) the producer of the Water&Soil® Water Retainer soil conditioner (www.waterandsoil.eu). The authors would gratify and thanks the Water&Soil® Ltd company for his contribution by providing the soil conditioner product used in the experimentations.

water&soil

المعهد الوطني للبحث الزراعي
Institut National de la Recherche Agronomique

National Institute for Agricultural Research

Scientific report

Use of Water Retainer to save water irrigation and to improve crop productivity In Morocco:

Case study: Silage Corn

Allal Tazi experimental station

Gharb region

Prepared by INRA scientific team

le Chef du Département Environnement et Ressources Naturelles
MOUSSADEK Rachid

Edition. Dec. 2018

1. Introduction

Drought stress is the most important factor limiting plant growth in arid and semi-arid regions. Due to water resource scarcity, water-saving agriculture is essential for sustainable development of crop production. Furthermore, droughts are predicted to become increasingly severe due to climate change (Gornall et *al.*, 2010). Hence, effective alternatives management strategies are required for the efficient use of water. One of the new methods used for managing water in soil is the use of soil conditioner materials such as polymers, hydrogels, and water retainer, as a storage tank to prevent water loss and increase irrigation efficiency. Thus, materials have been established as a soil conditioner to reduce soil water loss and increase crop yield. The application of this material to soil may increase water-holding capacities and nutrient utilization efficiency and reduce water loss (Lentz & Sojka, 1994; Lentz et *al.*, 1998). Currently, further extension of application domains of superabsorbent hydrogels was limited because the practically available products are mainly petroleum-based synthetic polymer with high production cost and poor environmental friendly properties. Recently, alternatives products were developed such as water and soil water retainer (WSWR). The WSWR is manufactured by Water& Soil Ltd. Company (Hungary). Studies showing the effect of water retainer are scarce and not conclusive. In this sense, this study is part of a research aiming to evaluate the impact of application the water retainer in soil surface on corn crop focusing on soil moisture, crop growth, biomass yield and water productivity. To measure the effects on corn plant development, seedlings were cultivated under field condition with different irrigation regimes.

2. Objectives

The objectives of this work was to determine the effects of application of water retainer solution on soil moisture, crop growth, biomass yield and water productivity of silage corn hybrids (Monastir) under normal (100%ETc) and drought stress conditions (75% and 50% ETc). To achieve these objectives the experimentation was conducted under field condition at Sidi Allal Tazi experimental farm (INRA Morocco).

3. Methodology

3.1.Experimentation

The experiment was carried out in in the experimental farm Sidi Allal Tazi of the Regional Agricultural Research Center (RARC of Kenitra (INRA Morocco) located north of Kenitra city, during Jun-October 2018. The silage corn hybrid “Monastir” was used in this study. The experiment was arranged in spilt-plot with 4 replicates by following randomized complete blocks (RCBD) design (Fig 1.), with main factorial irrigation regime in main plots with three levels (well-irrigated control at 100% ET_c, deficit irrigated (DI) at 75% ETc and 50% ET_c, and water retainer treatment is the second factor in sub-plot with two levels (Non-Treated 0ml/l and Treated 2ml of WSWR /m^2) applied to soil surface after seed sowing. Treated sub-plots have been received 4.8L of diluted WSWR per plot. Each sub-plot included 8 rows with spacing of 0.50 m and length of 6 m (24m^2). The experimental layout was presented in figure n°1. The soil was clay soil type locally named Dehs.

Seeds have sowed at 20/06/2018 and the product was sprayed in the top surface of plot substrate for treated ones and then all experimental plots were irrigated by the same amount of water (20mm). The plots were irrigated two times a week. The deficit irrigated plots received 75% or half amount of applied water to well-irrigated and with the same frequency watering. Before swing the soil of all experimental plots were amended by the fertilizer and was applied equivalent to 42 kg of N, 90 kg of P_2O_5 and 90 kg of K_2O per ha just before planting, followed by 69 and 92 kg of N/ha at 33 and 57 days after planting. Manual weeding was adopted at two-week intervals to avoid weeds competitions to corn plants. The plants were grown in rows and the distance between rows was 50 cm. The spacing between plants within each row was 25 cm (80000 plant. ha^{-1}). All other treatments were the same for control and treated sub-plots.

The climate in this area is semi-arid, Average of rain was about 520 mm; and mean temperature was °C, with a maximum in August that often exceeds 45 °C and a minimum in January of approximately 0°C. The climatic data for the studying periods were monitored from a local meteorological station at 500m and was presented in figures n°25-28.

Plant height was measured during the experimental period for 10 plants per sub-plots randomly marked in the 4th and 5th row for each sub-plot, the mean values of the measured plant were considered as representatives for each sub-plot. At the end of the experimental period all sub-plot were harvested and up ground parts (shoot: lives + stem+ tassels) were weighted for fresh weight (FW). 5 plants were randomly selected from each sub-plot to determine plant fresh and dry weight, ears fresh and dry weight and biomass yield. The ear to shoot ration was calculated as ears weight divided by shoot weight. Then, the samples were dried in an oven at 80°C at least one week, and dry (DW) and fresh (FW) biomass yield per unit area was measured. The amount of applied water was noted and water use efficiency (WUE) or water productivity (WP kg/m^3) was calculated as total plant biomass (kg) divided by total water applied (m^3) for treated and no-treated of 100%, 75% and 50% ETc sub-pots. Then total biomass yield per ha was estimated.

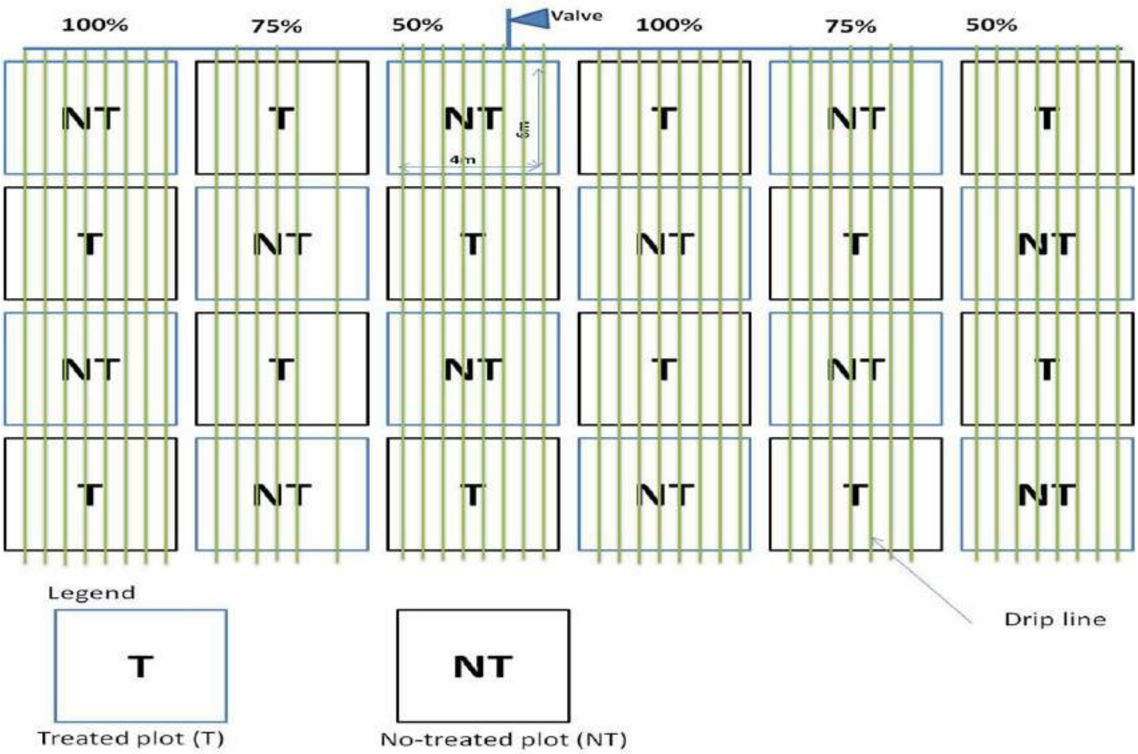


Fig 1. Experimental design in field condition

Fig2. Sowing corn seeds in the field plot experimentation at Sidi Allal Tazi farm

Fig3. Preparation the dilute WSWR solution in the backpack sprayer (16l capacity) (left) and spraying the dilute WSWR in the soil surface after sowing

Fig4. Drip line installed in the irrigated plots with emerged seeds (left) measuring soil moisture by device (right).

Fig 5. Harvesting plots and team work at field experimentation

Fig6. Weighting harvested fresh biomass for each sub-plot

3.2.Statistic analysis of data

Data were analyzed using the analysis of variance (ANOVA) procedures of SAS (SAS Institute, 2003). Effects were considered significant at P-values ≤0.05 in the F-test. Duncan multiple range test was conducted for comparison of means.

4. Results

4.1.Climate condition in Sidi Allal Tazi site and water application during experimentation

The rainfall over the experimental periods were 17.6mm with average maximum and minimum air temperatures of 33.11°C and 18.07°C (Fig7.), respectively, a mean potential evapotranspiration (ET_0) was 5.97 mm/day and cumulative crop evapotranspiration (ET_c) was 545.38mm (Fig9). The mean relative humidity was 66.85% over test period (Fig8).
The cumulative water applied in 2018 for the control 100% ETc, 75% and 50% ETc were 13.09 m^3 (545.38mm), 9.82 m^3 (426.6mm) and 6.54m^3 (290.3mm) per sub-plot (or per ha), respectively (Fig10.).

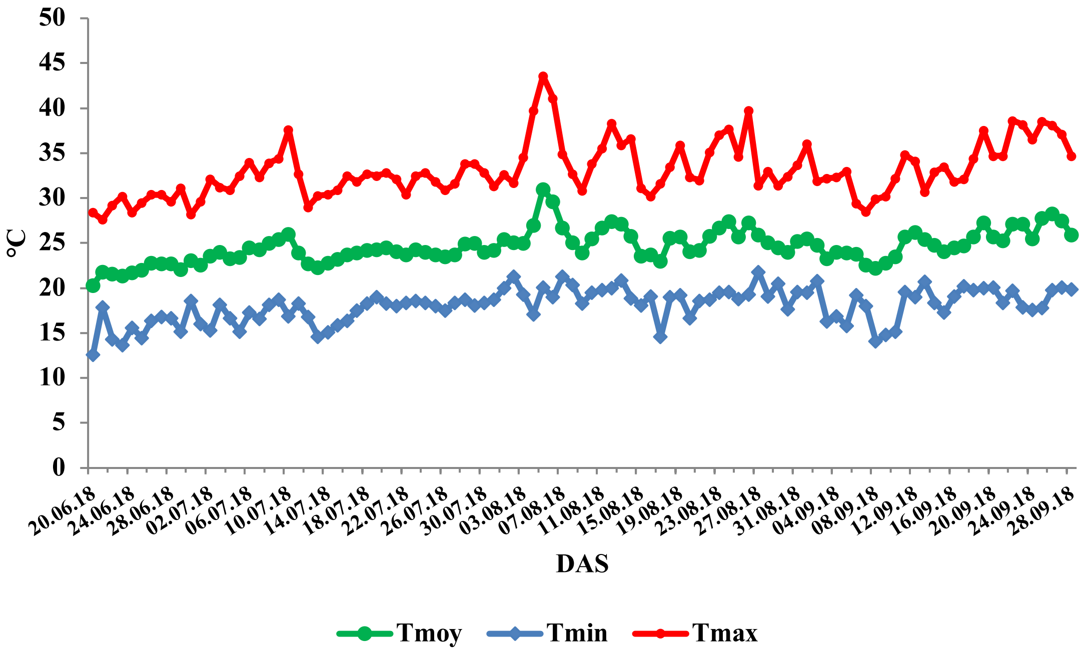


Fig7. Variation of air temperatures during experiment period

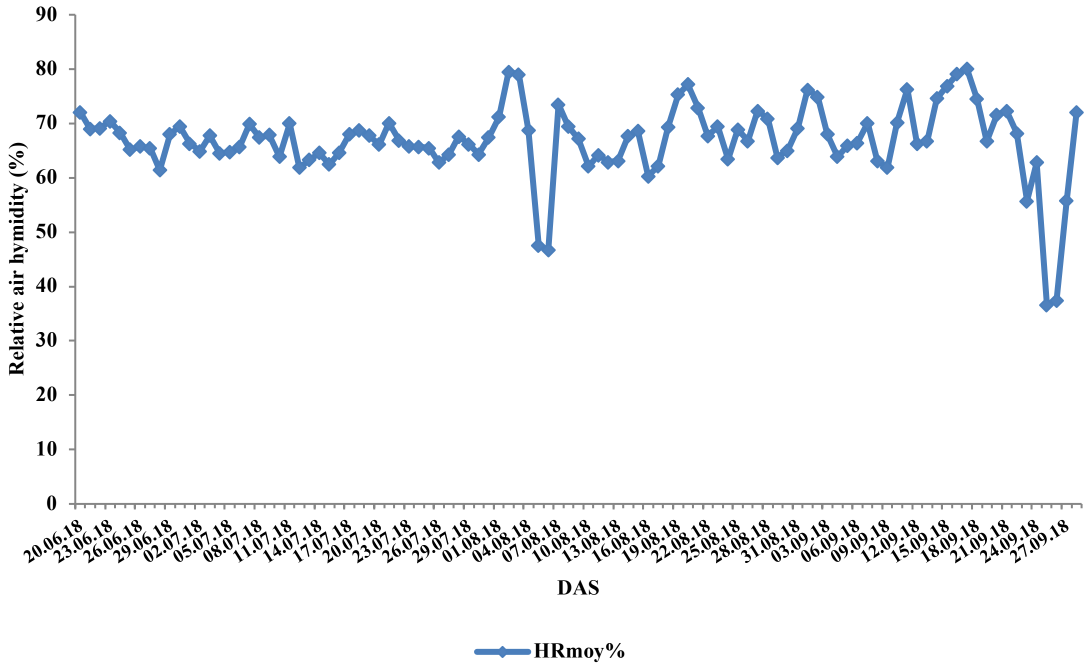


Fig8. Variation of relative air humidity (RH %) during experiment period

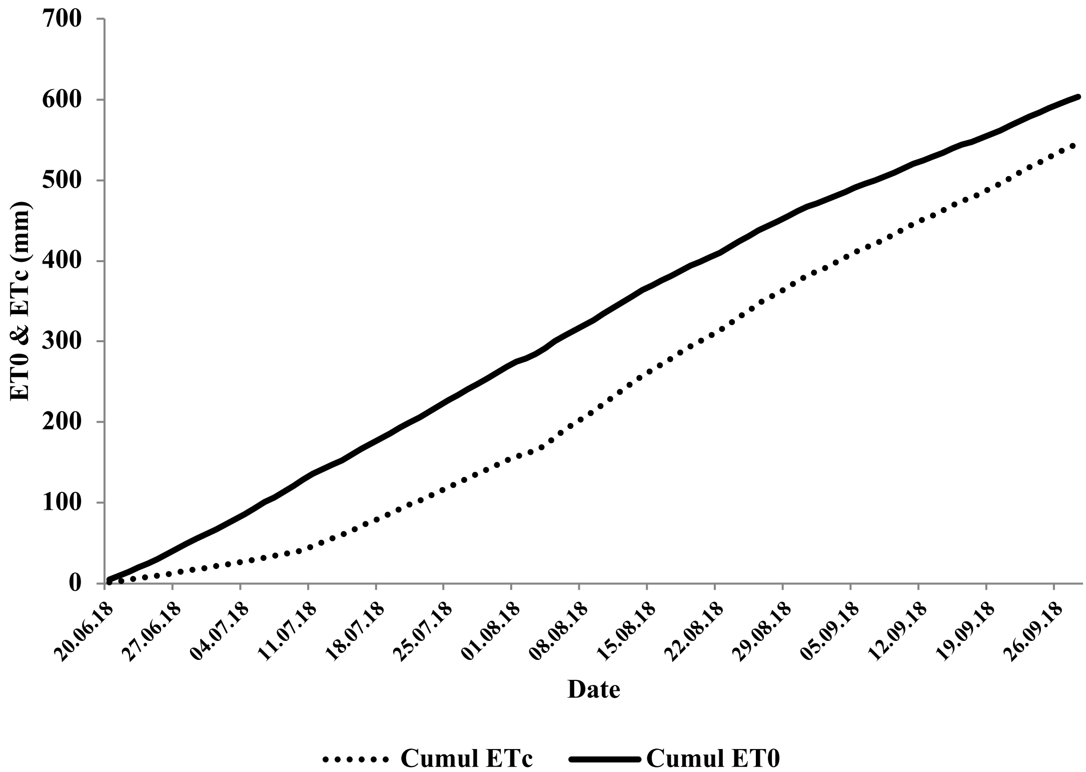


Fig9. Cumulative crop (ET_c) and potential evapotranspiration (ET_0) during experiment period (DAS: day after sowing)

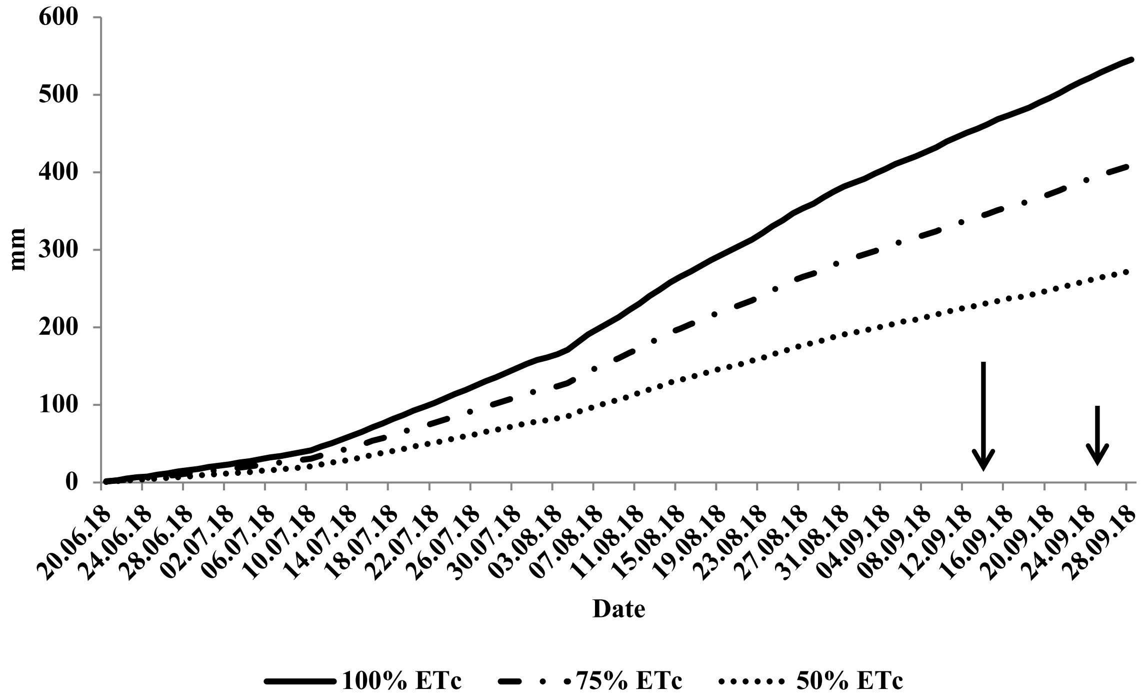


Fig10. Cumulative water applied (mm) for control (WI) and drought stressed (DI) pots during experiment period (DAS: day after sowing)

4.1.1. Effect of drought stress and water retainer on soil humidity

Soil was affected by the irrigation regimes and treatment, among various tested irrigation regimes, highest soil moisture was obtained from treated plots as compared to no-treated ones for each irrigation regimes and soil depth (Fig 11, 12 and 13).

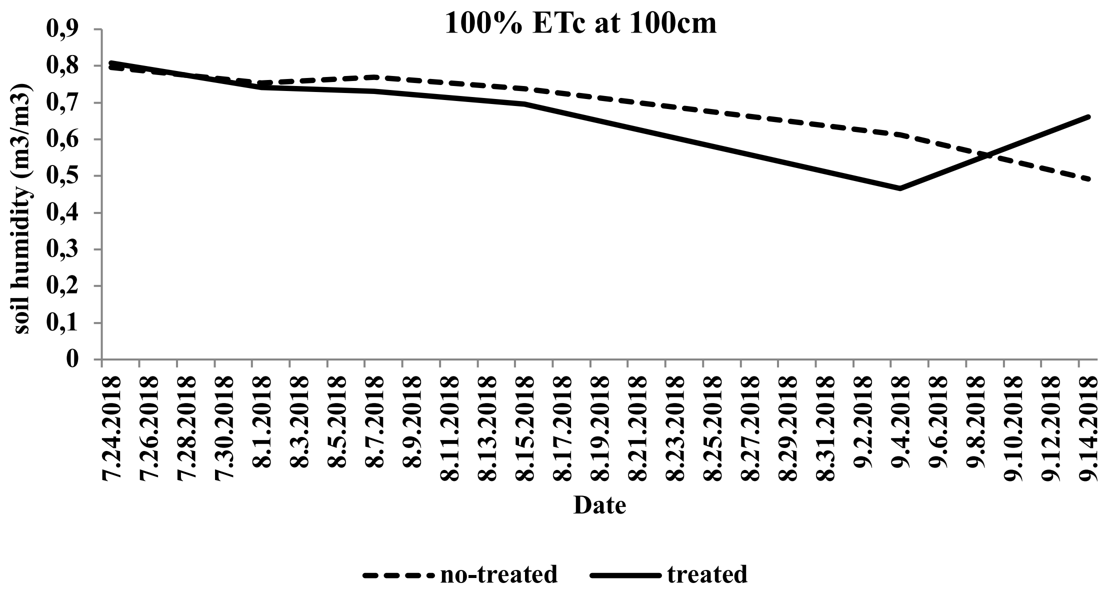


Fig11. Variation of soil moisture of 100% ETc at 100cm depth of treated and no-treated plots during experiment period

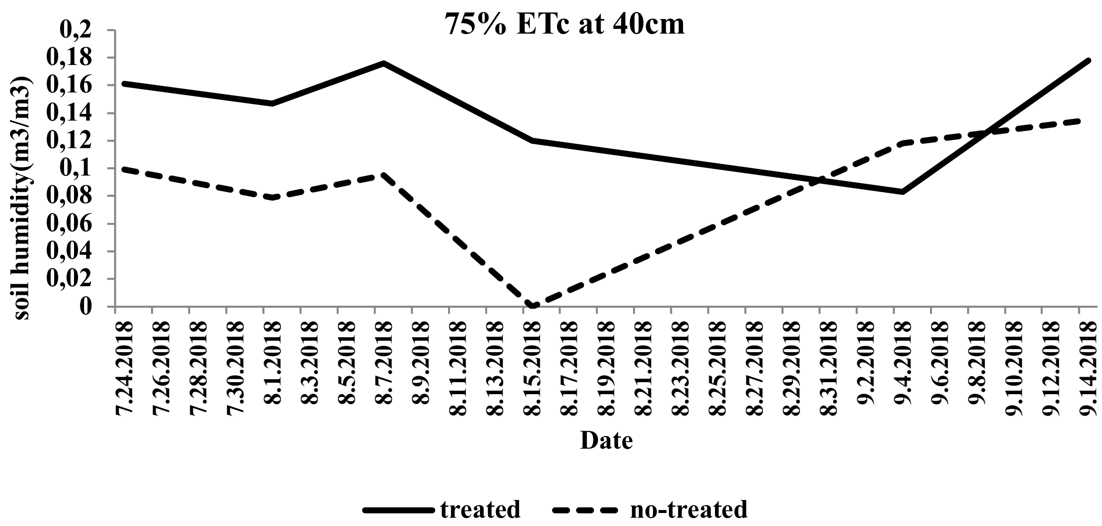


Fig12. Variation of soil moisture of 75% ETc at 40cm depth of treated and no-treated plots during experiment period

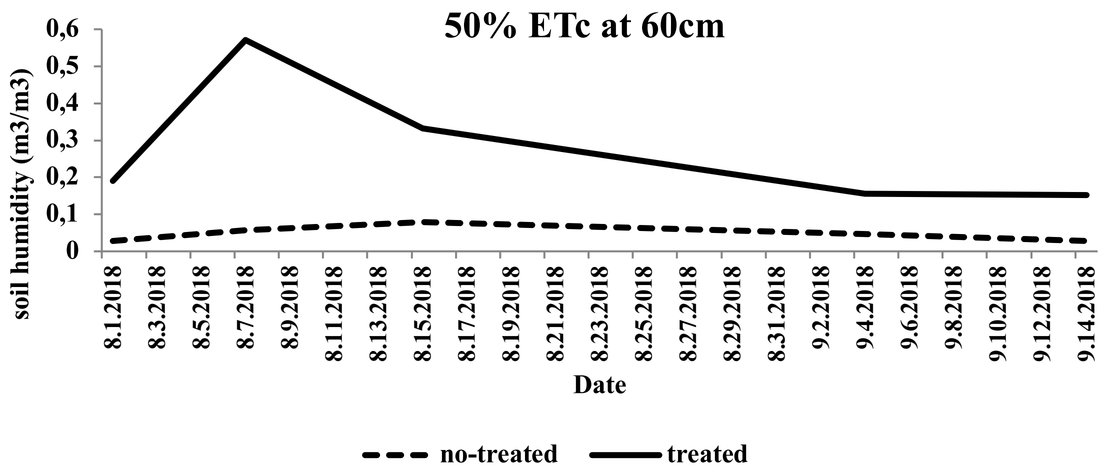


Fig13. Variation of soil moisture of 50% ETc at 60cm depth of treated and no-treated plots during experiment period

4.1.2. Effect of drought stress and water retainer on growth of corn seedlings

Plant growth was significantly affected ($P < 0.0001$) by the irrigation regimes (Table1.), among various tested irrigation regimes, highest plant height was obtained from 75%ETc regime (261.1 cm/plant) and will-irrigation control regimes (255.4cm/plant) while the lowest (244.7 cm/plant), was observed at deficit irrigation regime (50%ETc) (Fig14&15.). ANOVA analysis has revealed no significant effect WSWR treatment (T) (P=0.0690) on plant height at the end of the experimentation (Table1.).

Table1. Variance analysis (ANOVA) of irrigation regime (IR) and WSWR treatment (T) effects on plant height (cm) and number of leaves per plant (#/plant) at 59 and 91 day after sowing (DAS)

Parameters	IR	T	IR*T
Plant height 59 DAS (18/08/2018)	<0.0001	0.0917	0.7391
Plant height 91 DAS (19/09/2018)	<0.0001	0.0690	0.2162

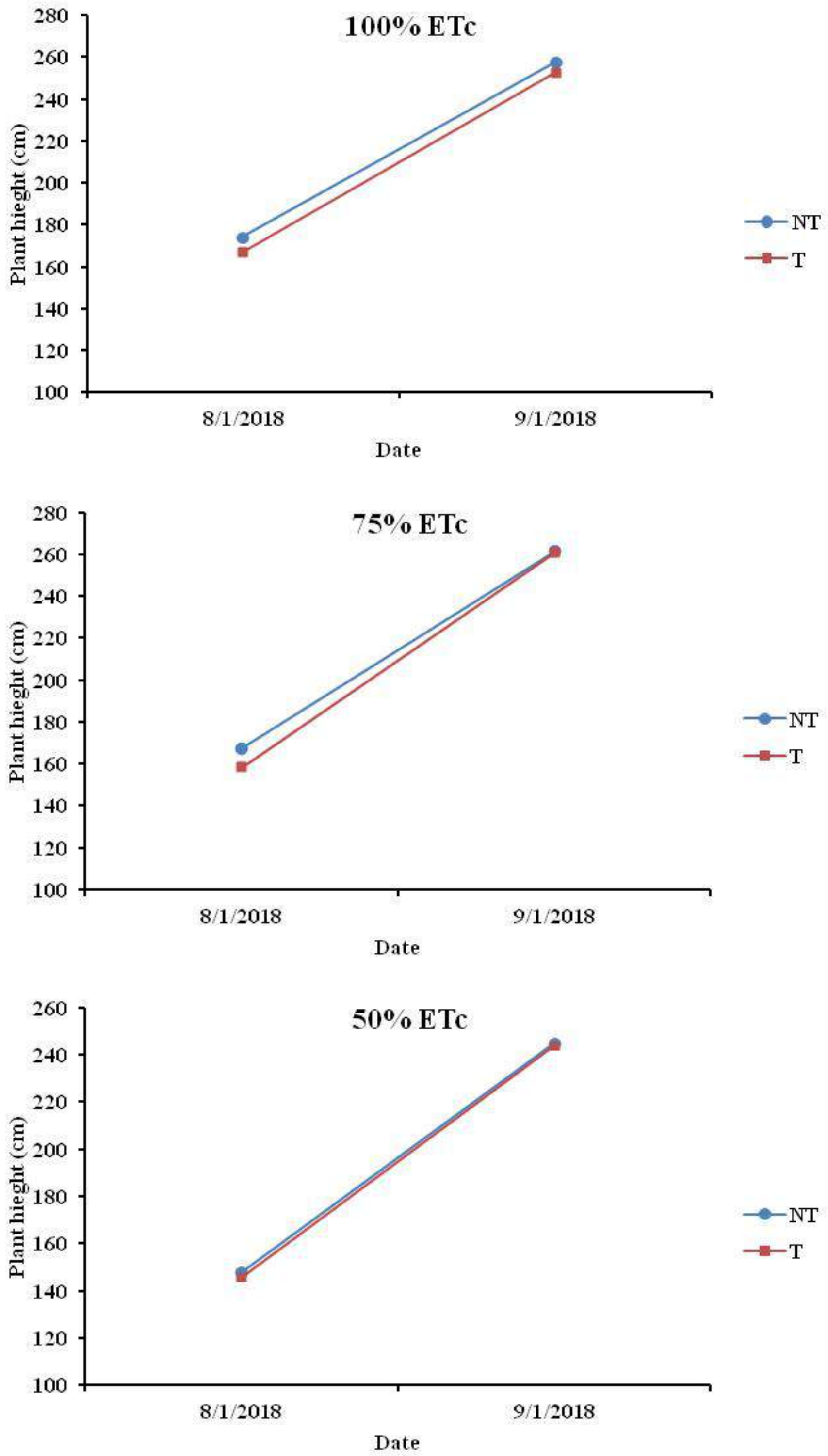


Fig14. Evolution of plant height of treated and no-treated plots under Well-irrigation (100% ETc) and deficit irrigation regimes (75% and 50% ETc) (at 18/08/2018 and 19/09/2018) (n=20).

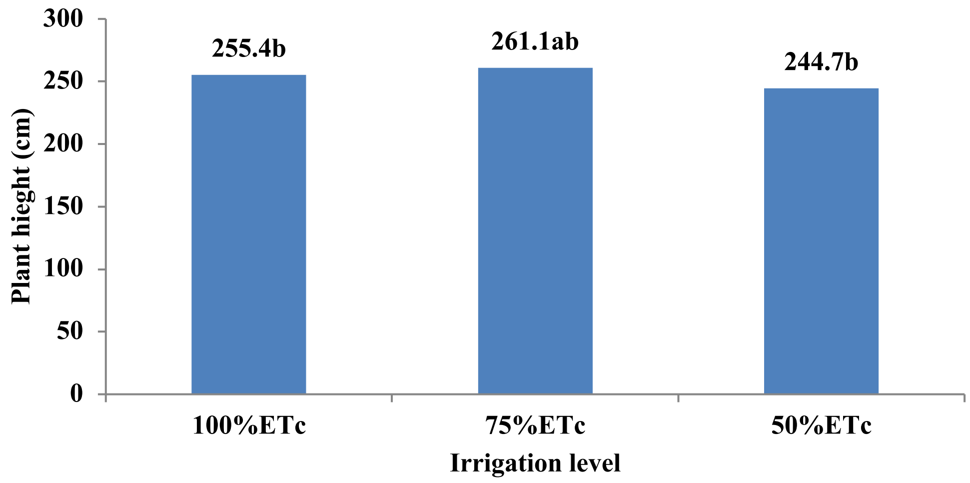


Fig15. Plant height under Well-irrigation (100% ETc), deficit irrigation regimes 75% and 50% ETc (measured at 19/09/2018) (n=20).

4.1.3. Effect of irrigation regime and water retainer on biomass production of corn seedlings

Shoot fresh and dry weight was not significantly affected (p=0.7203, p=0.1371, respectively) by the irrigation regimes or by WSWR treatment (p= 0.4789, p=0.5804) (Table 2). Data showed that WSWR treatment had increased the shoot fresh weight (g/plant) for all irrigation regimes. The highest shoot fresh weight was obtained from 75% ETc irrigation regimes (794.4 and 814.5 g/plant for no-treated and treated plots, respectively) (fig 16).

ANOVA analysis has revealed absence of significant effect of irrigation regimes (IR) (P=0.1371) and WSWR treatment (T) (p=0.5804) on shoot dry weight at the end of the experimentation (Table2.).

Highest shoot dry weight was observed from 75% ETc irrigation regimes (382.5 and 372.5 g/plant for no-treated and treated plots, respectively). (Fig17.).

Ears fresh and dry weight were not significantly affected by the irrigation regimes (p=0.2036, p=0.1681, respectively) and WSWR treatment (p=0.0737, p=0.3708, respectively) (Table2.). Also, the ANOVA analysis has revealed absence of significant effect of irrigation regimes (IR) (P=0.4367, p=0.9172, respectively) and WSWR treatment (T) (p=0.1605, p=0.1599, respectively) on ear to shoot ratio of fresh and dry weight basis, respectively, at the end of the experimentation (Table2.).

Fresh biomass yield were not significantly affected by the irrigation regimes and treatment (p= 0.1993, p=0.491, respectively) (Table2.). The highest values of fresh biomass yield were observed under well-irrigated 75%ETc regimes (34.31 and 35.73 t/ha for no-treated and treated plots, respectively) (fig 23). The results indicated that treatment had increased (but not significantly) the fresh biomass yield of the silage corn tested (fig 23).

Table2. Variance analysis (ANOVA) of irrigation regime (IR) and WSWR treatment (T) effects on shoot fresh and dry weight (g/plant), Ears fresh and dry weight per plant, Ear to shoot ratio on fresh and dry basis, plant water content and fresh biomass yield (t/ha)

Parameters	IR	T	IR*T
Shoot fresh weight	0.7203	0.4789	0.9071
Shoot dry weight	0.1371	0.5804	0.6904
Ears fresh weight	0.2036	0.0737	0.6226
Ears dry weight	0.1681	0.3708	0.8918
Ears to shoot ratio (Fresh weight)	0.4367	0.1605	0.6384
Ears to shoot ratio (dry weight)	0.9172	0.1599	0.9740
Water content (%)	0.0279	0.9793	0.4367
Fresh biomass yield	0.1993	0.491	0.5718

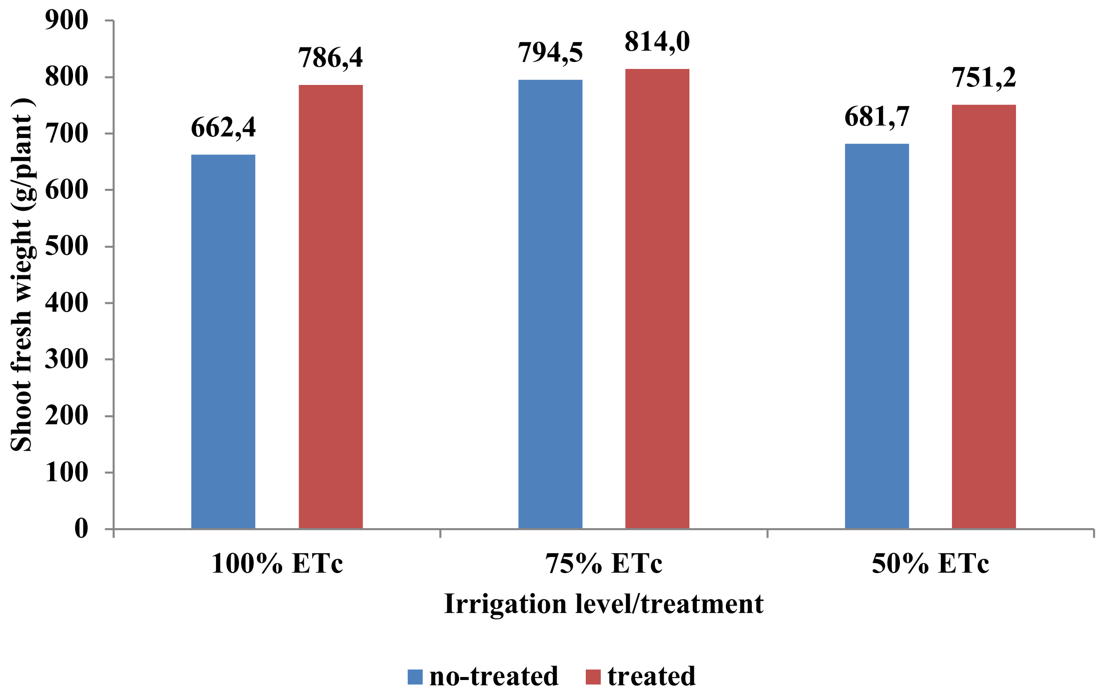


Fig16. Shoot fresh weight of treated and no-treated plots under 100%, 75% and 50%ETc irrigation regimes.

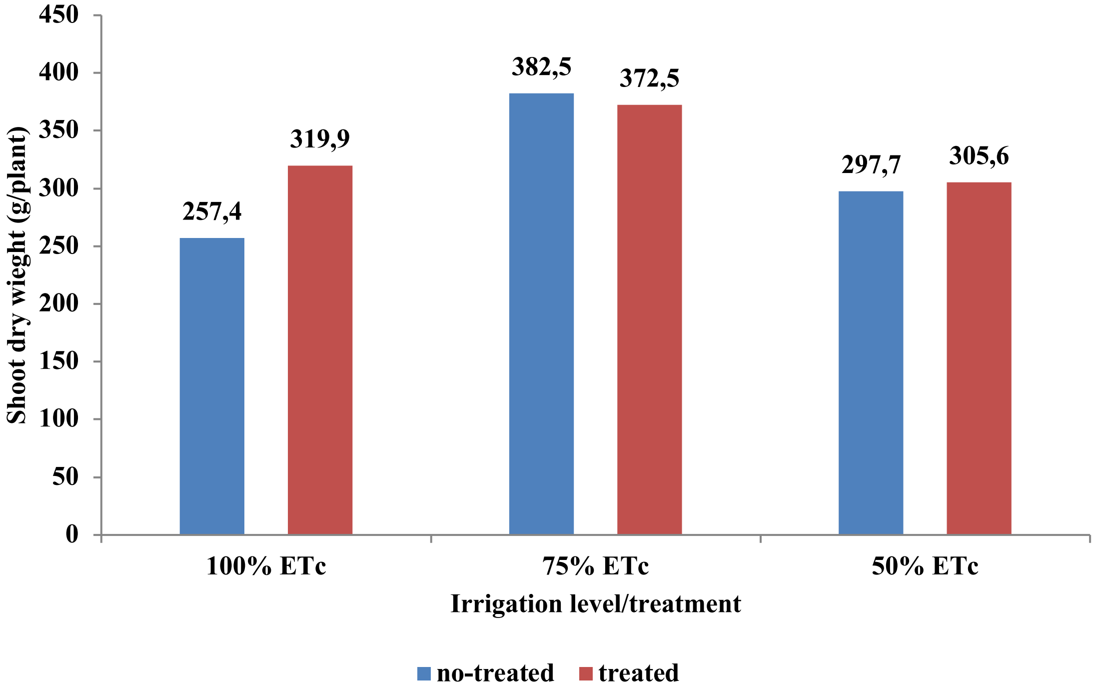


Fig17. Shoot dry weight of treated and no-treated plots under 100%, 75% and 50%ETc irrigation regimes.

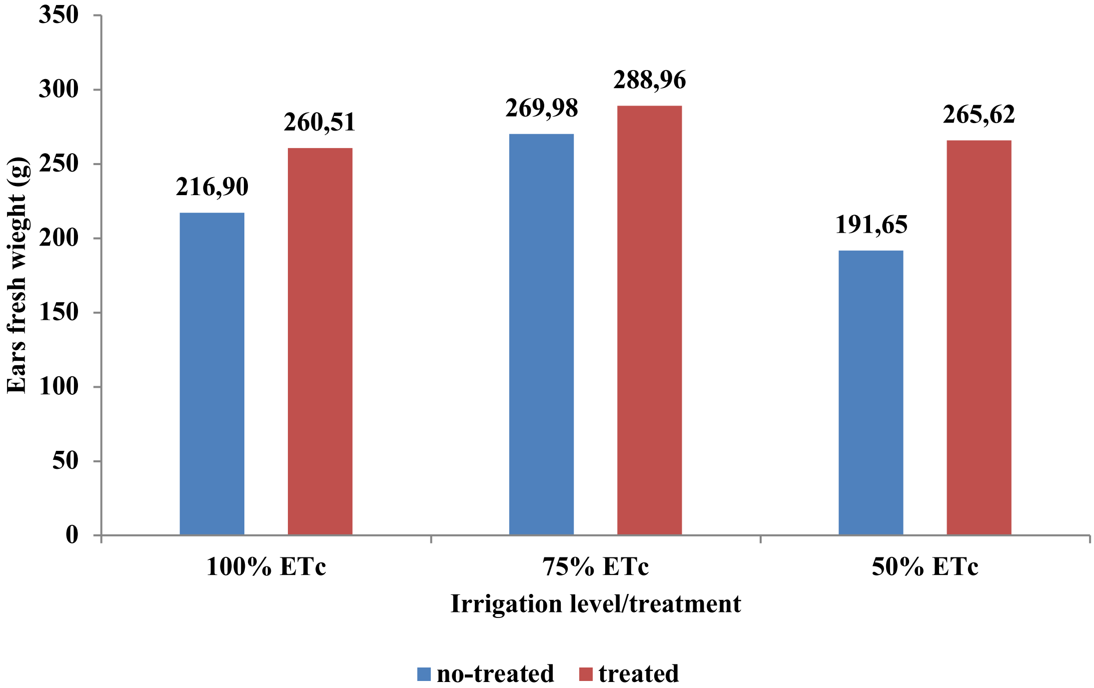


Fig18. Ears fresh weight of treated and no-treated plots under 100%, 75% and 50%ETc irrigation regimes.

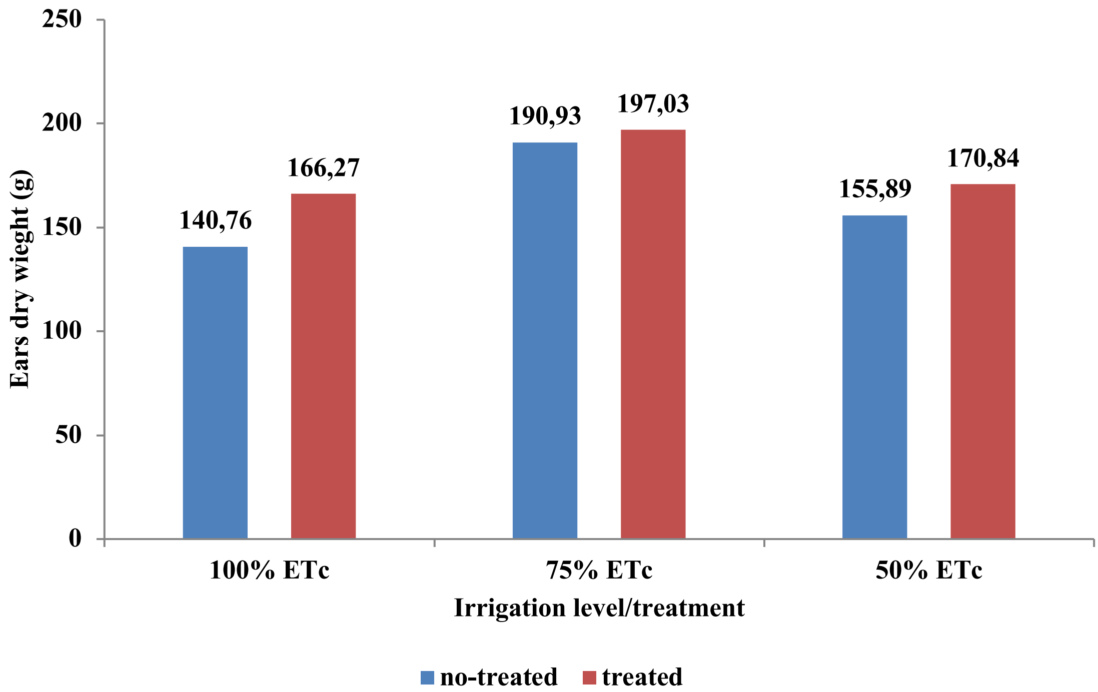


Fig19. Ears dry weight of treated and no-treated plots under 100%, 75% and 50%ETc irrigation regimes.

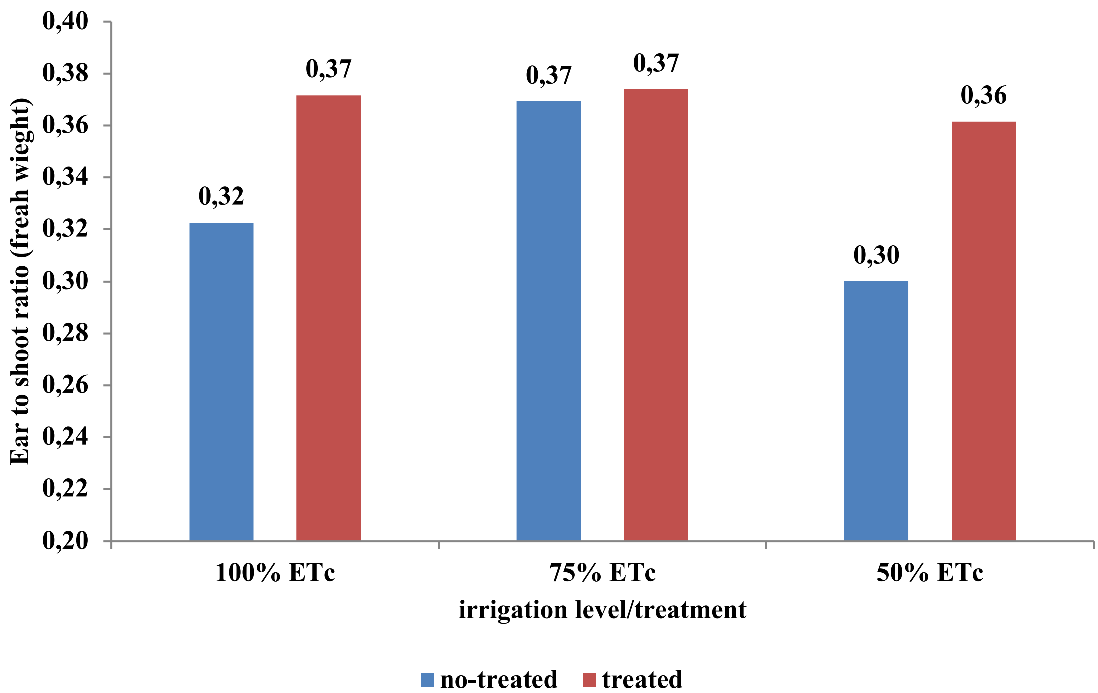


Fig20. Ear to shoot ratio (fresh weight basis) of treated and no-treated plots under 100%, 75% and 50%ETc irrigation regimes.

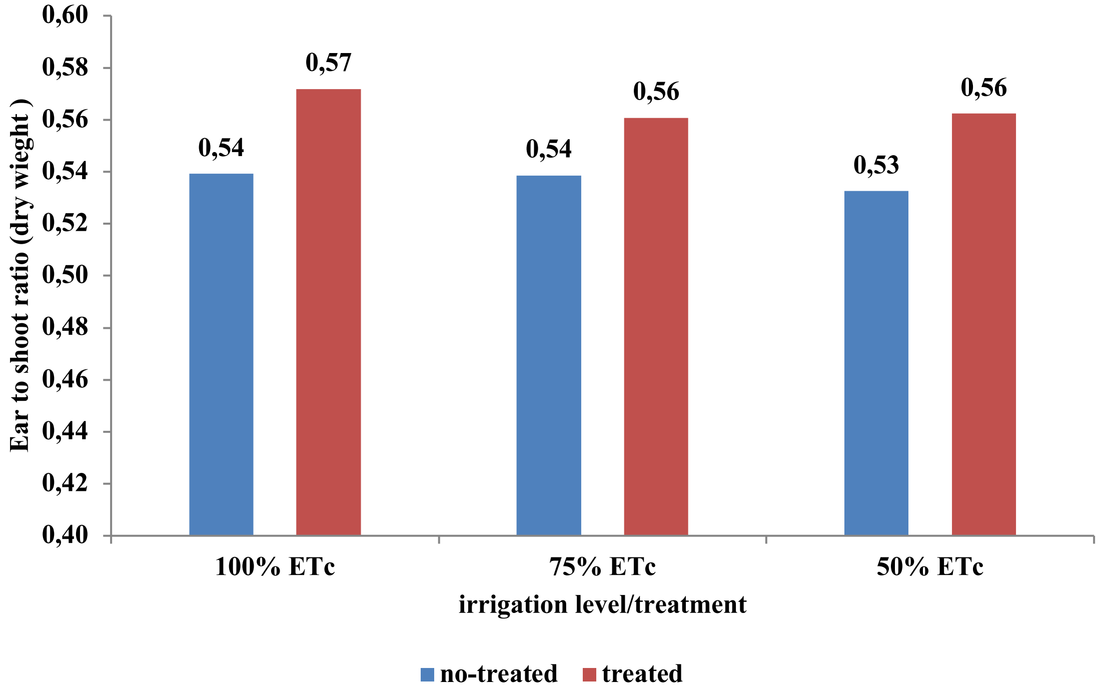


Fig21. Ear to shoot ratio (dry weight basis) of treated and no-treated plots under 100%, 75% and 50%ETc irrigation regimes.

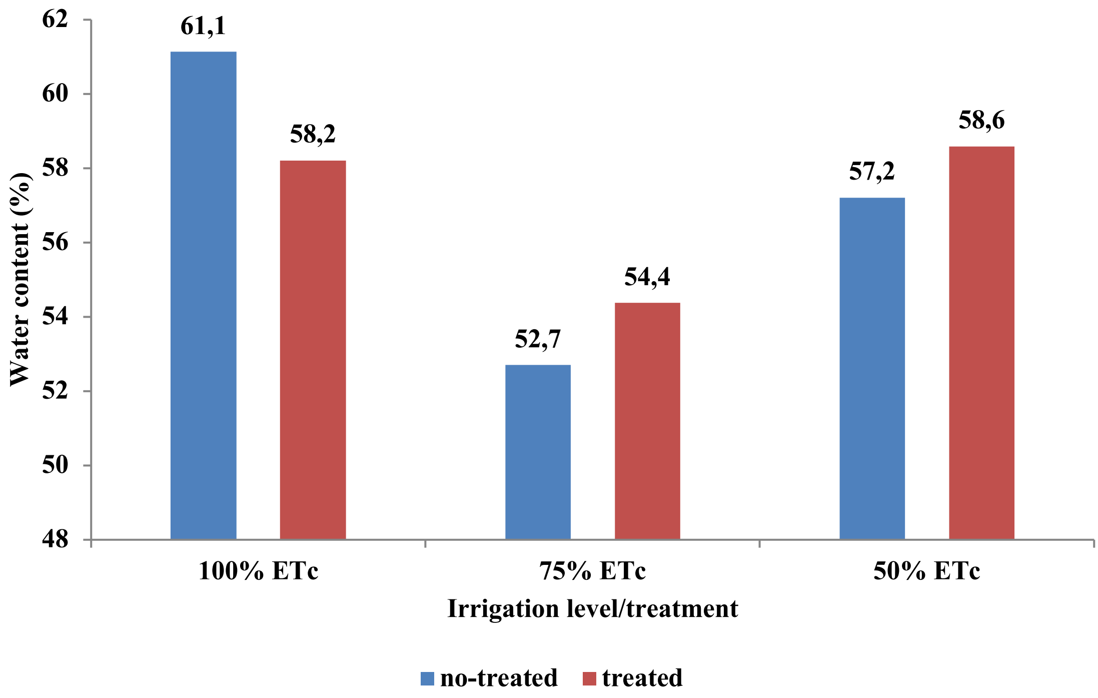


Fig22. Plant water content (%) of treated and no-treated plots under 100%, 75% and 50%ETc irrigation regimes.

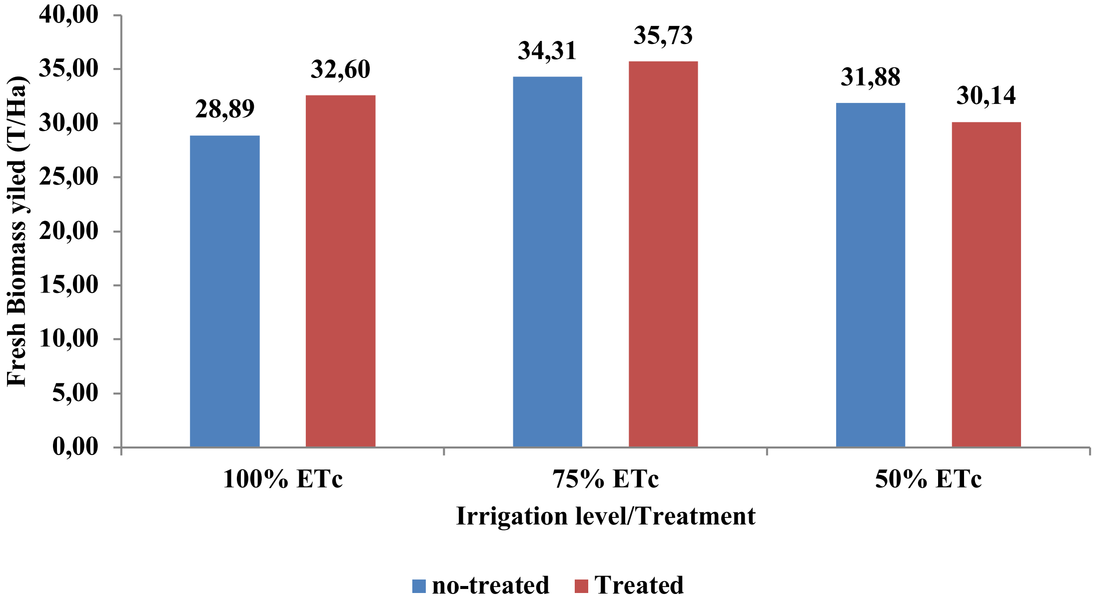


Fig23. Fresh biomass yield (t/ha) of treated and no-treated plots under 100%, 75% and 50%ETc irrigation regimes.

4.1.4. Effect of irrigation regime and water retainer on water productivity

Water productivity (kg of fresh corn biomass per 1m3 of water) was significantly affected by the irrigation levels ($p=0.0009$), but there was no significant effect of WSWR treatment on this parameter (Table 3.).

Data showed that the highest values of water productivity (fresh weight basis) was obtained under 50%ETc irrigation regime (10.98 10.38 and kg/m^3, for no-treated and treated plots, respectively), while the WSWR treatment have increased WP of plots irrigated by 100% and 75%ETc (fig24). The lowest values of WP were observed under well-irrigated regime (100% ETc) (5.13 and 5.79 kg/m^3, for no-treated and treated plots, respectively (fig24.).

Table3. Variance analysis (ANOVA) of irrigation regime (IR) and WSWR treatment (T) effects on water productivity (kg/m^3) fresh (FW) weight basis

Parameters	IR	T	IR*T
Water productivity (FW)	0.0009	0.5469	0.7819

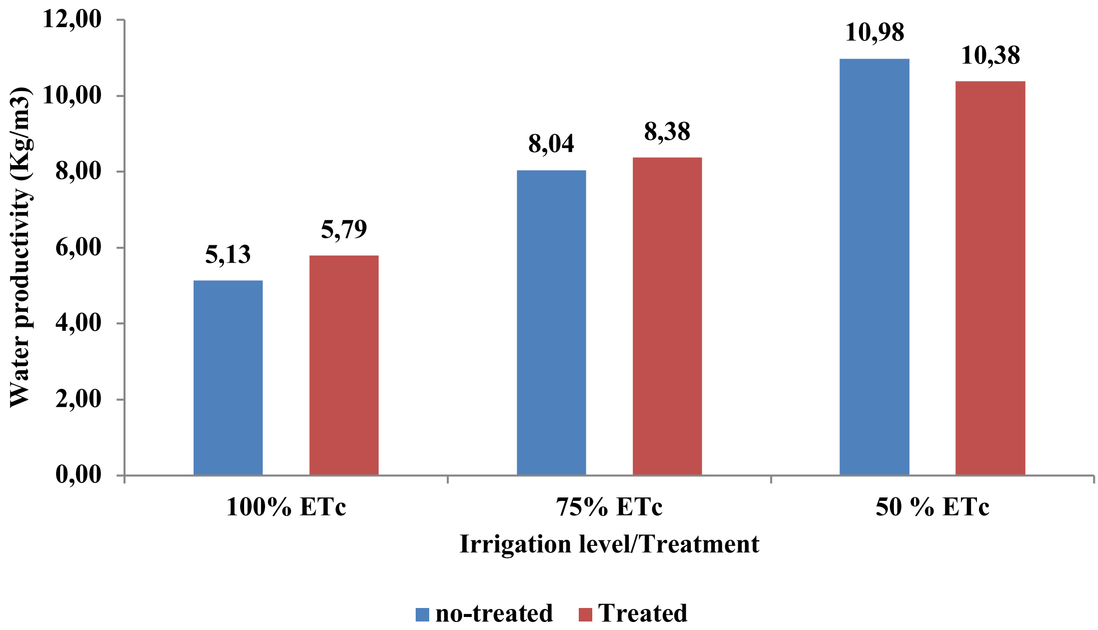


Fig24. Water productivity (fresh weight FW basis) of treated and no-treated plots under 100%, 75% and 50%ETc irrigation regimes.

Fig25. Silage corn under treated (T) well-irrigated (100%ETc) sub-plot

Fig26. Silage corn under no-treated (NT) well-irrigated (100%ETc) sub-plot

Fig27. Silage corn under treated (T) deficit-irrigated (75%ETc) sub-plot

Fig28. Silage corn under no-treated (NT) deficit-irrigated (75%ETc) sub-plot

Fig29. Silage corn under treated (T) deficit-irrigated (50%ETc) sub-plot

Fig30. Silage corn under no-treated (NT) deficit-irrigated (50%ETc) sub-plot

5. Conclusion

Results of this study revealed a noticeable effect of water deficiency on the production of forage. Under such experimental conditions, irrigation levels seemed to be a more influential factor compared to WSWR with regards to most parameters used.
WSWR increased soil moisture, plant height, shoot and ears weight, ear to shoot ration fresh biomass yield and water use efficiency under different irrigation regimes. Thus suggested that using WSWR was recommended under deficit irrigation regime (75% ETc), for saving water and increasing corn silage production.
Overall, considering the water scarcity situation in Morocco and importance of silage corn as a forage plant, application of WSWR can be useful to save more water that leads to produce more yields.

Acknowledgement

This work was carried out in collaboration with the Water&Soil® Ltd. (Hungary) the producer of the Water&Soil® Water Retainer soil conditioner (www.waterandsoil.eu). The authors would gratify and thanks the Water&Soil® Ltd company for his contribution by providing the soil conditioner product used in the experimentations.

water&soil

المعهد الوطني للبحث الزراعي
Institut National de la Recherche Agronomique

Royaume du Maroc
المملكة المغربية
المعهد الوطني للبحث الزراعي ★ INSTITUT NATIONAL DE LA RECHERCHE AGRONOMIQUE

National Institute for Agricultural Research

Scientific report

Use of Water Retainer to save water irrigation and to improve crop productivity In Morocco:

Case study: Olive and date palm

Marrakech Site

Prepared by INRA scientific team

Royaume du Maroc
المملكة المغربية
المعهد الوطني للبحث الزراعي ★ INSTITUT NATIONAL DE LA RECHERCHE AGRONOMIQUE

le Chef du Département
Environnement et Ressources
Naturelles
MOUSSADEK Rachid

Edition. Dec. 2018

1- INTRODUCTION

In Morocco, water scarcity appears as one of the main factors limiting agricultural development because of high drought incidence due to climatic changes (Fisher et al., 2002). At present and more in the future, irrigated agriculture will take place under water scarcity particularly in semi-arid regions. These areas are characterized by high evaporative demand (about 1500 mm/ year), low and irregular rainfall (200-300 mm/year), and repeated periods of droughts.

Insufficient water supply for irrigation emphasizes maximizing the production per unit of water consumed. Hence, the great challenge is to increase crop production, under little rainfall during the most critical phenological stages for yield production, with less water available for irrigation.

Therefore, it's necessary to adopt and disseminate renovating techniques aimed at saving water on a large scale in order to adapt to climate change. Among these innovative techniques; the "**Water Retainer**" which is an organic soil-conditioning product that retains the already existing humidity in the soil. Therefore, it creates a better humidity situation in the soil that increases crop yield.

2- Objective

This project aims to evaluate the impact of ***Water Retainer product*** applied by spraying on the surface with two different levels of dilution on agro-physiological parameters of young and palm date trees under drip deficit irrigation.

3-Case of young olive orchard

Olive (*Olea europaea L.*) is among the most important fruit trees in Morocco with more than 1 million ha. Marrakech region is one of the main areas of olive production which represent 16% of national olive orchards area (160 000 ha) and 25% of national olive fruit production (500 000 tones in 2018). Despite its economic and social importance, olive yields are very low (1 ton in rainfed areas and 1.5 to 3 tons in irrigated areas) because water irrigation is scarce and expensive.

We will experiment the use of '***Water Retainer product'*** as a new strategy to save and optimize water use on young olive orchards. Therefore, we need more information related to agro-physiological response of young olive tree to ***Water Retainer product*** applied by spraying on the surface under trees canopy.

3-1 Experimentation

3-1-1 Experimental site

The experiment was conducted in Sâada Research Station of INRA Marrakech. The characteristics of the experimental plot are as follow:

- Plot surface: 0, 52 Ha (81 trees)
- Plantation date: December 2010
- Plantation density: 156 trees per Ha (8m x 8 m);
- Variety: Menara
- Drip irrigation equipment: May 2018 (switched from flood irrigation which was applied since 2010).

Photo 1. Experimental plot

3-1-2 Studied treatments

Irrigation regimes:

Drip irrigation is the irrigation technique used in this experiment and the amount of water applied is controlled by the number of drippers and duration of irrigation. We studied 3 irrigation regimes:

- **Full irrigation** : 100 % ETC (four drippers of 25 liters per hour per tree)
- **Moderate deficit irrigation** : 75 % ETC (three drippers of 25 liters per hour per tree)

- **Severe deficit irrigation** : 50 % ETC (two drippers of 25 liters per hour per tree)

The amount of applied water was calculated by estimating tree evaporation (ETc). The ETc was calculated following the equation: ETc = ETo x Kc x Kr /Ne

Where **ETo** is the reference evapotranspiration (Penman Monteith), **Kc** is the crop coefficient for olive tree, **Kr** is the coefficient to correct for incomplete cover and **Ne** is the efficiency of irrigation network.

ETo was obtained by using daily data from an automatic weather station located some 50 m away from the experimental plot. The Kc values are reported by Orgaz and Fereres (1997) while we estimated a value of 0.8 for Kr (Fereres and Golhamer, 1990).

Water Retainer treatment

- Water Retainer dilution

Two Water retainer's dilutions were tested and compared to the control:

- **2 ml of the product per square meter**
- **4 ml of product per square meter**
- **Control (only water= 0 ml/ m^2).**

In Total 9 treatments were studied: Irrigation regimes (0%, 75% and 100% ETC) x Water Retainer dilutions (0, 2 and 4ml/m^2) = 3 x 3 =9.

- Surface treated

The surface sprayed depends on the canopy of the tree which depends on the tree age, density and management (irrigation, pruning etc.). Table 1 shows some examples of surface to be treated and the amounts of the product according to tree spacing, density, and age.

Table 1. Surface to be treated and the amounts of the product to be used according to tree spacing, density, and age (case of olive orchards).

Trees Spacing	Density (tree per Ha) (2)	Age	Approximate diameter of tree canopy (m) (1)	Surface to be treated per tree (m²)	Surface to be treated (m²/ha)	Target Dosage of Water Retainer product (ml/m²)	Amount of Water Retainer per tree (ml)	Amount of Water Retainer per (Ha)
5*5	400	young	2,0	3,1	1 256,0	2,0	6,3	2512
	400	mature	4,0	12,6	5 024,0	2,0	25,1	10048
7*4	357	young	2,0	3,1	1 121,0	2,0	6,3	2242
	357	mature	4,5	15,9	5 675,0	2,0	31,8	11350
7*7	204	young	2,4	4,5	922,4	2,0	9,0	1845
	204	mature	6,0	28,3	5 765,0	2,0	56,5	11530
8*8	156	young	2,4	4,5	705,4	2,0	9,0	1411
	156	mature	6,5	33,2	5 173,9	2,0	66,3	10348
10*10	100	mature	8,0	50,2	5 024,0	2,0	100,5	10048

3-1-3 Experimental plot design

The experimental design is a factorial plot (figure 1). The experimental plot is divided into 3 subplots of 3 lines of 9 olive trees. In each subplot is installed an irrigation regime.

Within each irrigation regime, we applied two dilutions of water retainer (2ml/m² and 4ml/m²) compared to control (0 ml/m²) with 4 repetitions for each treatment (1 tree/repetition). Trees were chosen according to their homogenous vigor.

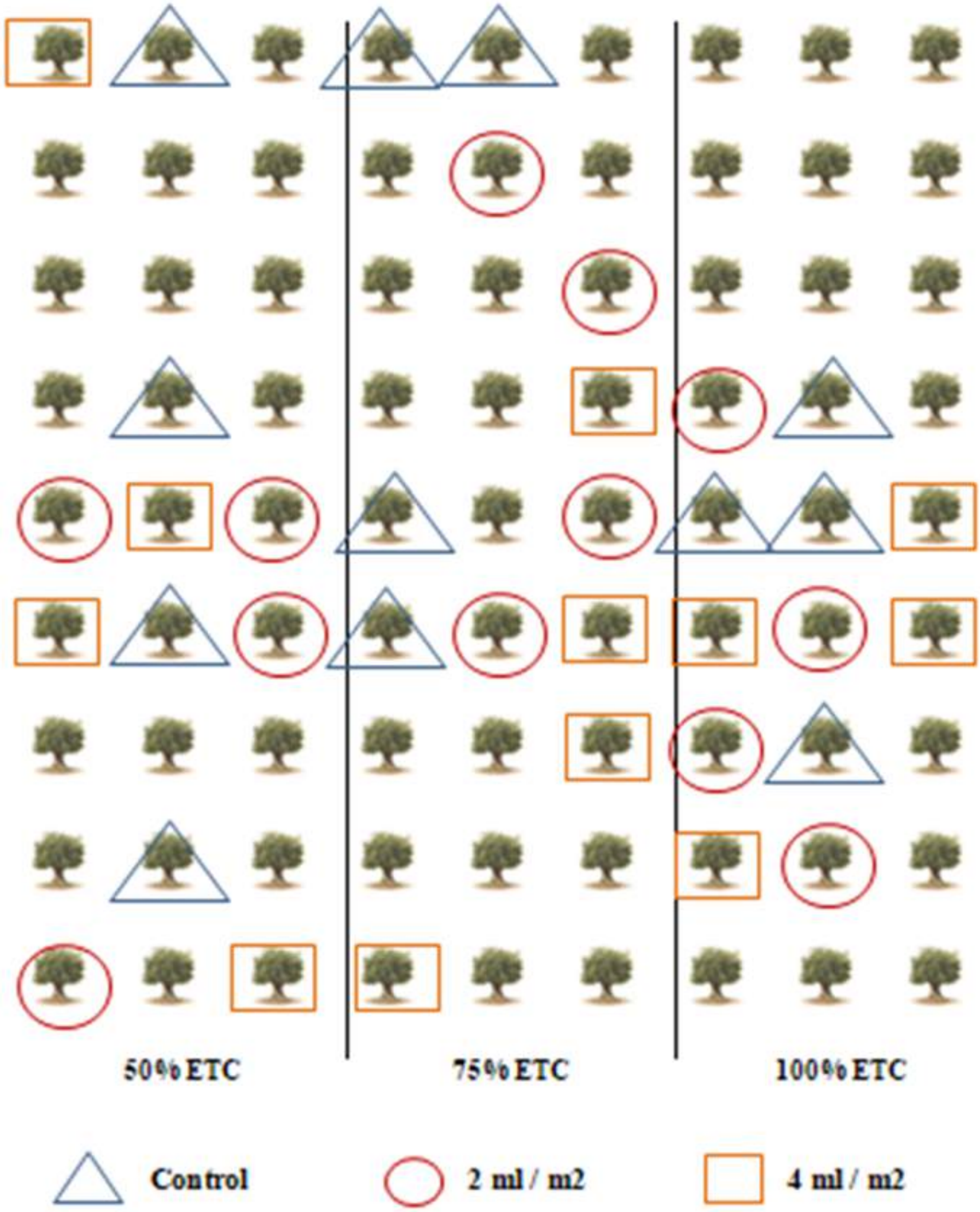


Figure 1. Experimental design (Factorial plot)

- **Calculation of the area to be treated**

In our case, calculation of the surface to be treated per tree is based on the average of trees canopy diameter which is estimated to 2, 4 m. The area calculated is 4, 52 m² per tree.

- **Amounts of product to be applied**

The amounts of product used per treatment are: 9 ml per tree or 108 ml for 12 trees (dose 2 ml) and 216 ml / 12 trees (dose: 4 ml). These amounts of the product were diluted with water in the tank of a

Motorized backpack sprayer which was used to spray the product on the soil. The tank capacity is 12 liters, which corresponds to one liter of solution per tree.

Photo 2. Preparation of Water Retainer' solution to spray

- **Mode of apply**

The amount of the product estimated for the 12 trees is diluted in 12 liters of water and sprayed on soil under canopy using a motorized knapsack atomizer. The frequency of renewal of the application of this product is 45 days.

Photo 3. Spray 'Water Retainer product" on the soil.

3-1-4 Parameters assessed

- Soil humidity
- Stomatal conductance
- Chlorophyll fluorescence
- New shoot growth
- Olive fruit yield
- olive fruit weight
- Maturity index
- Olive oil content

3-2 Results

3-2-1 Soil humidity

Soil profile was measured by "**Moisture Meter HH2"** (figure 2) between 0.1 and 1m below ground two days from last irrigation. . 5 treatments were been considered:

- 100% ETc-0 ml/m² (control)
- 75% ETc- 2ml/m²
- 75% ETC- 4ml/m²
- 50% ETc- 2ml/m²
- 50% ETc- 4ml/m²

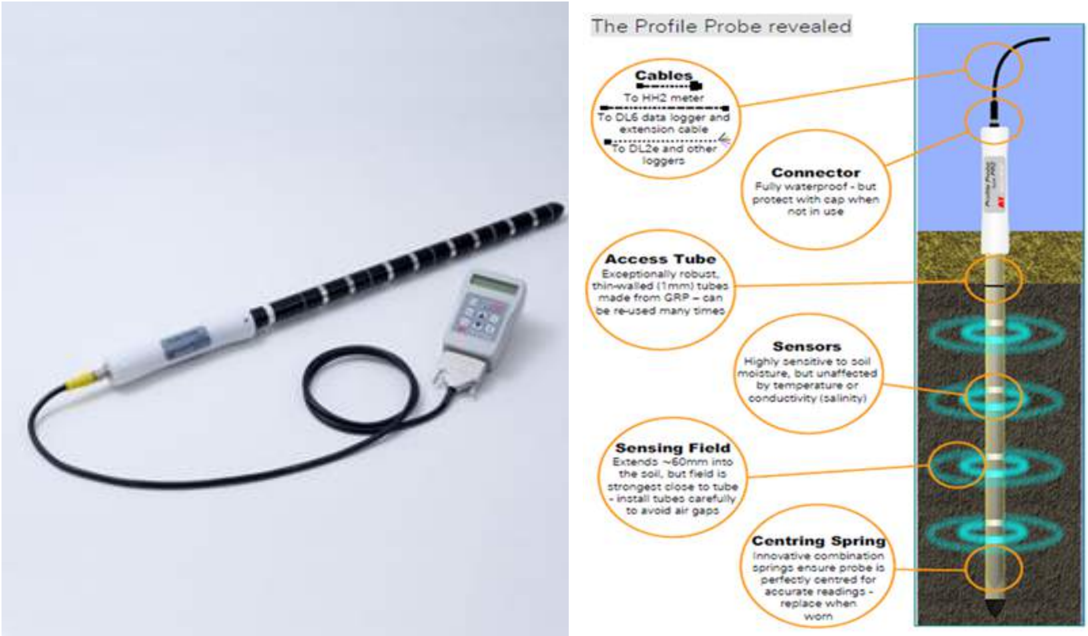


*Figure 2. "**Moisture Meter HH2**" instrument*

Photo 4. Soil moisture measurements in field trial

The obtained data shows that soil humidity increased with soil depth for all irrigation regimes (figure 3). The Water Retainer has a great impact in retaining soil humidity in case of deficit irrigation. In fact, soil humidity of the two irrigations regimes (75% ETc and 50% ETc) is above the values noted under full irrigation treatment (100% ETc) for both product dilutions used (2ml/m² and 4 ml/m²). In the case of moderate irrigation (75% ETc), spraying 2ml/m² of the product is sufficient to induce a better retaining of soil humidity. However, in case of sever water stress (50% ETc) better soil humidity maintenance is obtained by spraying 4ml/m² of the product (figure 4).

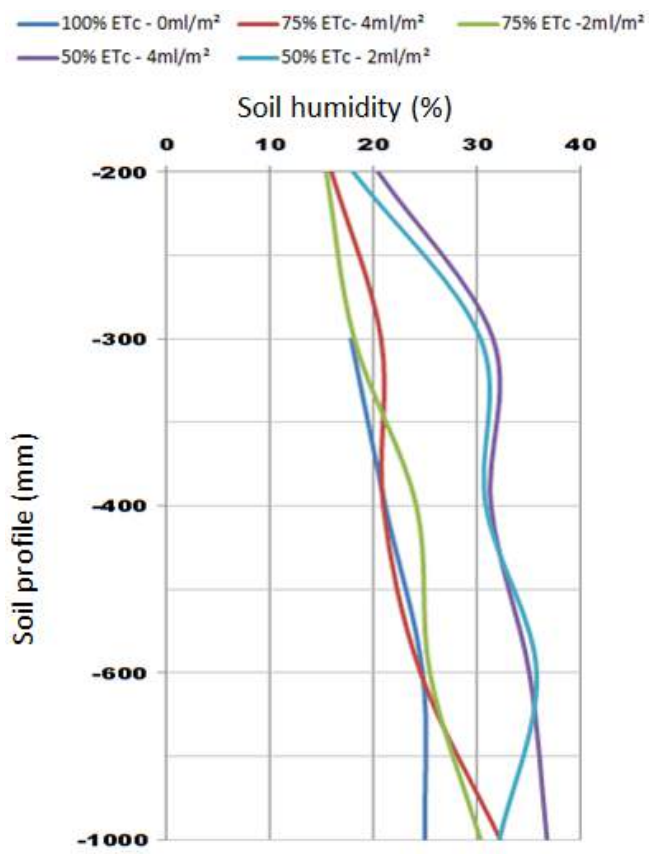


Figure 3. Soil profile in relation with irrigation regimes and water retainer dilution

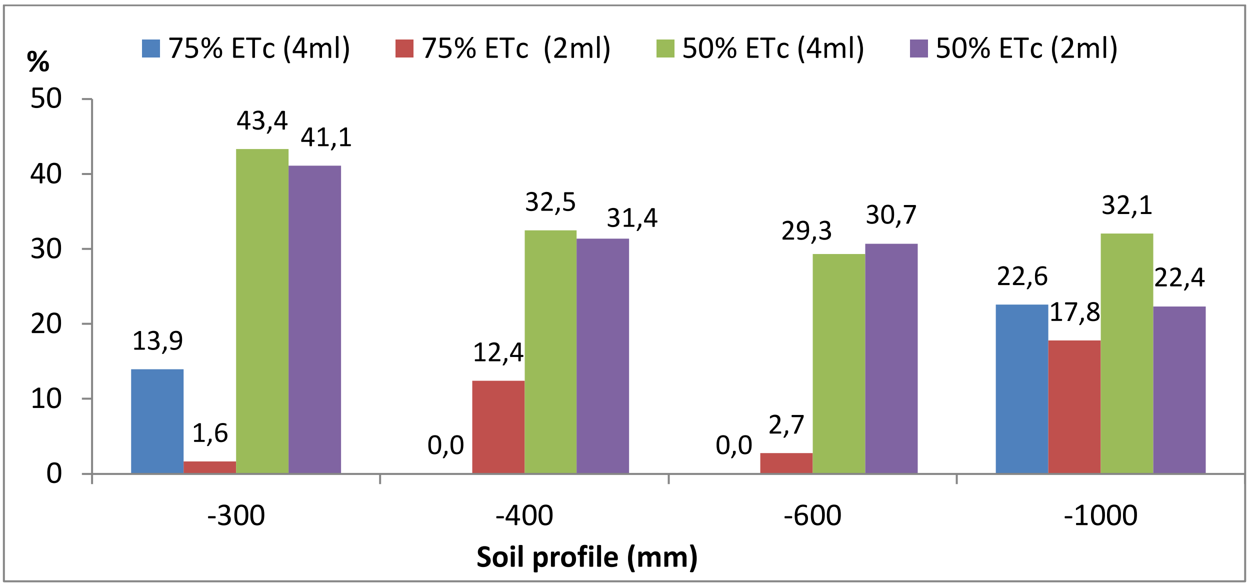


Figure 4. Rates of soil humidity retained by 'Water Retainer' compared to control 100% ETc-0ml/m²

To evaluate the performance of the product in case of severe drought stress, we suspended irrigation in the trial and we assessed soil humidity during the 5 following days. The first soil humidity was measured the second day after stopping irrigation (figure 5).

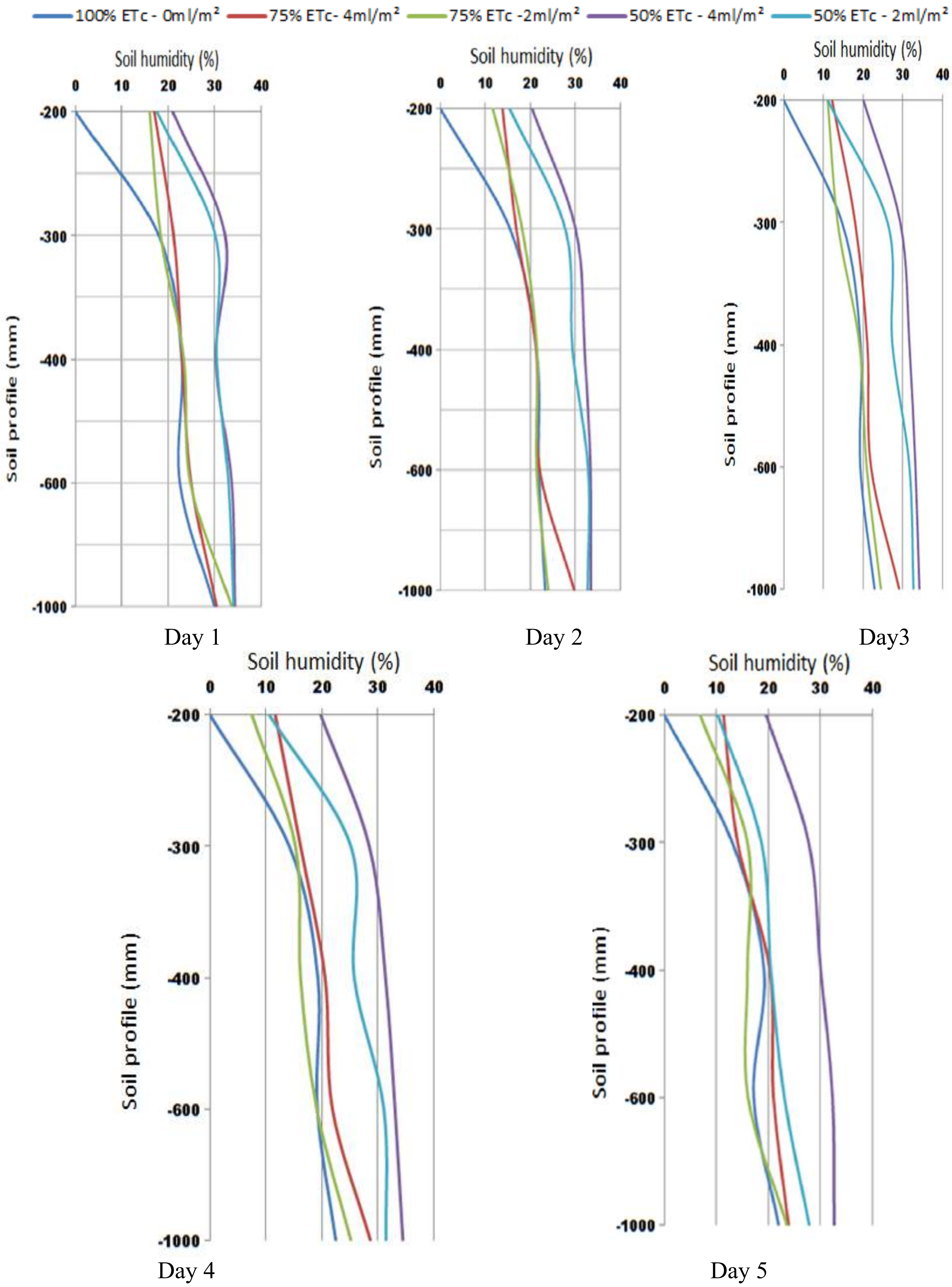


Figure 5. Evolution of soil humidity measured in second day after suspending irrigation during 5 successive day according to water irrigation regimes and soil sprayed ***Water Retainer*** *dilutions*

We noted that in the absence of **Water Retainer**, the soil dries continuously from soil surface compared to the other treatments (figure 4). The difference between the five studied treatments is significant from the second day (table 2).

However, Water Retainer dilution leading to a better soil water content depends on irrigation regime. In case of moderate deficit irrigation (75% ETc) only 2 ml/m² is sufficient. But in case of server deficit irrigation, the concentration of the product must double (4 ml/m²).

Table 2. ANOVA: Effect of studied treatments on soil humidity

Dates of measurements	df	Means square	Fisher	P (α=5)
Day1 (17-09-2018)	4	113,6	2,1	0,121 NS
Day2 (18-09-2018)	4	163,3	3,5	0,026
Day3 (19-09-2018)	4	173,8	3,4	0,028
Day4 (20-09-2018)	4	177,4	3,3	0,031
Day5 (21-09-2018)	4	156,0	3,8	0,019

3-2-2 Stomatal conductance

Stomatal conductance (gs) was measured at midday using a porometer (Leaf porometer, model SC1, DECAGON DEVICES, version, 2012). It was expressed in mmol of H_2O m^{-2} s^{-1}. Three replicates per tree were considered. Under water deficit, the closure of stomata induces the limitation of CO_2 assimilation and consequently a strong disturbance of photosynthetic activity and the decrease of the relative water content. Hence more open stomata allowing greater conductance, and consequently indicating that photosynthesis and transpiration rates are potentially higher.

Photo 5. Stomatal conductance measurements

Analysis of Variance (ANOVA) shows a high significant difference among studied treatments (table 3).

Table 3. ANOVA: Effect of studied treatments on physiological parameters

Parameters	df	Mean square	Fisher	P (α=5)
Stomatal conductance	8	3811,63	6,74	<0.001
Chlorophyll fluorescence	8	0,021	39,98	<0.001

Low values of this parameter were obtained under deficit irrigation control (without spraying Water Retainer product '0ml/m²'); 50% ETc- 0ml/m² and 75% ETc- 0 ml/m² with 144.5 and 167.7 mmH_2O $m^{-2}s^{-1}$ respectively (figure 6). The use of Water Retainer has a great impact on stomatal conductance with 18.8% and 14.3% for 50% ETc and 75% ETc respectively. According to Newman & keuls analysis, no significant difference was noted with the control 100% ETc, 75% ETc-2ml/4ml and 50% ETc-2ml/4ml. Concerning dilution treatments of the product, we did not note a significant difference between 2ml/m² and 4 ml/m².

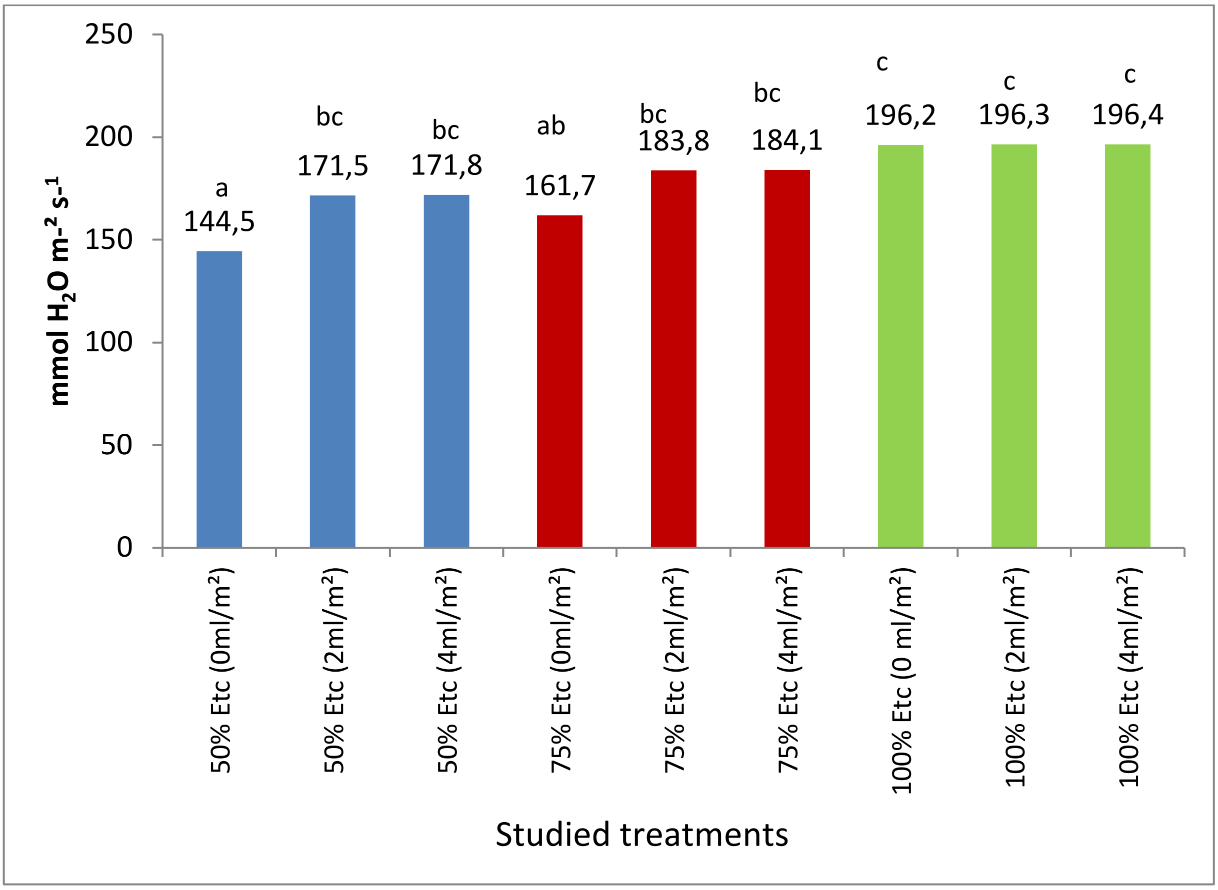


Figure 6. Stomatal conductance of olive trees measured under different studied treatments (Values with same letter did not differ significantly P (α=5%)).

3-2-3 Chlorophyll fluorescence

Chlorophyll fluorescence is an effective approach to determine the efficiency of photosystem II and can be expressed as the ratio of the rate of the photochemical activity and the total rate of absorbed energy dissipation (Fv/Fm). Recently it has become one of the best tools for the detection of stress state and stress adaptation in plants.

Chlorophyll fluorescence was measured using a portable chlorophyll fluorescence meter (OPTI-SCIENCES OS30p+) after 20 min of dark adaptation. Chlorophyll fluorescence was estimated by the Fv/Fm ratio, which represents the maximum quantum yield of photosystem II. It was calculated as Fv/Fm = (Fm – Fo) / Fm, where Fm and Fo are maximal and minimal fluorescence of dark adapted leaves, respectively, and Fv is variable fluorescence.

Photo 6. fluorimeter OPTI-SCIENCES OS30p+

Photo 7. Chlorophyll fluorescence measurements

A significant difference was shown among studied treatments (table 3). The water Retainer has a significant positive effect on chlorophyll fluorescence (figure 7). This parameter was improved by 22.7% and 11.4% under 72% ETc and 50% ETc irrigation regimes respectively. Also, no significant difference was noted between the two dilutions of the product (2 and 4 ml/m²).

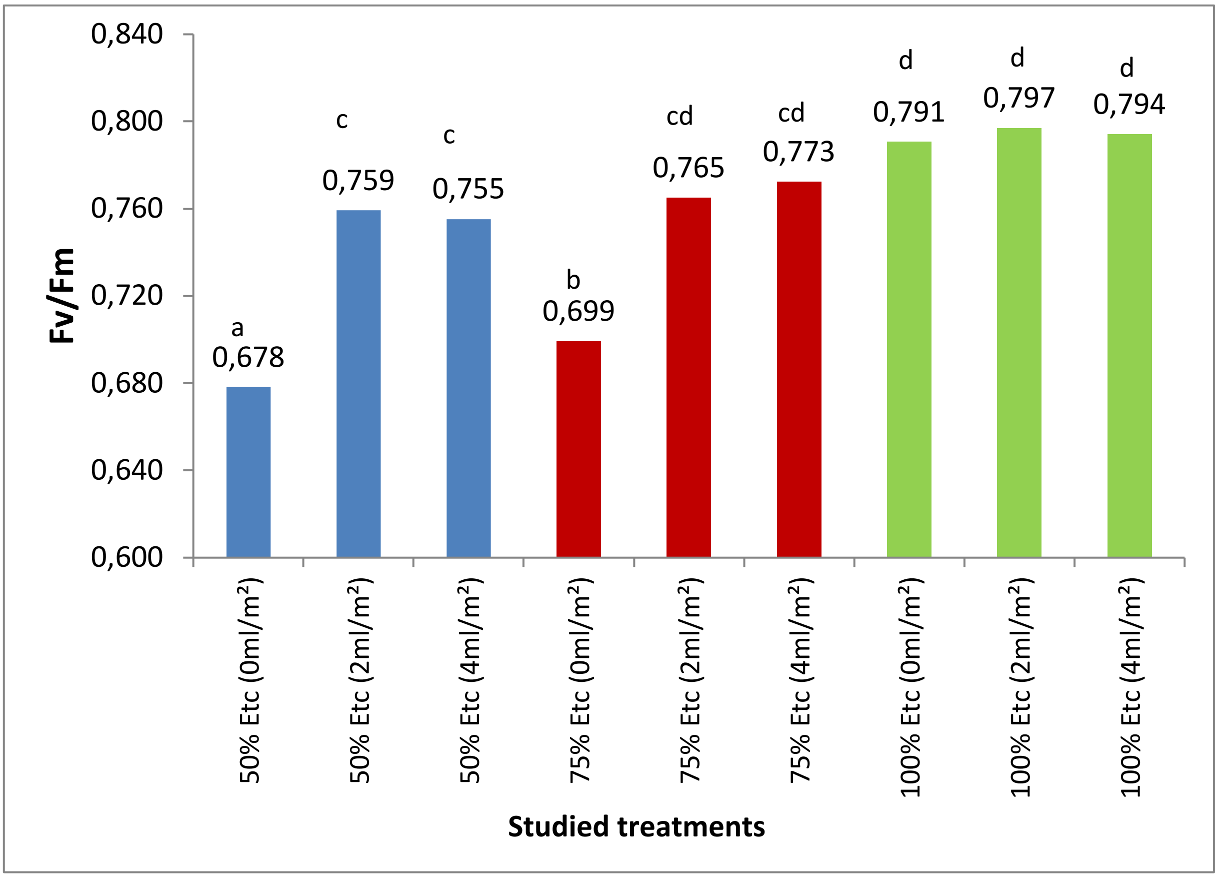


Figure 7. Chlorophyll fluorescence of olive trees measured under different studied treatments (Values with same letter did not differ significantly P (α=5%)).

3-2-4 Vegetative growth

The state of the vegetative growth during this year determines the next year's flowering rate. Thus, to obtain a good production, it is necessary to have a good vegetative growth every year. The growth rate is largely affected by environmental conditions, such as irradiance; water availably, soil fertility, and growth regulators.

The effect of **Water Retainer** on the vegetative growth is studied by assessing the new shoot elongation using digital Caliper.

Results show a significant positive impact of Water Retainer, used as soil spray, on the shoot growth in case of two deficit irrigations (75% ETc and 50% ETc). Under moderate water stress (75% ETc), this parameter was increased by 14.5% and under sever water stress (50% ETc), it increased by 15%. However high shoot growth was obtained with dilutions of 2ml/m² and 4ml/m² under the first and the second irrigation regimes respectively (figure 8).

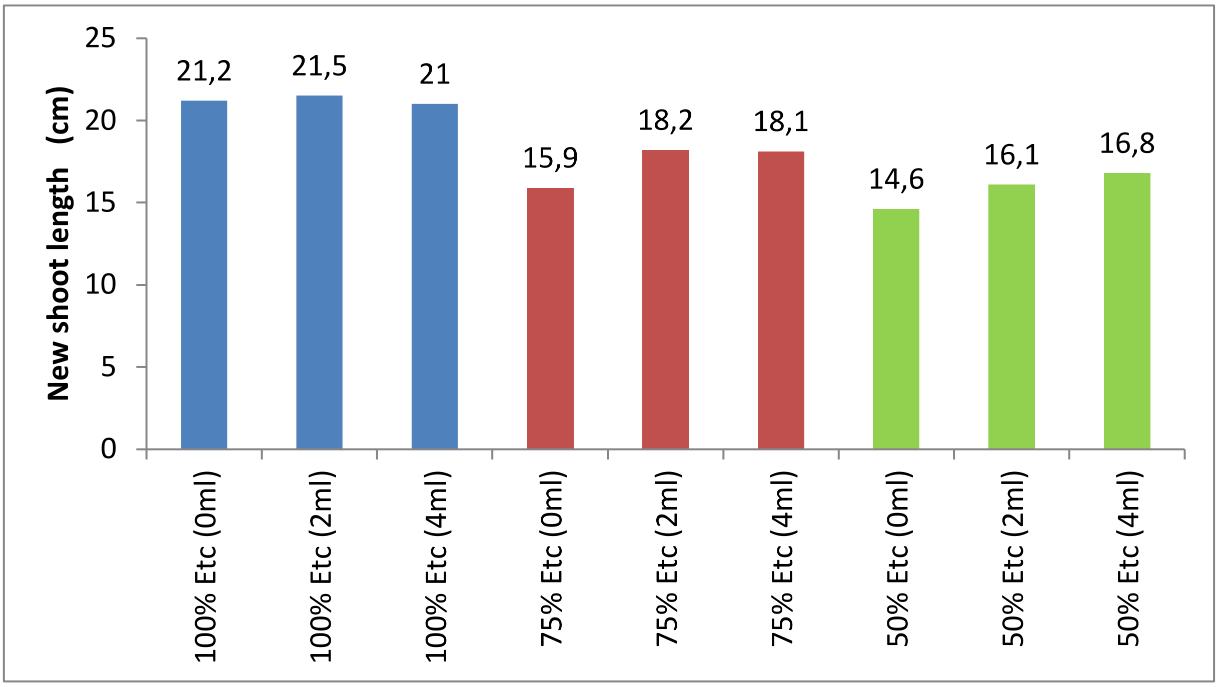


Figure 8. New Shoot length of olive trees measured under different studied treatments (Values with same letter did not differ significantly P (α=5%)).

Photo 8. New shoot growth measurements

3-2-5 Olive fruit yield

Although olive is among the most drought resistant plant species, production is increased when irrigation is applied in dry climates. The increased production of olive fruits is based on the water use efficiency which strongly depends on soil moisture during sensitive phenological stages.

In our experiment, the use of Water Retainer product increased significantly the olive yield under the three irrigation regimes by keeping soil moisture. The best improving fruit yield estimated to 225% was obtained under moderate deficit irrigation (75% ETc) using a product dilution of 4ml/m² (figure 9).

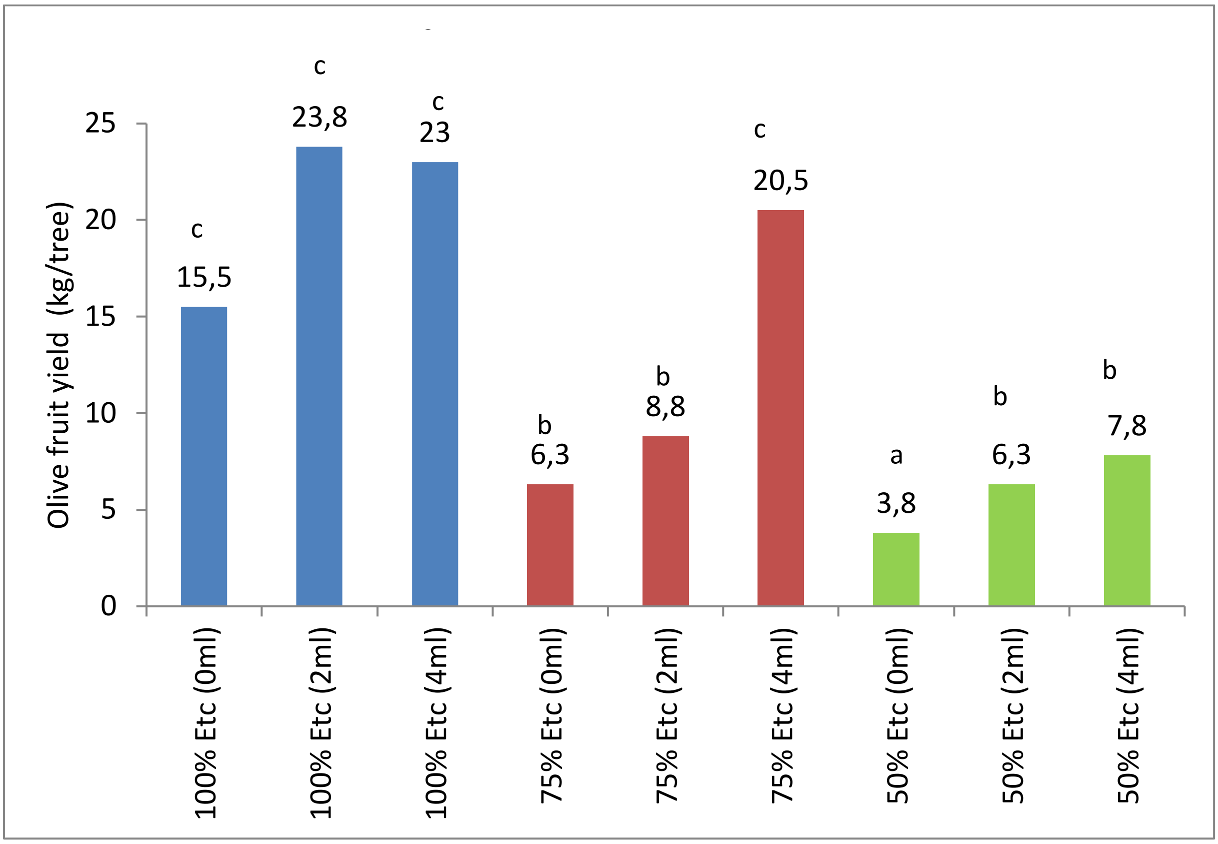


Figure 9. Olive fruit yield estimated under different studied treatments (Values with same letter did not differ significantly P (α=5%)).

3-2-6 Maturity index

Maturity index is a useful parameter for producers because it enables them to identify the optimal harvest time to improve the quantitative and qualitative characteristics of olive oil production. In fact, harvest time is the first and most crucial decision to make in the production process of virgin olive oil.

Maturity index in of samples harvested under all studied treatment did not present a significant difference (figure 10).

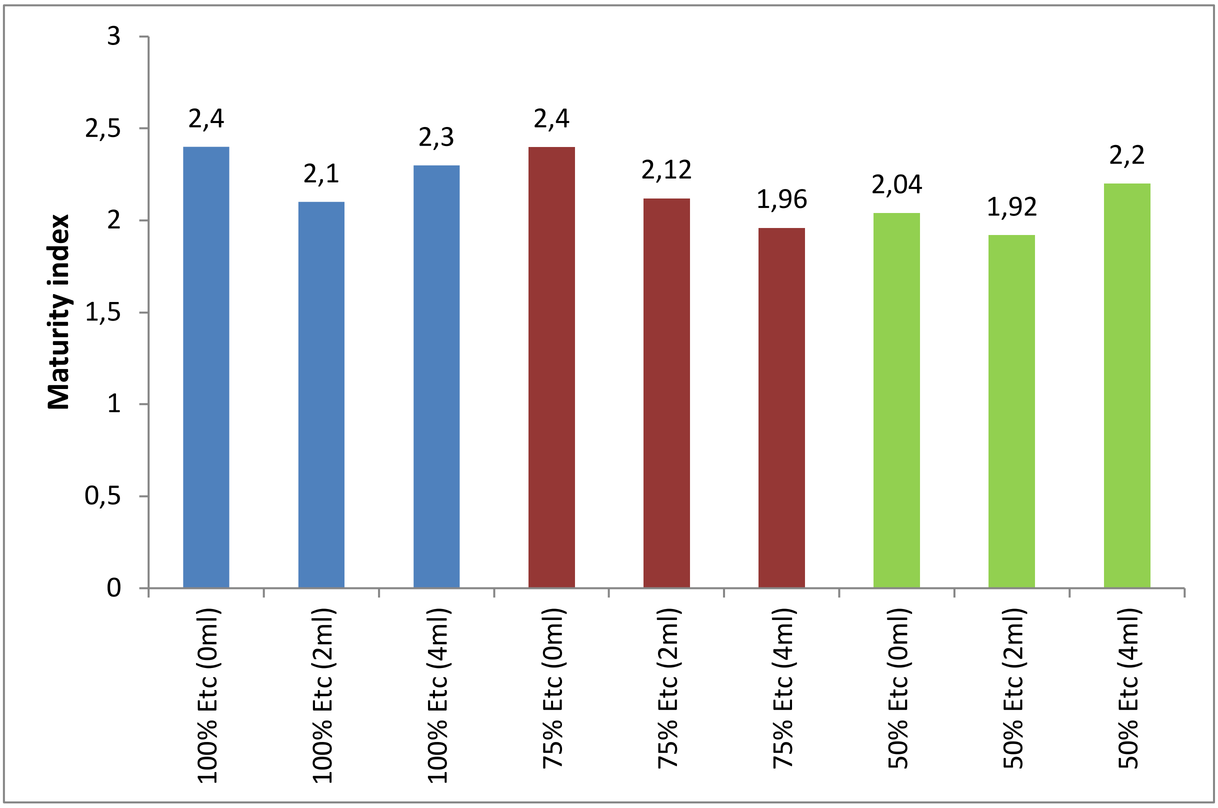


Figure 10. Maturity index of olive fruits harvested under different studied treatments

3-2-7 100 olive fruits weight

No significant difference was shown among studied treatments (figure 11). Our previous studies on fruit caliber in relation with stress showed a negative correlation between fruit caliber and tree olive fruit charge. Thus, under sever deficit irrigation (50% ETc) the low tree olive yield induced a low tree olive charge leading to a large caliber olive fruit.

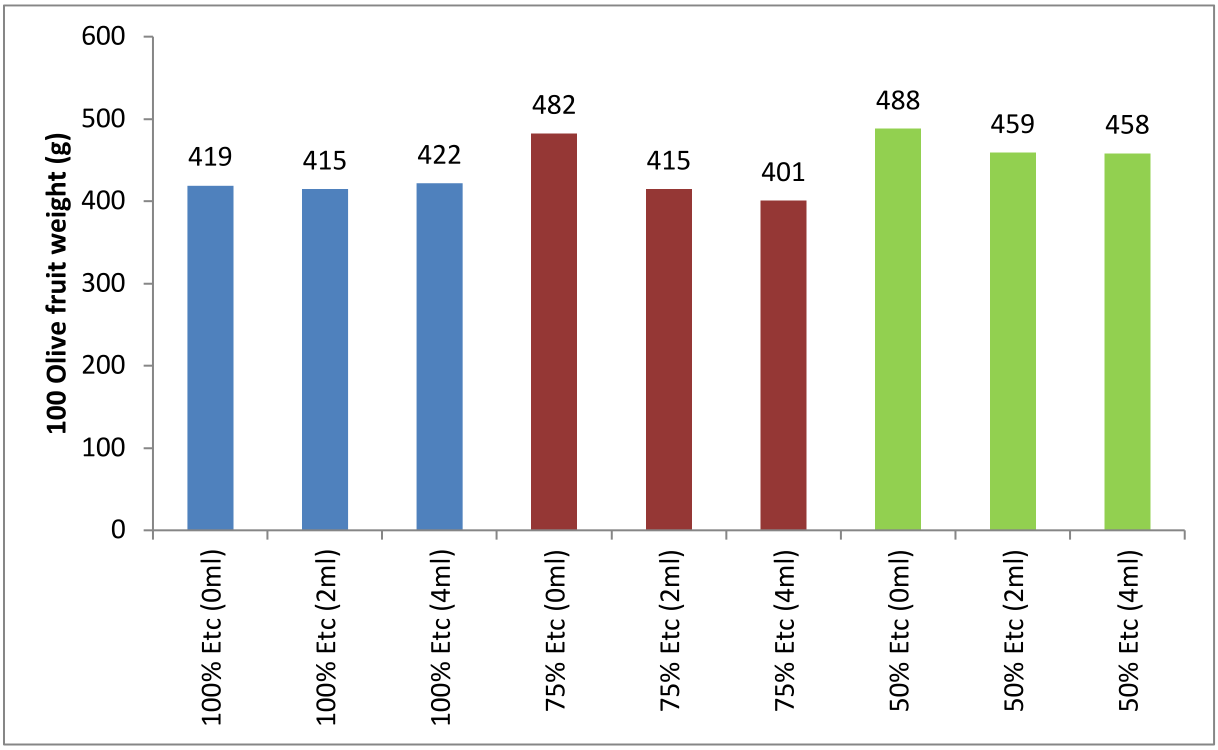


Figure 11. 100 fruit weight harvested under different studied treatments

3-2-8 Olive oil content

Olive oil yield showed a significant difference among studied treatments. This parameter was increased significantly with amounts of irrigation water supplied (figure 12). Therefore deficit irrigation had a negative impact on oil yield.

However, applying Water Retainer product, by spraying soils under the olive tree canopies, had positively improved oil conent in deficit irrigation treatments. Dilution of 4ml/m² induced the high oil content in both moderate and server deficit irrigation. For the first irrigation regime (75% ETc) spraying 4ml/m² of the product oil content had increased by 3.1% For the second irrigation regime (50% ETc), this parameter had increased by 2.4%.

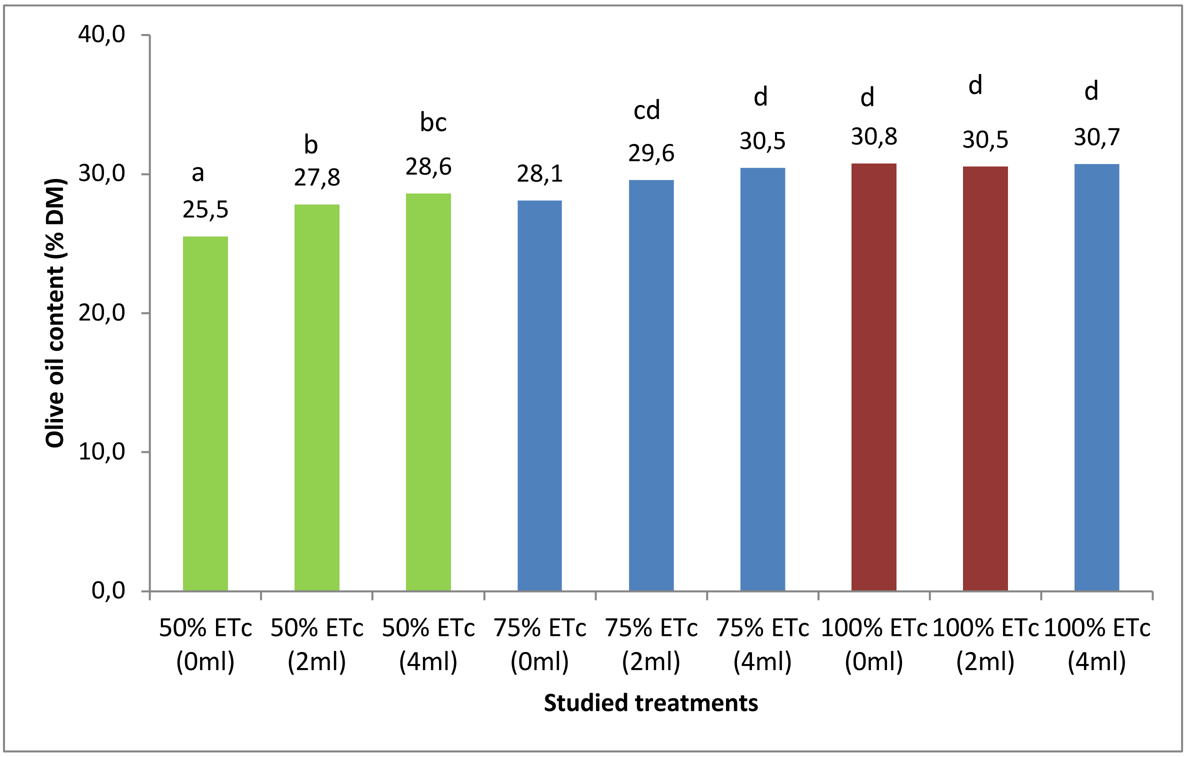


Figure 12. Olive oil content according to studied treatments.

Photo 13: Olive oil yield measurements

4- Case of young date palm trees

In Morocco, date palm (*Phoenix dactylifera* L.) is one of the oldest fruit crops grown in the arid and oasis regions and it's an essential component of the oasis ecosystem. The total number of date palm in Morocco is estimated at 4.8 million covering an area estimated at 48 000 ha. Also, date palm plays important ecological roles by ensuring a micro-climate in oasis and by limiting the desertification. Increasing local production of date fruits requires developing new agronomical management practices especially water management. Because, water resources are limited and new innovations to save water are needed.

4-1 Experimentation

4-1-1 Experimental site

The experiment was conducted in Sâada Research Station of INRA Marrakech. The characteristics of the experimental plot are as follow:

- Plantation date: December 2015
- Plantation density: 123 trees per Ha (9m x 9 m);
- Variety: Sedrate
- Drip irrigation equipment: installed in 2017.

Photo 14. Experimental plot

4-1-2 Studied treatments

Irrigation regimes:

Drip irrigation is the irrigation system used in this trial and the amount of water applied is controlled by the number of drippers and duration of irrigation. We studied 3 irrigation regimes:

- **Full irrigation** : 100 % ETC (4 drippers of 25 liters per hour per tree)
- **Moderate deficit irrigation** : 75 % ETC (3 drippers of 25 liters per hour per tree)
- **Severe deficit irrigation** : 50 % ETC (2 drippers of 25 liters per hour per tree)

The amount of applied water was calculated by estimating tree evaporation (ETc) as indicated above.

Water Retainer treatment

- **Water Retainer dilution**

Two Water retainer's dilutions were tested and compared to the control:

- **2 ml of the product per square meter**
- **4 ml of product per square meter**
- **Control (only water= 0 ml/ m²).**

In Total 9 treatments were studied: Irrigation regimes (0%, 75% and 100% ETC) x Water Retainer dilutions (0, 2 and 4ml/m²) = 3 x 3 =9.

- **Surface treated**

The surface sprayed depends on the canopy of the tree which depends on the tree age and density. In our case, canopy diameter of young tree is 1 m. Thus, calculated area to be sprayed with the product is 0.8 m² / tree. Therefore, the amount of the product used is 1.6 ml / tree (2 ml/m² dose) and 3.2 ml / tree (dose: 4 ml/m²).

4-1-3 Experiment plot design

- ***Repetitions***: four trees per retainer dose's and irrigation regime. Trees were chosen according to their homogenous vigor and fertilization.
- ***Experimental plot Design***: Factorial design: (figure 13)
- ***Mode of application***: the amount of the product intended for the 12 trees is diluted in 12 liters of water and sprayed on soil under canopy using a knapsack atomizer.

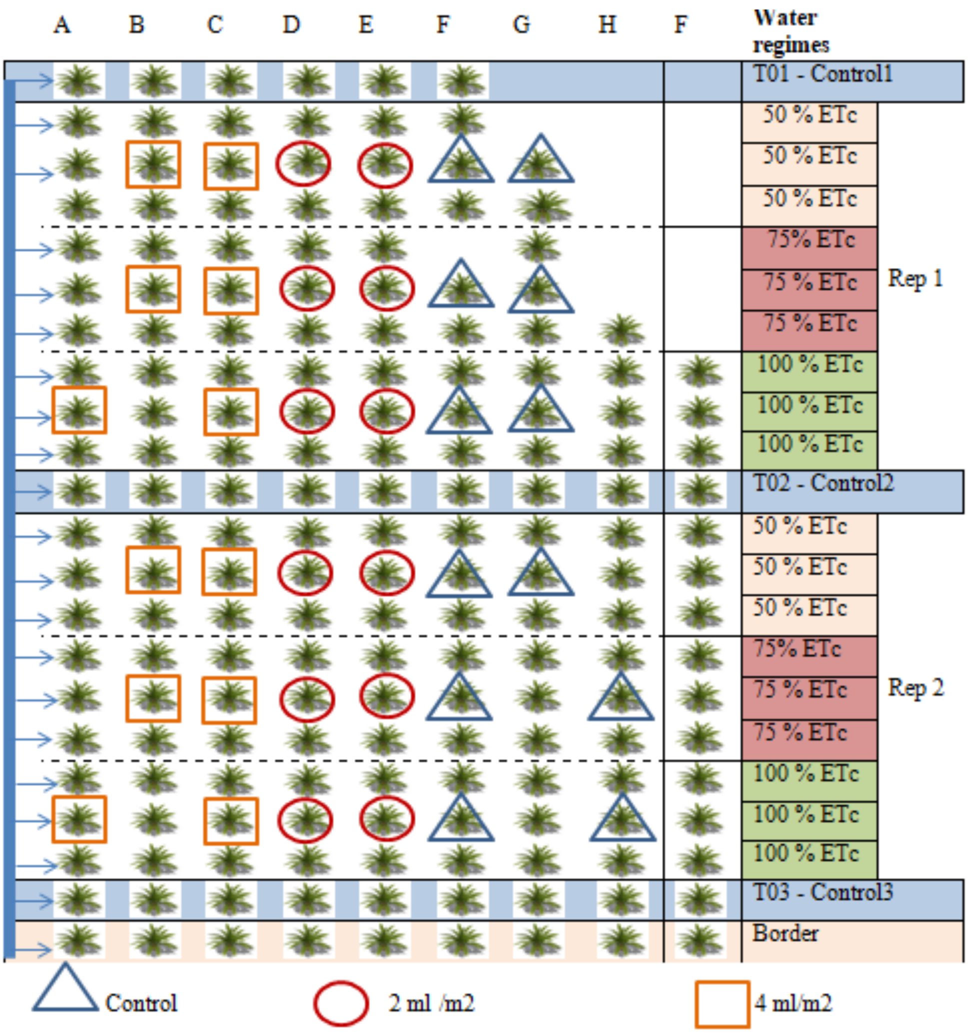


Figure 13. Experimental plot design.

Photo 16. Spray ‘Water Retainer product” on the soil.

- Soil humidity
- Chlorophyll fluorescence
- Number of leaves (palms)
- Length of the leaf of the middle crown

- Length of the basal, medial and apical pinnate leaflets (3 palms of the middle crown)

4-2 Results

4-2-1 Soil humidity

Soil profile was measured by "**Moisture Meter HH2"** (figure 2) between 0.1 and 1m below ground two days from last irrigation. Same as the first experimentation, 5 treatments were been considered:

- 100% ETc- 0 ml/m² (control)
- 75% ETc- 2ml/m²
- 75% ETC- 4ml/m²
- 50% ETc- 2ml/m²
- 50% ETc- 4ml/m²

Photo 17. Soil moisture measurements.

The impact of Water Retainer in maintaining soil moisture is positive in case of in case of moderate deficit irrigation (75% ETc). Values of soil profile humidity obtained for this irrigation regime were above the values noted under full irrigation regime (100% ETc) for both product dilutions used (2ml/m² and 4 ml/m²) (figure 14).

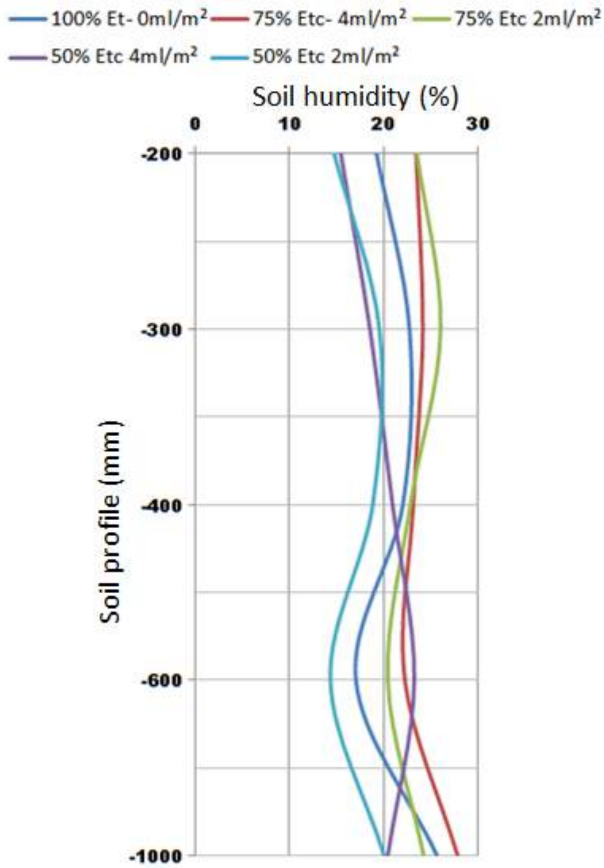


Figure 14. Soil humidity profile in relation with studied treatments

In case of imposed water stress during one week, the performance of Water Retainer was assessed by measuring soil moisture for 5 successive days from the second day after suspending irrigation (figure 15). Obtained result for this parameter shows that during the 5 days after stopping irrigation significant difference was noted among considered treatments (table 4). We also noted that moderate deficit irrigation (75% ETc) of Water Retainer with both dilutions (2 and 4 ml/m²) induced high values followed by server deficit irrigation (50% ETc) using a dilution of the product of 4ml/m². Thus in case of drought conditions it's better to use a dilution of 4ml/m².

Table 4. ANOVA: Effect of studied treatments on soil humidity

Dates of measurements	df	Means square	Fisher	P (α=5)
Day2 (17-09-2018)	4	35,173	7,179	0,001
Day3 (18-09-2018)	4	27,373	3,894	0,017
Day4 (19-09-2018)	4	40,184	4,967	0,006
Day5 (20-09-2018)	4	24,146	2,996	0,043
Day6 (21-09-2018)	4	27,054	3,157	0,036

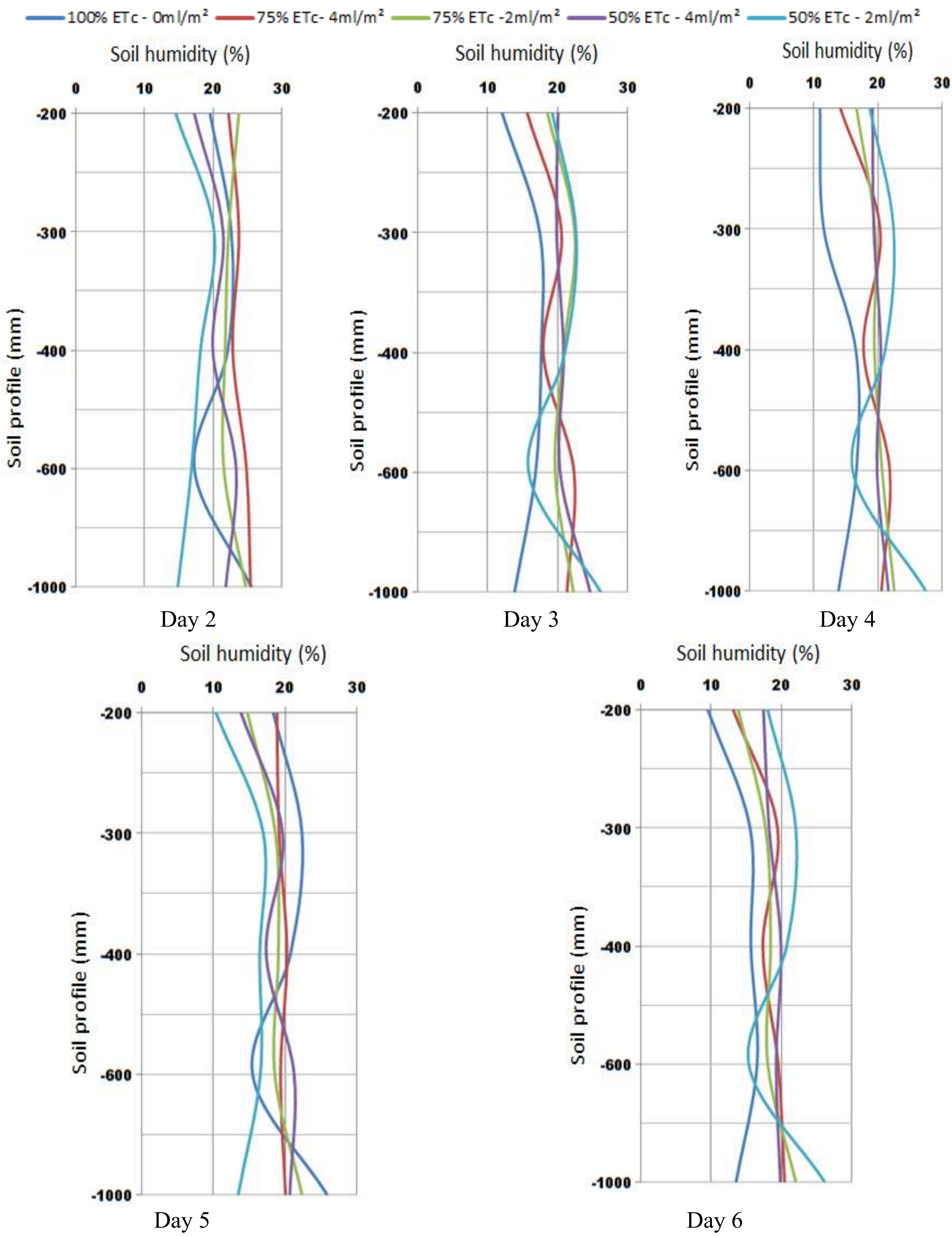


Figure 15. Evolution of soil humidity measured 5 successive days after suspending irrigation

4-2-2 Chlorophyll fluorescence

Chlorophyll fluorescence was measured using a portable chlorophyll fluorescence meter (OPTI-SCIENCES OS30p+) according to methodology described in the first experiment.

Photo 18. Measuring chlorophyll fluorescence in the field

A significant difference was shown among studied treatments (table 5).

Table 5. ANOVA: Effect of studied treatments on Chlorophyll fluorescence

Chlorophyll fluorescence	df	Mean square	Fisher	P (α=5)
Chlorophyll fluorescence	8	0,011	12,496	<0.001
Residual Error	99	0,001		

The water Retainer has a significant positive effect on chlorophyll fluorescence (figure 7). This parameter was improved by 6.2% and 6.4% under 75% ETc and 50% ETc irrigation regimes respectively by using a dilution 4ml/m² of the product.

However by spraying 2ml/m² of the product, the chlorophyll fluorescence has increased only by 5.0% and 5.8% compare to treatments not using Water Retainer for the same irrigation regime.

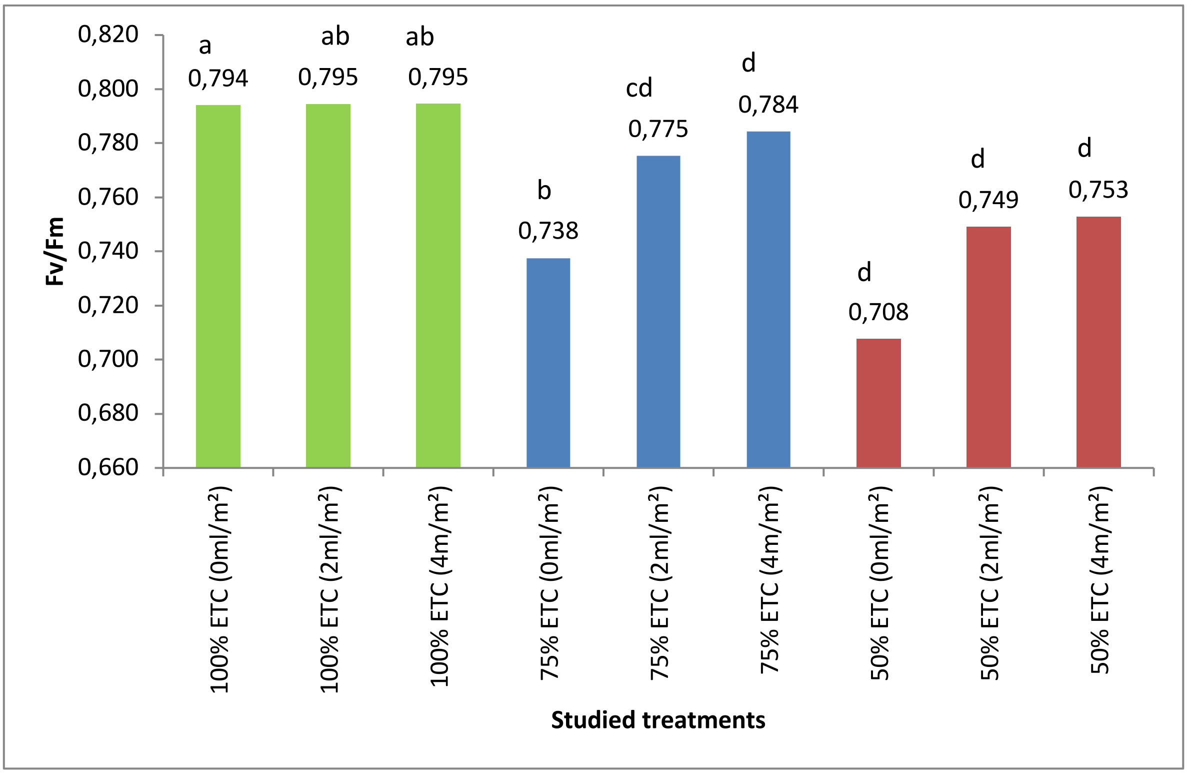


Figure 16. Chlorophyll fluorescence of olive trees measured under different studied treatments (Values with same letter did not differ significantly P (α=5%)).

5- Results dissemination

In order to disseminate the results of this project, a workshop was organized by INRA in collaboration with soil & Soil Company for the benefit main agricultural marketing companies, extended agent, Regional Directorate of Agriculture, researchers, cooperatives, and farmers.

Main agronomical results related to the impact of Water Retainer to increase production of 4 crops (olive, citrus, corn, and date palm) were presented to audience by INRA Researchers responsible for conducting experimentation. The Director of soil & Soil Company gave a presentation about the product and main results achieved in experimentations testing this product around the world.

Photo 19. Workshop of discussing agronomical trial results

Demonstration of using water retainer was given to the participant in the field day.

Photo 20. Demonstration of applying water retainer on the soil.

6- Recommendations

According to results achieved in our experiments, Water Retainer has a good potential to maintain soil moisture and then saving water in drought conditions. These results need to be confirmed for another year. Thus, we planned to continue the two trials on olive and date palm trees for one more year.

Photo 21. Workshop participants

Horticrop Research Limited
P.O. Box 79135-00200
Nairobi.
Tel: 0734616103/ 0773100344
info@horticrop.co.ke

EFFICACY REPORT TO KSTCIE

Season 1 – Mwea Trial Site, Kirinyaga County

Project Ref:	WS/WR/2018/4/001
Title:	**Efficacy of Water Retainer in reducing water need in cultivation of French beans**
Date:	October 2018

Client:

Water & Soil Limited,
1027 Budapest, Lipthay u. 9.
Hungary.

Principal Investigator:

Patrick M. Koome, MSc.

TABLE OF CONTENTS

ABSTRACT

Water Retainer (WR), which retains soil humidity and makes it available to the roots, was evaluated on its efficacy to reduce the need for irrigation in cultivation of French beans for the purpose registration. The first trial site evaluation was done in Mwea, Kirinyaga County, in Horticrop Research Limited’s research site, located in agro-climatic zone 4. The first season experiment was conducted between July 2018 and September 2018. The experiment was conducted with French bean variety *Serengeti* that was cultivated in open field conditions. The experiment was laid out in a randomized complete block design and treatments replicated four (4) times. The treatments in the experiment were three (3) levels of varying irrigation with Water Retainer, a commercial standard (Stockosorb) at the recommended rate and a control (100% irrigation). The available soil moisture in all treatments was calibrated after sowing using a soil moisture meter. Consecutively, the need for irrigation was determined by measuring the available soil moisture in all treatment plots daily using a soil moisture meter. The meter readings from each plot were tabulated to obtain the mean measurement for available soil moisture per treatment. Irrigation was done to treatments that the average available soil moisture was determined at 50-75% level. Treatment effect was assessed by measuring leaf development, development of plant height, root length, dry matter and the marketable yield of French beans.

Results from the first season trial evaluation showed that, Water Retainer reduced the need for irrigation in French beans. Overall, Water Retainer treatments WR+50% Irrigation (T2), WR+60% Irrigation (T3) and WR+ 70% Irrigation (T4) received 42%, 33%, and 24% less water respectively in the entire growing season of French beans compared to the untreated control. The effect of Water retainer in reducing the need for irrigation was comparable to Stockosorb treatment T5 which received 44% less irrigation compared to the untreated control which received optimum irrigation (100% irrigation). French bean in Water Retainer treatment T4 (WR+ 70% Irrigation) showed normal growth and development of leaves, plant height, roots and dry matter which was comparable to the untreated control (T1) which received the optimal irrigation. Overall, the marketable yield of French beans from Water Retainer treatment T4, was comparable to the yield that was obtained from the untreated control (T1) and Stockosob treatment (T5).

The second site trial evaluation is ongoing in Timau, Meru County, whose results will be compared for consistency with the results that were obtained from the Mwea, Kirinyaga County Trial site.

INTRODUCTION

1.1 Test Product(s)

Test Product: WATER RETAINER (WR)

Reference product: STOCKOSORB® 660

1.2 Product Information and Mode of action

WATER RETAINER – Water Retainer contains food industry by-product of vegetable origin, with high content of organic matter; absorbent, moistening and surfactant substances; protected mixture of water. Water Retainer is composed of organic matter 80% m/m, dry matter 40% m/m, and mineral elements.

Effect of Water Retainer on the soil and the plant

Water Retainer reduces loss of soil water by absorbing soil humidity that is lost by evaporation through capillary action. Water Retainer transforms this humidity back to liquid water, retains it in the soil and makes it available to the roots. Effect of Water Retainer in the soil translates to reduced need for irrigation while the crop attains similar yield as a crop that is cultivated under the standard irrigation regime.

STOCKOSORB – STOCKOSORB is a soil conditioner for water and nutrient retention and release in substrates and soils. STOCKOSORB is composed of 98.7% Polyacrylic Acid-Potassium Salt (crosslinked).

Effect of STOCKOSORB on the soil and the plant

Upon contact with water, STOCKOSORB swells quickly, creating a hydrogel by absorbing and retaining large quantities of plant available water. During the soil drying process, both water and water-soluble nutrients are released to the plant in a uniform manner.

1.3 Objectives

The overall objective was to evaluate the effectiveness of Water Retainer (WR) in reducing the need for irrigation in irrigated French beans. The specific objectives were to;

i. Determine the effectiveness of Water Retainer to enhancing water holding capacity of the soil

ii. Evaluate the effects of Water Retainer on shoot development and the total dry matter of French beans

iii. Compare the effectiveness of WATER RETAINER to STOCKOSORB 660 as the reference product.

iv. Evaluate the effect of Water Retainer on the yield of French beans

METHODOLOGY

2.2 Experiment site

At the first trial site, the experiment was conducted at the Horticrop Research Limited's research site in Mwea, Kirinyaga County whose co-ordinates are X: 37.36607502 E, Y: - 0.60239501 S. Mwea is located at the lower midland zone 4 (LM4) at an altitude of 1,216.44 Meters above sea level. The area is semi-arid with soils classified as nitosols. The area receives bimodal rainfall with an average rainfall of about 850 mm. The average temperature is about 22ºC.

At the second trial site, the trial was conducted at Horticrop Research Limited research site in Timau (Meru County) which lies at an altitude of 2230m above sea level. The area experiences a bimodal rainfall with an average rainfall of 739 mm. The average temperature is 16.0 ºC. The soils in the area are broadly classified as phaeozems.

At location 3, the trial will be conducted at a commercial farm in Naivasha (Nakuru County) whose co-ordinates are X-0.7960580, Y 36.4054550. The area lies at an altitude of 2080 meters above sea level. The trial site is located within 500m from fresh water lake Naivasha. The average temperature in the trial location is 18.4ºC during cool months to 15.7ºC during warm months. The average monthly precipitation is 119 mm but dry months like January can receive as low as 34mm (Yearly average rainfall is around 700mm). The soils in the area are alluvial soils which are characterised by high clay content, rich in nutrients and prone to degradation and erosion.

2.2 Agro-climatic Requirements of French beans

Agro-climatic requirements for French beans are altitude between 1000-2100m above sea level, and temperatures between 14 – 32 ºC. Irrigation is required during the dry season to maintain continuous production. The crop period of French beans is 60 days

2.3 Experimental layout and design

The experiment was laid out in a randomized complete block design (RCBD) and treatments replicated four (4) times. Experimental plots measured 3m by 4m.. The spacing between blocks was 1.5m. In total, twenty (20) experimental plots of French bean crop were established.

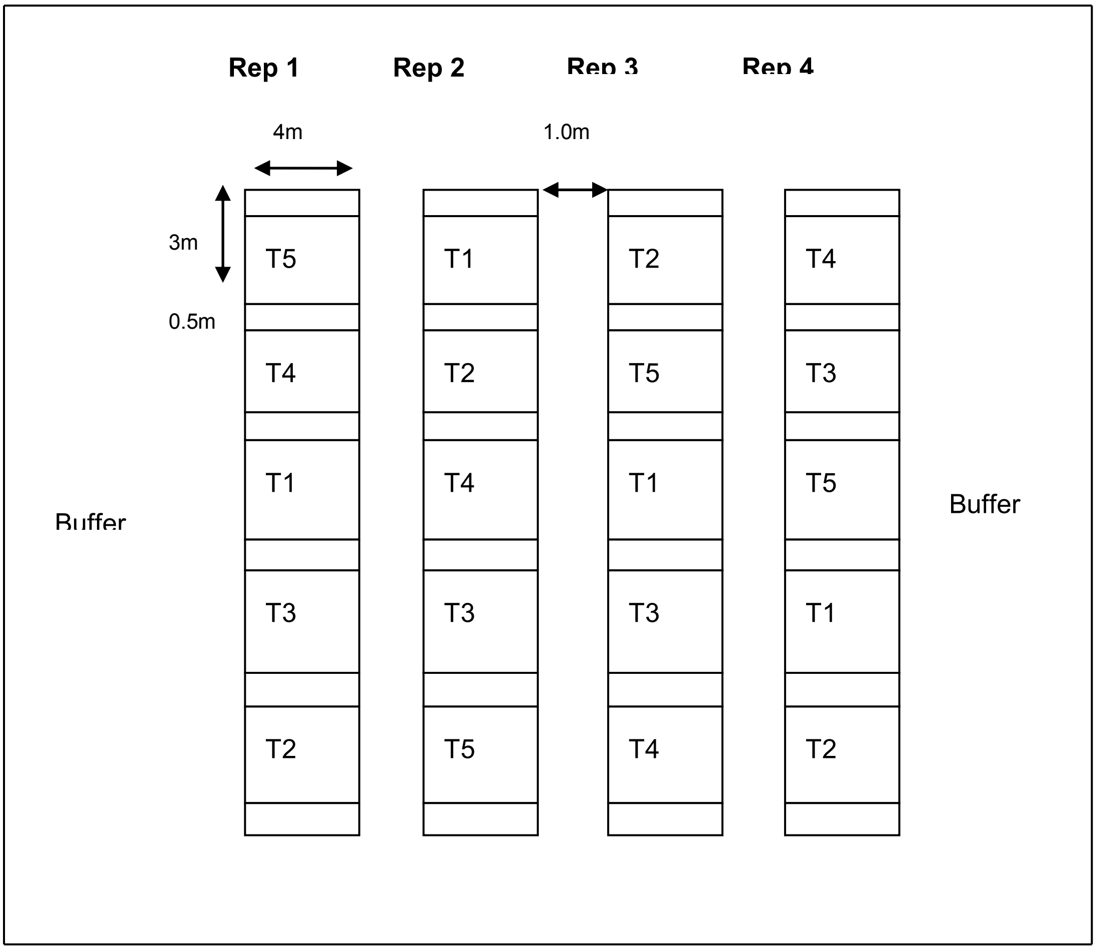


Figure 1: RCBD Trial Layout

2.4 Crop establishment

At trial site 1, Land cultivation was done by hand tillage, followed by forming of raised beds on which French beans were directly sown. In each bed, three (3) single rows of French beans were directly sown at a spacing of 30 cm between the rows and 15cm within the rows.

Plate 1: Raised seed beds read for or sowing French beans

2.5 Method of product application

Water Retainer was diluted 100 times in water and sprayed on the surface of the seedbed immediately after sowing of French beans. Water Retainer treatments were applied by spraying on the surface of the soil using a 20-L knapsack sprayer fitted with hollow cone nozzle (Plate 2). Measuring cylinders were used to achieve accurate measures of the test product.

Stockosorb was applied by broadcasting the granules of the product on the surface of the seedbed before sowing of French beans. After application, Stockosorb was manually incorporated/ tilled-in into the soil to a depth of 10-15cm followed by sowing of French beans (Plate 3).

Table 1: Product application per treatment

T/No	Product	Method of application	Product quantity per $12m^2$ plot
1	Untreated Control	-	-
2	Water Retainer 1.0 ml/m^2	Spray	12ml Water Retainer
3	Water Retainer 1.0 ml/m^2	Spray	12 ml Water Retainer
4	Water Retainer 1.0 ml/m^2	Spray	12 ml Water Retainer
5	STOCKOSORB 18 kg/acre	Broadcast.	27 grams Stockosorb

Application of Water Retainer treatments

Plate 2: Spraying of Water Retainer on the surface of the seedbed using a knapsack sprayer

Application of Stockosorb treatment

Plate 3: Broadcasting and incorporation of Stockosorb in the soil

2.6 Calibration of the available soil moisture

Calibration of soil moisture was done using a soil water meter to establish the available soil moisture at sowing as illustrated in plate 4.

Plate 4: Measuring of soil moisture using a soil water meter.

The average soil meter reading of dry soil in all treatment plots was calculated as **2.5 meter reading, equivalent to 0-50% available soil moisture**.

Plate 5: Watering using a watering can.

After sowing and application of both Water Retainer and Stockosorb, all treatment plots were irrigated to 75-100% available soil moisture (Wet) using a watering can (Plate 5). The available soil moisture (at a depth of 15 cm) was measured after every irrigation with 5 liters until 75-100% available soil moisture was attained.

Fifteen (15) mm of water was used to increase the available soil moisture from 0-50% available soil moisture to (75-100% available soil moisture) (Table 2).

Table 2: Irrigation guide			
Available soil moisture as a percent of available water capacity	Moisture Meter reading	Action	Amount of irrigation required/ bed to achieve 75-100% available soil moisture
Dry (0-50% available soil moisture)	1-3	Irrigate	15mm
Moist (50 -75% available soil moisture)	**4-6**	**Irrigate**	10mm
Wet (75-100% available soil moisture)	7-9	Don't irrigate	none

During the consecutive irrigation, which was done three (3) days later, 10mm of water was applied in the untreated control to increase the available soil moisture from 50-75% level to the desired 75-100% level. The irrigation regime for the Water Retainer and Stockosorb treatments was calculated as outlined in table 3.

Table 3: Irrigation regime per treatment

T/No	Product	Treatments	Irrigation per application
1	Untreated Control	100% irrigation	10 mm
2	Water Retainer 1.0 ml/m^2	50% less irrigation	5 mm
3	Water Retainer 1.0 ml/m^2	40% less irrigation	6 mm
4	Water Retainer 1.0 ml/m^2	30% less irrigation	7 mm
5	STOCKOSORB 90 g/m^2	50% less irrigation	5 mm

2.7 Irrigation plan

The need for irrigation was determined by measuring the available soil moisture in all treatment plots daily using a soil moisture meter. The meter readings from each plot were tabulated to obtain the mean measurement for available soil moisture per treatment. Irrigation was done to all plots that the average available soil moisture was determined at 50-75% level.

Rainfall data

Rainfall that was received in the trial site was recorded and converted to supplementary source of soil moisture for the French beans using the conversion ratio below:

1ml of rainfall = 1 liter of water per m^2 (or 10m^3/ha)

Plate 6: Rain gauge was installed at the trial site

DATA COLLECTION AND ASSESSMENTS

3.1 Sampling plants

After establishment of the French bean crop in the experimental layout, ten (10) sample plants were selected in the net area of each plot by randomisation as per the randomisation matrix in table 4. The sampling plants were tagged for the purpose of non-destructive and destructive assessments

Table 4: Sampling plants randomisation matrix:

Crop	Plant density in the net area of each bed (1m x 0.6m) – central row	Number of sampling plants in the net area of each bed	Random sampling numbers
French beans	13 plants	5 plants	#2, 3, 6,8,11

3.2 Assessment of phytotoxicity

Assessment of phytotoxicity due to Water Retainer on French beans was done weekly. Assessment was done by checking crop reactions associated with phytotoxicity such as chlorotic or necrotic spots and bleaching appearances. The intensity of such reaction on French beans was scored on a scale of 0-5 (Table 5).

Table 5: Severity score of phytotoxicity injury

Severity Score	Level of Phytotoxicity
0	No phytotoxicity
1	Very slight phytotoxicity (<5%)
2	Slight phytotoxicity (5 - 10%)
3	Significant phytotoxicity (10-20%)
4	Extensive phytotoxicity (> 20%)
5	Total burn-down of crop

3.3 Schedule of assessments

Table 6: Assessment Schedule

Planting date	**7.7.2018**		
Assessment	**Measurement**	**Stage**	**Scheduled Date**
Emergence	14.7.2017		
Number of leaves/ plant	Count all mature leaves	10 DAE 20 DAE 30 DAE 40 DAE	24.7.2018 03.8.2018 13.8.2018 23.8.2018
Plant height	Base to the highest tip of the plant by use of a ruler		
Root length	Crown to the longest tip by use of a ruler		
Biomass (Root and Shoot)	Harvest biomass, oven dry and measure using a weighing scale in grams	40 DAE	23.8.2018
Yield	Yield: Harvesting specifications for fresh pods • Pods should have a stalk on them • Should have small seeds • Be soft with soft strings • Be turgid and tender • Have a width of 6-9mm • Have a length of 12-14cm	At harvest	29.8.2018 06.9.2018 12.9.2018

DAE – Days after Emergence

3.4 Harvesting

Harvesting was done by picking mature French beans pods from the net area of each treatment plot and the yield graded into marketable grade based on the specification in table 6. The mean yield from each treatment was extrapolated to tons per hectare. Data was further subjected to analysis of variance of means using Genstat.

3.5 Statistical analysis and Reporting

Data that was obtained was subjected to analysis of variance using GenStat statistical application. Means were separated using Duncan's Multiple Range Test at the $p<0.05$. Results were presented in tables and graphs. Interpretation of data was provided to each table and graph.

Treatment combinations as determined using GenSat

Treatment combinations on each unit of the design

Block	1	2	3	4
Plots				
1	5	1	2	4
2	4	2	5	3
3	1	4	1	5
4	3	3	3	1
5	2	5	4	2

Treatment factors are listed in the order: Treatments.
Analysis of variance

Source of variation:	d.f.
Reps stratum	3
Reps.Plots stratum	
Treatments	4
Residual	12
Total	19

RESULTS

4.1 Trial Field; Mwea Trial Site, Kirinyaga County

Plate 7-12: Experimental site of season 1 trial of Water Retainer at Horticrop Research trial site in Mwea

Plate 8: T1- Untreated+100% Irrigation (T1)

Plate 9: T2 - WR+50% Irrigation (T2)

Plate 10: T3 - WR+60% Irrigation (T3)

Plate 11: T4 - WR+70% Irrigation (T4)

Plate 12: T5 - Stockosorb+50% Irrigation (T5)

4.2 Treatment effect on irrigation requirement of French beans

During the ten (10) weeks crop period, a total 28.9 mm of rainfall was received at Mwea trial site. In addition, irrigation was done weekly as determined using a soil moisture meter. In total, twenty three (23) irrigations were done in T1 and T5, while in Water Retainer treatments T2, T3 and T4, twenty four (24) irrigations were done during the entire crop season (Table 7).

Table 7: Water usage as Irrigation and rainfall per treatment in one season of French beans at Mwea Trial site

Crop stage	Planting			Vegetative			Flowering		Harvest		
Week	wk 27	wk 28	wk 29	wk 30	wk 31	wk 32	wk 33	wk 34	wk 35	wk 36	Total number of irrigations
Untreated+100% Irrigation (T1)	1	2	2	2	1	3	4	3	3	2	23
WR+50% Irrigation (T2)	1	2	2	2	1	3	4	4	3	2	24
WR+60% Irrigation (T3)	1	2	2	2	1	3	4	4	3	2	24
WR+70% Irrigation (T4)	1	2	2	2	1	3	4	4	3	2	24
Stockosorb+50% Irrigation (T5)	1	2	2	2	1	3	4	3	3	2	23
Rainfall		3.8mm			10mm 5.5mm 2.1mm		2mm			4.7mm 0.8mm	Total rainfall (mm)
Weekly rainfall	0mm	3.8mm	0mm	0mm	17.6mm	0mm	2mm	0mm	0mm	5.5mm	28.9mm

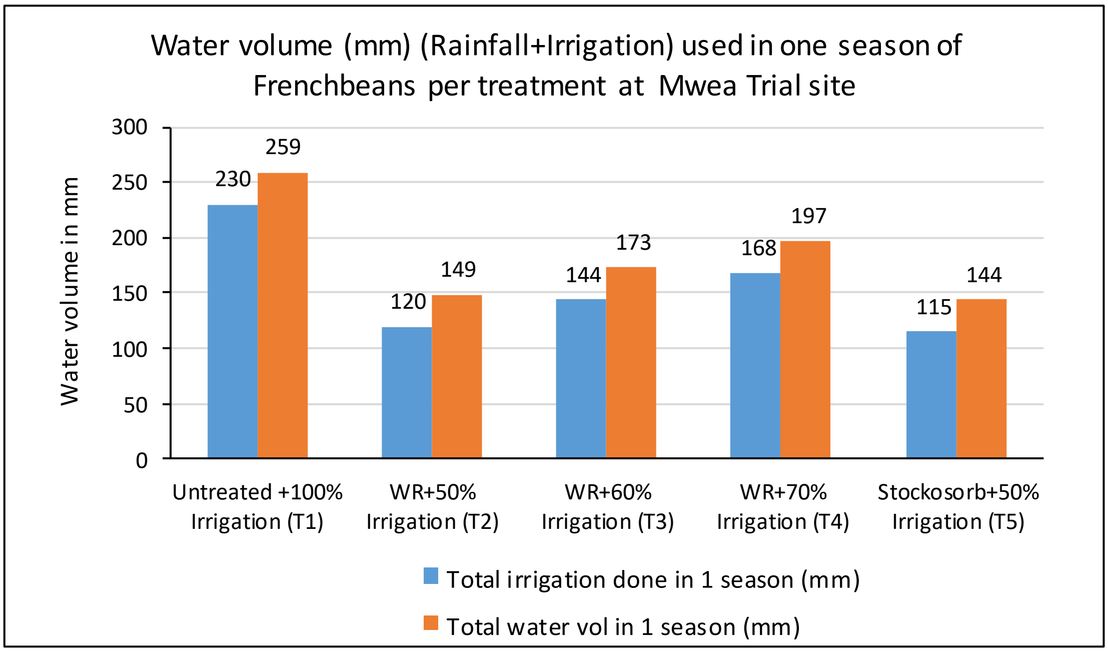


Fig 3: Quantity of water used to grow one season of French beans at Mwea trial site

While T1 treatment received a total of 259mm of water in the entire season of French beans, Water Retainer treatments T2, T3 and T4 as well as Stockosorb treatment T5 received 42%, 33%, 24% and 44% less water respectively in the entire growing season of French beans compared to the untreated control (Table 8; Figure 3).

Table 8: Water requirement per treatment in one season of French beans			
Treatment	Total water quantity in 1 season (mm)	Difference in water quantity compared to the untreated control (mm)	Percent reduction in water requirement compared to the untreated control
Untreated control+100% Irrigation (T1)	259	0	0%
WR+50% Irrigation (T2)	149	110	42%
WR+60% Irrigation(T3)	173	86	33%
WR+70% Irrigation (T4)	197	62	24%
Stockosorb+50% Irrigation (T5)	144	115	44%

4.3 Germination of French beans

Water Retainer treatments T2, T3, T4 had more than 70% germination which was comparable to the untreated control treatment (T1) (Table 9).

Table 9: Germination of French beans per treatment	
Treatment	Germination (percent)
Untreated +100% Irrigation (T1)	77.1%
WR+50% Irrigation (T2)	72.6%
WR+60% Irrigation (T3)	71.3%
WR+70% Irrigation (T4)	74.9%
Stockosorb+50% Irrigation (T5)	65.9%

4.4 Phytotoxicity

Water Retainer did not cause any observable phytotoxicity on French beans throughout the trial period.

4.5 Treatment effect on leaf development in French beans

Treatments differed significantly in leaf development of French beans throughout the trial period at 5% level of significance. At flowering stage (40 DAE) treatment T1 had the highest rate of leaf development which was comparable to Water Retainer treatment T4 (Table 10; Figure 4).

Table 10: Leaf development in French beans at different growth stages

Treatment	10 DAE		20 DAE		30 DAE		40 DAE	
Untreated+100% Irrigation (T1)	2.0	b	4.5	b	6.9	b	9.2	c
WR+50% Irrigation (T2)	1.5	a	3.6	a	5.0	a	5.8	a
WR+60% Irrigation (T3)	1.5	a	3.8	a	6.3	b	7.5	b
WR+70% Irrigation (T4)	1.5	a	3.9	a	6.6	b	8.5	bc
Stockosorb+50% Irrigation (T5)	1.9	b	4.1	ab	6.4	b	7.5	b
P-Value	<.001		0.032		0.01		0.001	
ESE	±0.07		±0.17		±0.32		±0.42	

Treatments with the same letter along the column are not significantly different at P≤0.05 according to DMRT

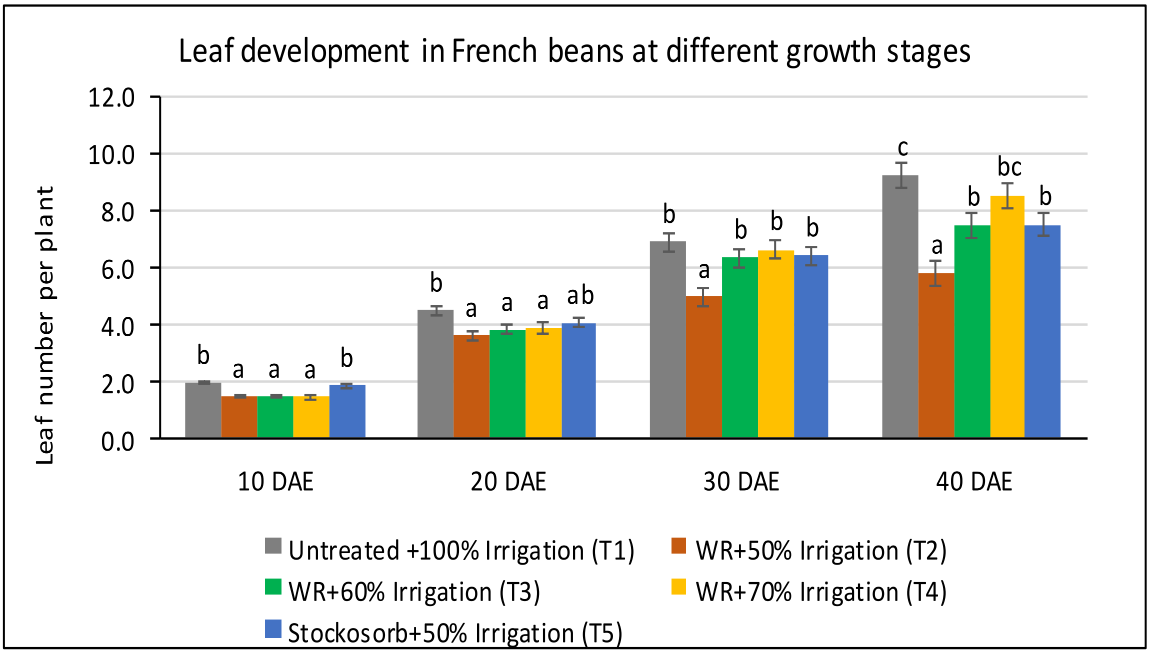


Fig 4: Leaf development in French beans. Treatments with the same letter across the bars are not significantly different at P≤0.05 according to DMRT. Error bars represent Standard Error of treatment means.

4.6 Treatment effect on plant height of French beans

Treatments differed significantly in height of French beans at 30 and 40 DAE. At the flowering stage of the crop (40 DAE) only treatment T2 had a significantly shorter French bean crop compared to the other treatments at 5% level of significance (Table 11; Figure 5).

Table 11: Plant height of French beans at different growth stages

Treatment	20 DAE		30 DAE		40 DAE	
Untreated+100% Irrigation (T1)	15.2	a	23.4	c	25.9	b
WR+50% Irrigation (T2)	13.0	a	17.5	a	18.5	a
WR+60% Irrigation (T3)	13.6	a	20.6	b	22.8	b
WR+70% Irrigation (T4)	13.6	a	22.0	bc	22.8	b
Stockosorb+50% Irrigation (T5)	16.7	a	20.9	b	22.9	b
P-Value	0.268		<.001		0.009	
ESE	1.23		0.68		1.12	

Treatments with the same letter along the column are not significantly different at P≤0.05 according to DMRT

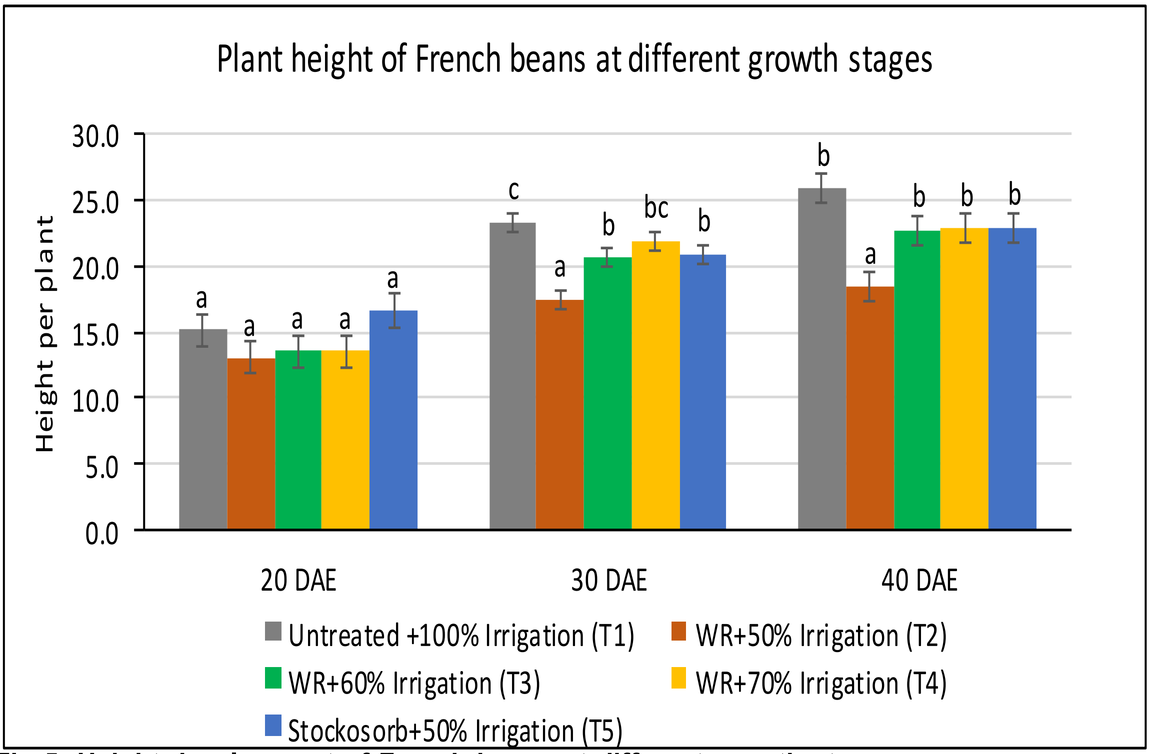


Fig 5: Height development of French beans at different growth stages. Treatments with the same letter across the bars are not significantly different at P≤0.05 according to DMRT. Error bars represent Standard Error of treatment means.

4.7 Treatment effect on root development

At flowering stage (40 DAE), treatments did not differ significantly (P=0.516) in the length of roots of French beans at 5% level of significance. Root development in Water Retainer treatments (T2, T3 and T4) as well as the reference product (T5) was comparable to that of the untreated control (T1) (Table 12).

Table 12: Root length of French beans at different treatment levels at 40 DAE

Treatment	Root length in (cm)	
Untreated+100% Irrigation (T1)	23.1	a
WR+50% Irrigation (T2)	19.8	a
WR+60% Irrigation (T3)	20.8	a
WR+70% Irrigation (T4)	20.1	a
Stockosorb+50% Irrigation (T5)	25.0	a
P-Value	0.516	
ESE	±2.39	

Treatments with the same letter along the column are not significantly different at P≤0.05 according to DMRT

4.8 Treatment effect on dry matter accumulation of French beans

At flowering stage (40 DAE), treatment T2 had the lowest accumulation of dry matter which differed significantly (P<.001) from the other treatments. Water Retainer treatments (T3 and T4) had comparable dry matter to the untreated control (T1) and the reference product (T5) (Table 13).

Table 13: Dry matter of French beans at different treatment levels at 40 DAE

Treatment	Root length in cm	
Untreated+100% Irrigation (T1)	32.3	b
WR+50% Irrigation (T2)	14.8	a
WR+60% Irrigation (T3)	27.5	b
WR+70% Irrigation (T4)	27.0	b
Stockosorb+50% Irrigation (T5)	25.0	b
P-Value	0.017	
ESE	±3.01	

Treatments with the same letter along the column are not significantly different at P≤0.05 according to DMRT

4.9 Treatment effect on the yield of French beans

Treatments differed significantly (P=0.006) in yield of French beans at 5% level of significance. The quantity of marketable yield of French beans in Water Retainer treatment (T4) was comparable to yield that was obtained from the untreated control (T1) and Stockosorb treatment (T5). Water Retainer treatments T2 and T3 had significantly lower yield of French beans compared to the untreated control (T1) (Table 13).

Table 14: Yield of French beans at different treatment levels

Treatment	Yield in tons/ha	
Untreated+100% Irrigation (T1)	10.5	c
WR+50% Irrigation (T2)	3.6	a
WR+60% Irrigation (T3)	5.9	ab
WR+70% Irrigation (T4)	9.7	c
Stockosorb+50% Irrigation (T5)	8.3	bc
P-Value	0.006	
ESE	±1.14	

Treatments with the same letter along the column are not significantly different at P≤0.05 according to DMRT

T1 T2 T3 T4 T5

Plate 13: Samples of marketable yield of French beans that was harvested from different treatments

Key:

Untreated+100% Irrigation (T1)
WR+50% Irrigation (T2)
WR+60% Irrigation (T3)
WR+70% Irrigation (T4)
Stockosorb+50% Irrigation (T5)

CONCLUSION

Results that were obtained from the first season trial evaluation at Mwea trial site, Kirinyaga County showed that;

1. Water Retainer reduced the need for irrigation in French beans. Overall, Water Retainer treatments T2, T3 and T4 received 42%, 33%, and 24% less water respectively in the entire growing season of French beans compared to the untreated control. The effect of Water retainer on the need for irrigation was comparable to Stockosorb treatment T5 which received 44% less irrigation compared to the untreated control.
2. French bean in Water Retainer treatment T4 showed normal growth and development of shoots, plant height, roots and dry matter up to the flowering stage (40 DAE), which was comparable to the untreated control (T1) which received the optimal irrigation.
3. The marketable yield of French beans obtained in the Water Retainer treatment T4, was comparable to the yield that was obtained from the Untreated control (T1) and Stockosob treatment (T5)

The second site trial evaluation is ongoing in Timau, Meru County whose results will be compared for consistency with the results that were obtained from the Mwea, Kirinyaga County Trial site.

REFERENCES

PCPB. (2013, January 28). Information on Directions for Use/Application Rates. To Accredited Institutions (Crop)(PCPB/111/REG/Vol.1/13/24).

PCPB. (n.d.). Protocol for Evaluating the Efficacy for Pest Control Products in Kenya. Kenya.

United States Department of Agriculture. (1998, April). Estimating Soil Moisture by Feel and Appearance. *Program Aid Number 1619*(Program Aid Number 1619).

APPENDIX

Appendix 1: Trial schedule

<table>
<tr><td>Research Company</td><td colspan="4">HORTICROP RESEARCH LIMITED</td></tr>
<tr><td>Trial Site</td><td colspan="4">Horticrop Research Limited’s research sites:
Site 1:Mwea, Kirinyaga County
Site 2: Timau, Meru County
Site 3: Naivasha, Nakuru County</td></tr>
<tr><td>Product</td><td colspan="4">Water Retainer</td></tr>
<tr><td>Number of trial season</td><td colspan="4">Two Seasons at 3 locations
Season 1: Mwea and Timau Trial Sites;
Season 2: Mwea, Timau and Naivasha Trial Site (Confirmatory trial)</td></tr>
<tr><td>Target use</td><td colspan="4">Water retention of the soil, Growth parameters and yield</td></tr>
<tr><td>Crops</td><td colspan="4">French beans</td></tr>
<tr><td>Commercial Variety</td><td colspan="4">Serengeti from Syngenta</td></tr>
<tr><td>Crop period</td><td colspan="4">8 weeks</td></tr>
<tr><td rowspan="2">Trial period</td><td colspan="2"></td><td>Start</td><td>End</td></tr>
<tr><td colspan="2">French beans</td><td>July 2018</td><td>September 2018</td></tr>
<tr><td>Fertilizer use</td><td colspan="4">At plating: none
At 1 week stage: TSP 200 kg/ha + Urea 200 kg/ha
At 5 weeks stage: CAN 200 kg/ha</td></tr>
<tr><td>Type of Irrigation</td><td colspan="4">Rainfall and supplementary irrigation in each treatment will be done with amount of water outlined in Tables 5 (Mwea) & 7 (Timau) using a watering can</td></tr>
<tr><td>Herbicide use</td><td colspan="4">None</td></tr>
<tr><td rowspan="3">Non target pesticide use</td><td></td><td>Trade name</td><td>A.I</td><td>Target pest</td></tr>
<tr><td>1</td><td>Confidor WG</td><td>Imodacloprid</td><td>Bean fly</td></tr>
<tr><td>2</td><td>Ortiva</td><td>Azoxystrobin</td><td>Leaf spot</td></tr>
</table>

Appendix 2: Assessment of Growth parameters in French beans data sheet

ASSESSMENT OF GROWTH PARAMETERS OF FRENCH BEANS

PROJECT: WATER RETAINER

Season: …………………………..…………**Site**……………….……………………**Name**………………………………

Date:

Parameter: **Unit of measure:**

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
Block 1										
T5										
T4										
T1										
T3										
T2										
Block 2										
T1										
T2										
T4										
T3										
T5										
Block 3										
T2										
T5										
T1										
T3										
T4										
Block 4										
T4										
T3										
T5										
T1										
T2										

Other Observations (Phytotoxicity, effect on non-target organisms, e.t.c)

Checked (Name & Sign)

Approved (Name & Sign)

Appendix 3: Soil moisture meter measurements data sheet

DATA SHEET: Soil moisture measurements

Project ID: SW/WR/KEP/French beans

Date: ____________________

Date of next measurement: ____________________

Name of data collector : ____________________

Assessment of soil moisture per treatment

Treatment	T1		T2		T3		T4		T5	
Replication	Bed 1	Bed 2	Bed 1	Bed 2	Bed 1	Bed 2	Bed 1	Bed 2	Bed 1	Bed 2
Rep 1										
Rep 2										
Rep 3										
Rep 4										
Mean mositure level										
Action Taken										

Irrigation guide		
Available soil moisture as a percent of available water capacity	Moisture Meter reading	Action
Dry (0-50% available soil moisture)	1 to 3	Irrigate
Moist (50 -75% available soil moisture)	**4 to 6**	**Irrigate**
Wet (75-100% available soil moisture)	7 to 9	Don't irrigate

Checked (Name & Sign)

____

Approved (Name & Sign)

____

greenhouse trial and research centre
soil science consultants
www.greenhousetrial.co.za
Dr Arrie (JA) Janse van Vuuren +27 82 573 2923
Pr.Sci.Nat.(Soil Science)
SACNASP Registration No. 401598/83
arrievv@telkomsa.net
Prof. Andries (AS) Claassens +27 84 581 6488
claassensa@telkomsa.net

INDEPENDANT RESEARCH FACILITY

Statistical **POT TRIALS** - different crops and treatments including root studies
REPORTS on yield, plant and soil analysis
Nutrition **RECOMMENDATIONS**
Assistance with **REGISTRATIONS** - Act 36 of 1947

REPORT TO

water&soil

WATER RETAINER

SOIL CONDITIONER CONCENTRATE

EVALUATING THE EFFICACY OF "WATER RETAINER" IN SOIL WHEN APPLIED AT VARIABLE APPLICATION RATES, AND THE EFECT ON PLANT BIOMASS PRODUCTION OF MAIZE AND BEANS

JULY 2018

MULTI-DISSIPLINêRE PLANT & GROND KONSULTANTE MPY (BPK).
Handeldrywend as "Greenhouse trial and research Centre".
MULTI DISCIPLINARY PLANT & SOIL CONSULTANTS PTY (LTD).
Trading as "Greenhouse trial and research Centre".
COMPANY/MAATSKAPPY: Reg.No. 2010/013053/07; VAT/BTW: Reg.No. 4220256095
Portion 113, Farm Elandsfontein, District Bapsfontein 412 JR
Dr Arrie van Vuuren 082 573 2923, Professor Andries Claassens 084 581 64

TABLE OF CONTENT

1 INTRODUCTION

The use of water retainers to increase the available water in soil by preventing evaporation of water from the soil surface of the uncovered areas could have a positive effect during water stress periods. The increase in plant available water of treated soil should have a positive efect on plant biomass production.

Whith the introduction of new products in the soil conditioner market, the efficacy of these products to improve water holding capacity of a soil and the subsequent benefit to the plants needs to be confirmed.

2 SCOPE

The scope of this study was to do a pot trial under controlled environmental conditions to evaluate:

1. The effectiveness of a the water retainer product at variable application rates on the biomass production of beans and maize,
2. To evaluate whether the product has any phyto-toxic effect.

3 MATERIAL AND METHODS

3.1 Soil

A loamy sand (Babsfontein) soil was used. The attached analysis results were done at the end of the trial.

BAPSFONTEIN SOIL																	
TREATMENT			mg/kg									Calculation			cmol(+)/kg	g/ml	mg/kg
	pH (KCl)	P Bray1	Na	K	Ca	Mg	% Ca	% Mg	% K	% Na	Ca:Mg	(Ca+Mg)/K	Mg:K	Na:K	CEC	Density	S
1. Soil	5,14	1	21	48	596	119	71,6	23,3	3	2,1	3,1	32,1	7,9	0,7	4,2	1,041	30
2. Soil + Fert.	4,99	7	14	36	490	96	72,2	23,3	2,7	1,8	3,1	35,2	8,6	0,7	3,4	1,221	30

3.2 Test product

Water retainer product

3.3 Treatments and application rates

3.3.1 Pot trial

Based on the recommended application rate as prescribed for the product, it was used in combination with a standard fertilizer, together with half, full and double the recommended application rates. This is in accordance with the requirements of the Registrar of Act 36 of 1947 to be able to register the product as a group 3 fertilizer. Together with these treatments a reference treatment which received only fertilizer was included (Treatment 1).

The different application rates are as set out in Table1.

The product was diluted 1000 times in order to get the equivalent volumes below into the pots (1liter dissolved in 100liters of water for each 1000m2) and applied onto the soil surface after seeds were planted and band placement of the fertilizer.

Table 1. Treatments.

1	Soil +3:2:2(35) Control
2	Soil +3:2:2(35) + 0.5x (15 ml/pot)rec rate
3	Soil +3:2:2(35) + 1 x (30 ml/pot)
4	Soil +3:2:2(35) +2 x (60 ml/pot)

3.4 Crop

Maize and beans

3.5 Trial layout

Pots containing 6 kg of soil were treated as follows:
At planting 2g/pot of a 3:2:2(35) bulk blended mixture was applied as a band in the middle of the pot. This reference 3:2:2(35) was compiled with MAP, LAN and KCl. After planting the a diluted product was applied as set out in table 1 During the trial period the daily irrigation was interrupted from time to time to stress the plants and then the water content measured and expressed as % water content.

Treatments were replicated 4 times.

At harvest the plants of the different replicates were cut above the soil, weighed (wet mass), oven dried at 65°C and weighed again (dry mass). The replicates were then combined and sent to the laboratory for chemical analysis. At the same time soil samples from the different replicates were taken in the middle and side of the pot. The replicate samples were then pooled and send to the lab for chemical analysis.

3.3.2 Laboratory trial

Soil columns were prepared by filling up two perplex tubes with soil. After adding water to the columns, one column receive the product while the seconf column were not treated with the product. They were weighed daily and the water loss due to evaporation noted.

3.6 Statistics

A SAS program was used to calculate the ANOVA’s, LSD (Fisher unprotected t-test) and CV.

4 RESULTS AND DISCUSSION

4.1 Yield results

4.1.1 Maize biomass yield

From the biomass yield of maize in Table 2, Treatment 1 received only the basic fertilizer application and was used as control.

At all the application rates, **wet biomass yields** were **statistically significantly higher** than the control.
The **dry biomass yield** at half the application rate was higher than the control, however not statistically significantly. The other application rates were similar to the control.

Table 2. Plant biomass of maize as influenced by variable application rates of product

No.	TREATMENTS	WET	DRY
1	Soil +3:2:2(35) Control	25.82 b	14.95 ab
2	Soil +3:2:2(35) + 0.5x (15 ml/pot)	30.02 a	15.14 a
3	Soil +3:2:2(35) + 1 x (30 ml/pot)	29.32 a	14.82 b
4	Soil +3:2:2(35) +2 x (60 ml/pot)	29.48 a	14.96 ab
	LSD (p= 0.05)	**2.95**	**0.318**

Figure 1. Wet biomass of maize as influenced by variable application rates of the product

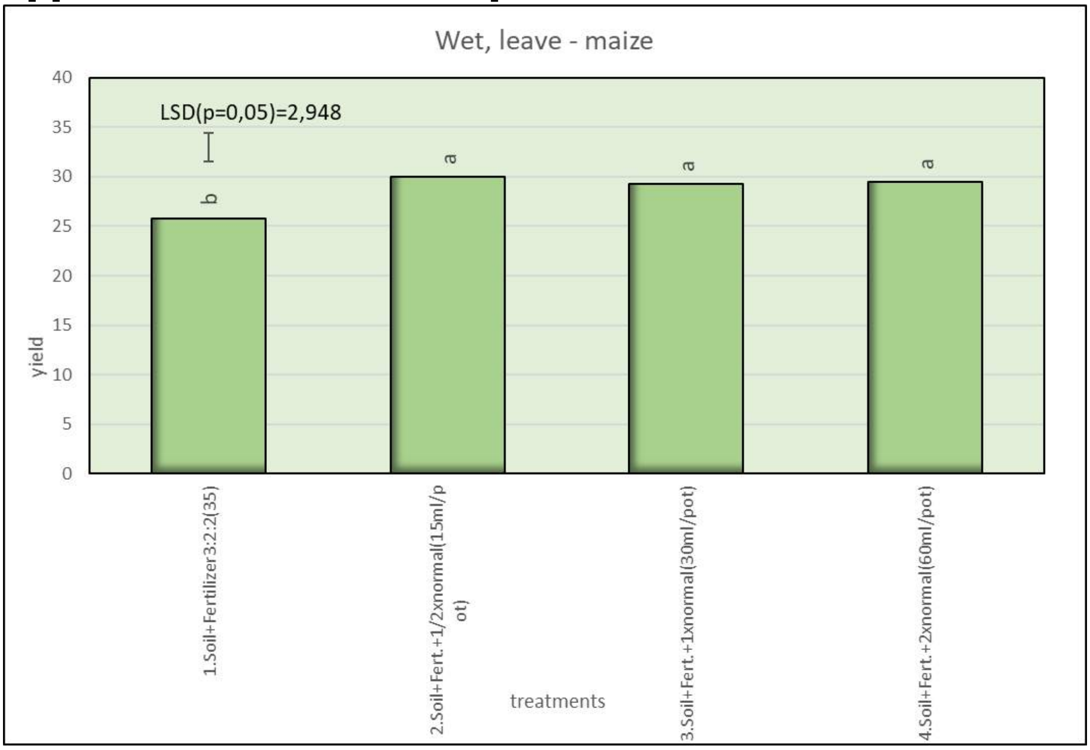
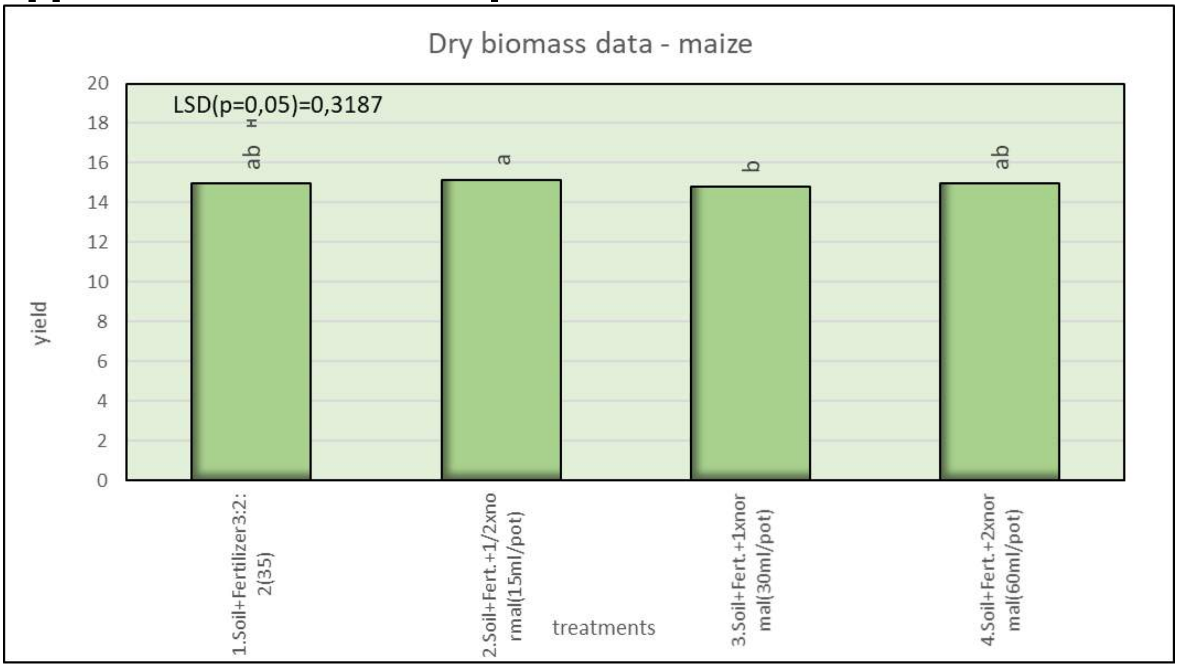


Figure 2. Dry biomass of maize as influenced by variable application rates of the product



4.1.2 Bean biomass yield

Based on the biomass yields of beans in Table 3, the following was found:

Treatment 1 received only the basic fertilizer application and was used as control.

The beans did not respond to the different application rates that were applied to the soil, most probably due to thr fact that the biomass production was much lower thean the maize and thus less moisture was taken up.

Table 3. Biomass of beans as influenced by variable application rates of the product

No.	treatment	WET	DRY
1	Soil +3:2:2(35) Control	21.14 a	14.64 a
2	Soil +3:2:2(35) + 0.5x (15 ml/pot)	21.52 a	15.08 a
3	Soil +3:2:2(35) + 1 x (30 ml/pot)	21.14 a	14.79 a
4	Soil +3:2:2(35) +2 x (60 ml/pot)	22.44 a	15.08a
	LSD (p= 0.05)	2.83	0.536

Figure 3. Wet beans biomass as influenced by variable application rates of the product

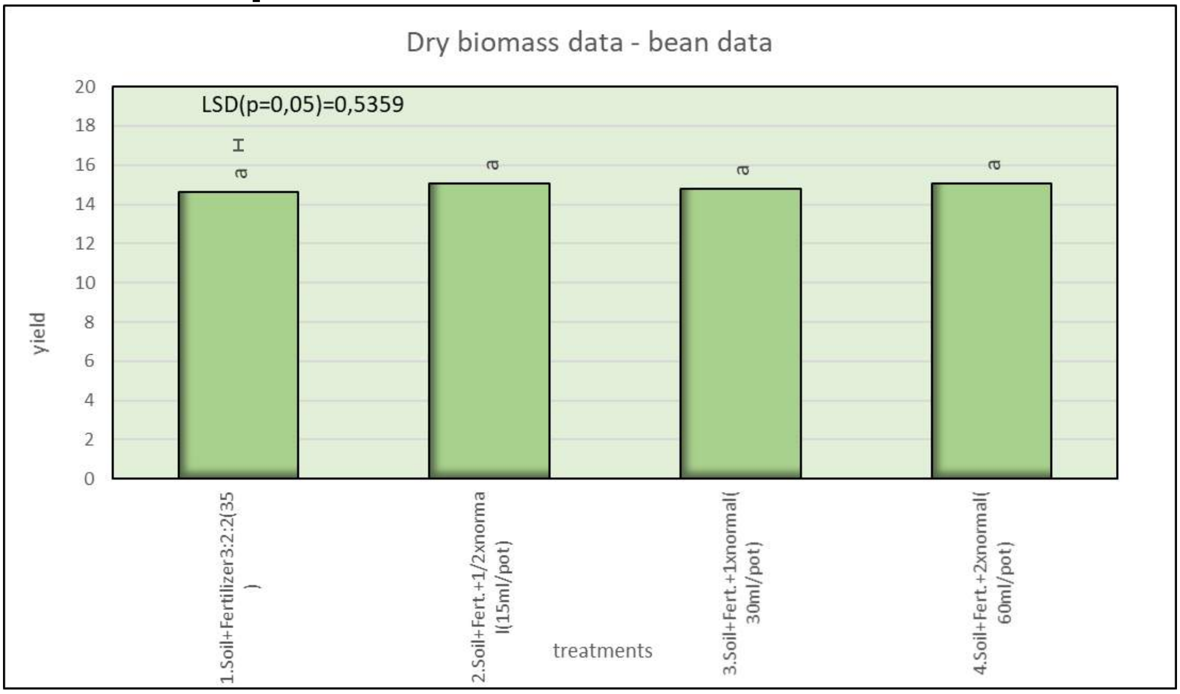
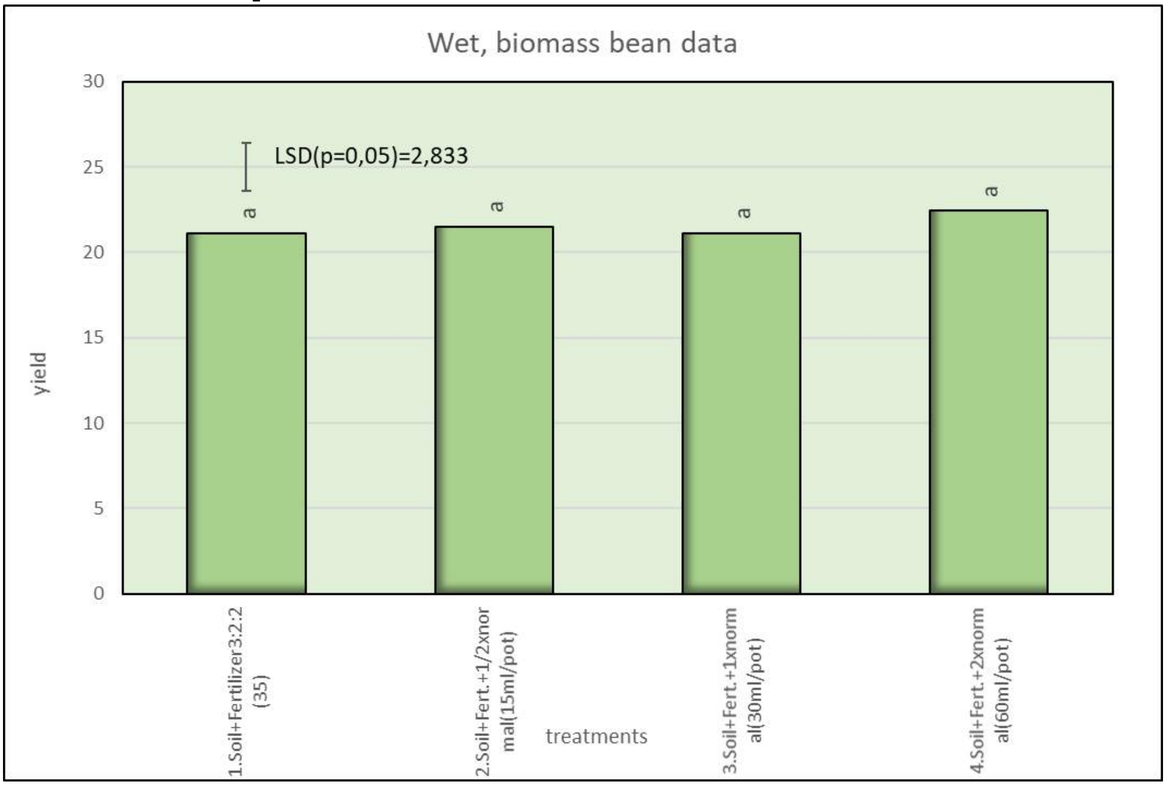


Figure 4. Dry beans biomass as influenced by variable application rates of the product



4.2 Plant analysis

4.2.1 Maize

Based on the plant analysis data in Table 4 there were no significant responses due to the variable application rates applied.

Table 4. Leaf analysis results of the maize as influenced by variable application rates of the product

		Ca	Mg	K	Na	S	P	Fe	Mn	Cu	Zn	B	Mo	N	Al
No	**Treatment**	%	%	%	mg/kg	%	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	mg/kg
1	Soil +3:2:2(35) Control	0.45	0.37	2.33	23	0.26	0.38	166	1051	10.12	51	6.4	0.96	3.05	106
2	Soil +3:2:2(35) + 0.5x (15 ml/pot)	0.46	0.37	2.56	18	0.28	0.37	158	1209	9.82	57	10.2	0.51	2.16	92
3	Soil +3:2:2(35) + 1 x (30 ml/pot)	0.44	0.39	2.66	20	0.26	0.36	189	983	9.37	47	9.7	0.42	3.19	138
4	Soil +3:2:2(35) +2 x (60 ml/pot)	0.50	0.41	2.37	22	0.24	0.35	173	952	9.18	46	10.4	0.58	3.85	160

4.2.2 Beans

From the data in Table 5 there was a slight increase in the K, P, Mn and B content when increasing application rates of the product was applied.

Table 5. Leaf analysis results of the beans as influenced by variable application rates of the product

		Ca	Mg	K	Na	S	P	Fe	Mn	Cu	Zn	B	Mo	N	Al
Tr no	**treatment**	%	%	%	mg/kg	%	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	mg/kg
1	Soil +3:2:2(35) Control	0.72	0.45	1.75	26	0.21	0.29	168	1174	7.25	58	9.59	0.44	3.82	156
2	Soil +3:2:2(35) + 0.5x (15 ml/pot)	0.82	0.46	1.83	22	0.21	0.32	190	1349	7.35	55	12.46	0.43	3.95	206
3	Soil +3:2:2(35) + 1 x (30 ml/pot)	0.84	0.48	1.87	25	0.22	0.35	168	1454	7.78	61	10.80	0.11	3.91	180
4	Soil +3:2:2(35) +2 x (60 ml/pot)	0.82	0.45	2.01	24	0.22	0.38	190	1355	7.64	60	11.90	0.13	3.22	219

4.3 Soil analysis

From the soil analysis data in Table 5, the core sample that was taken in the centre of the pot was significantly higher than the samples that were taken at the side of the pot. This was mainly due to the fact that the fertilizer was band placed in the centre of the pot and represents the residual effect of the applied fertilizer. The treatments however did not influence the nutrient content in the soil either in the centre or on the side.

Table 5. Soil analysis results as influenced by variable application rates of the product

Water Retainer				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Tr no	Treatment Land Ref	Tr site	pH (KCl)	PBray1	Na	K	Ca	Mg	S
1	Soil +3:2:2(35) Control	1 Middle	4.72	168	19	52	242	59	2.97
2	Soil +3:2:2(35) + 0.5x (15 ml/pot)	2 Middle	4.75	120	11	53	229	56	6.12
3	Soil +3:2:2(35) + 1 x (30 ml/pot)	3 Middle	4.69	105	8	42	219	43	3
4	Soil +3:2:2(35) +2 x (60 ml/pot)	4 Middle	4.74	137	7	41	115	42	3.26
1	Soil +3:2:2(35) Control	1 Kant	4.22	24	8	22	93	26	6.8
2	Soil +3:2:2(35) + 0.5x (15 ml/pot)	2 Kant	4.14	4	7	21	66	26	4.13
3	Soil +3:2:2(35) + 1 x (30 ml/pot)	3 Kant	4.12	2	10	27	129	29	6.99
4	Soil +3:2:2(35) +2 x (60 ml/pot)	4 Kant	4.04	4	9	22	117	35	5.12

4.3 Laboratory study

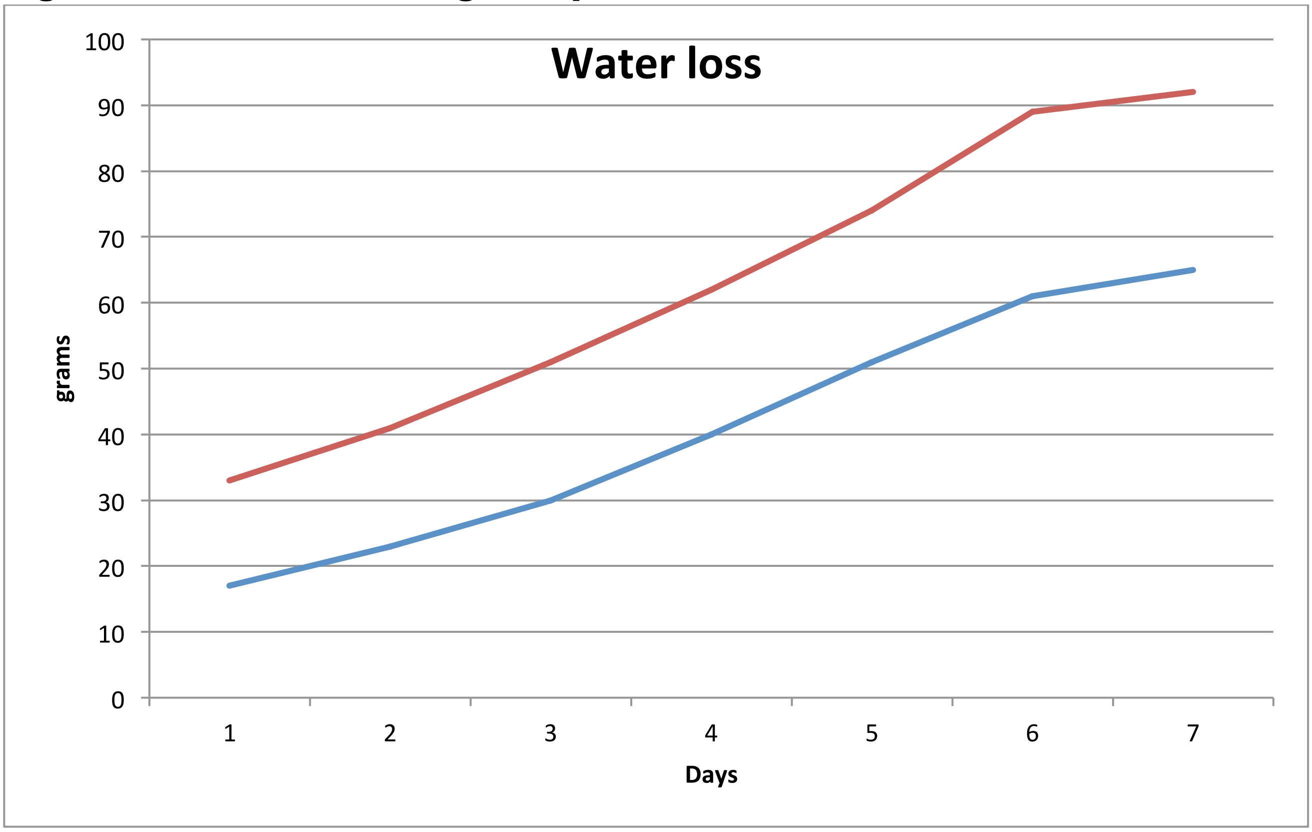
Two perspex columns 30cm in diameter and 30cm high, were prepared by fixing a fine net at the bottom of the tubes to prevent the soil from moving out of the columns. The columns were then filled with the same amount of a unbuffered sandy soil and the 1liter of water applied to both columns. The columns were left in order for the free water to drain from the column.

Columns were weighed and the normal recommended application rate of the water retainer applied to the one column on the surface of the soil. The same amount of water without the water retainer was applied to the remaining column.

Columns were weighed on a daily basis thereafter for 7 days.

From Figure 5. Less water evaporated from the treated soil compared to the treated soil.

Figure 1. Water loss through evaporation from the surface of the columns



SOIL WITH WATER RETAINER **SOIL WITHOUT WATER RETAINER**

CONCLUSIONS

Greenhouse Trial

- **The maize wet biomass yield was statistically significantly higher than the control on all the application rates.**

- **The beans biomass yield did not show any benefit when this product was applied on the surface of the soil, probably due to lower water demand compared to the maize.**

- **The nutrient content of the plants were not significantly influenced due to the surface application of the product.**

Laboratory Trial

- **When evaluating the evaporation from the surface of the treated and untreated soil the treated soil lost considerably less water due to evaporation.**

ANNEXURES

STATISTICAL REPORT OF GREENHOUSE TRIAL

Nicolene M Cochrane[1] CochraneN@arc.agric.za (MSc (UP) & SACNASP)
[1]ARC-Central Office, Biometry Services, Pretoria, South Africa.

Purpose of study – *Water wise* report

Statistical methods

An one-way ANOVA was done on different soil treatments on Beans and Maize for wet- and dry biomass yield respectively. The experimental design will be a *complete randomize* design for each of the above mentioned, due to the rotating of the different treatments.

The standardized residuals was acceptable normal distributed (Shapiro-Wilks test) and therefor the means of the significant effects were separated using Fisher's Unprotected t-test (least significant difference – LSD) tested at the 5% level of significance (Snedecor & Cochran, 1980).

Al data analyses were performed using SAS 9.4 statistical software (SAS 2014).

Results

1. Table 1.1: ANOVA on dry, maize yield data

ANOVA for beans dry biomass data			
Source	**DF**	**MS**	**Fprob**
Tmt	3	0.245	0.245
Error	16	0.160	
Total Corrected	19		

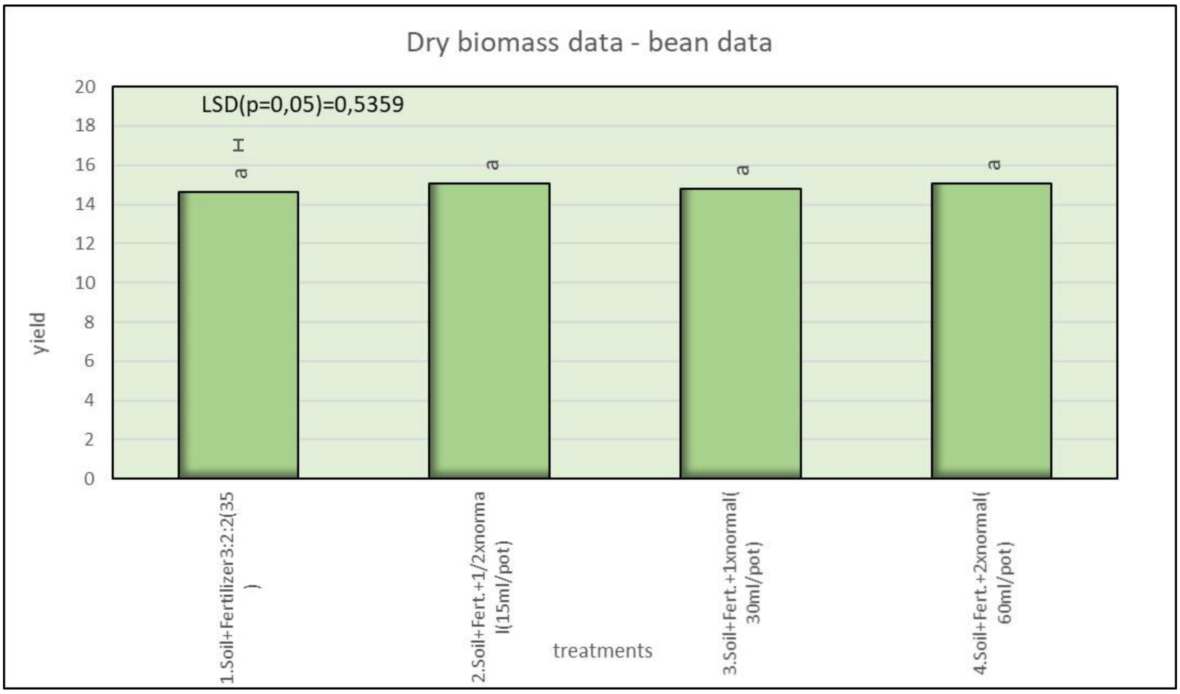
Where DF = Degrees of freedom, MS = Means Square and Fprob= Significant level of F-Ratio
A significant level less than 0.05 is considered as a significant effect and indicated in bold

Table 1.2 - T groupings and means for yield over the 4 treatments

Tmt no	yield	t grouping
1.Soil+Fertilizer3:2:2(35)	14.64	a
2.Soil+Fert.+1/2xnormal(15ml/pot)	15.08	a
3.Soil+Fert.+1xnormal(30ml/pot)	14.78	a
4.Soil+Fert.+2xnormal(60ml/pot)	15.08	a
LSD(p=0.05)=0.5359		

Means with the same letters do not differ significantly at the 5% significant level

Graph 1 – Means for dry bean yield



2. Table 2.1: ANOVA on wet bean biomass data

ANOVA for beans,wet, biomass data			
Source	**DF**	**MS**	**Fprob**
Tmt	3	1.881	0.740
Error	16	4.465	
Total Corrected	19		

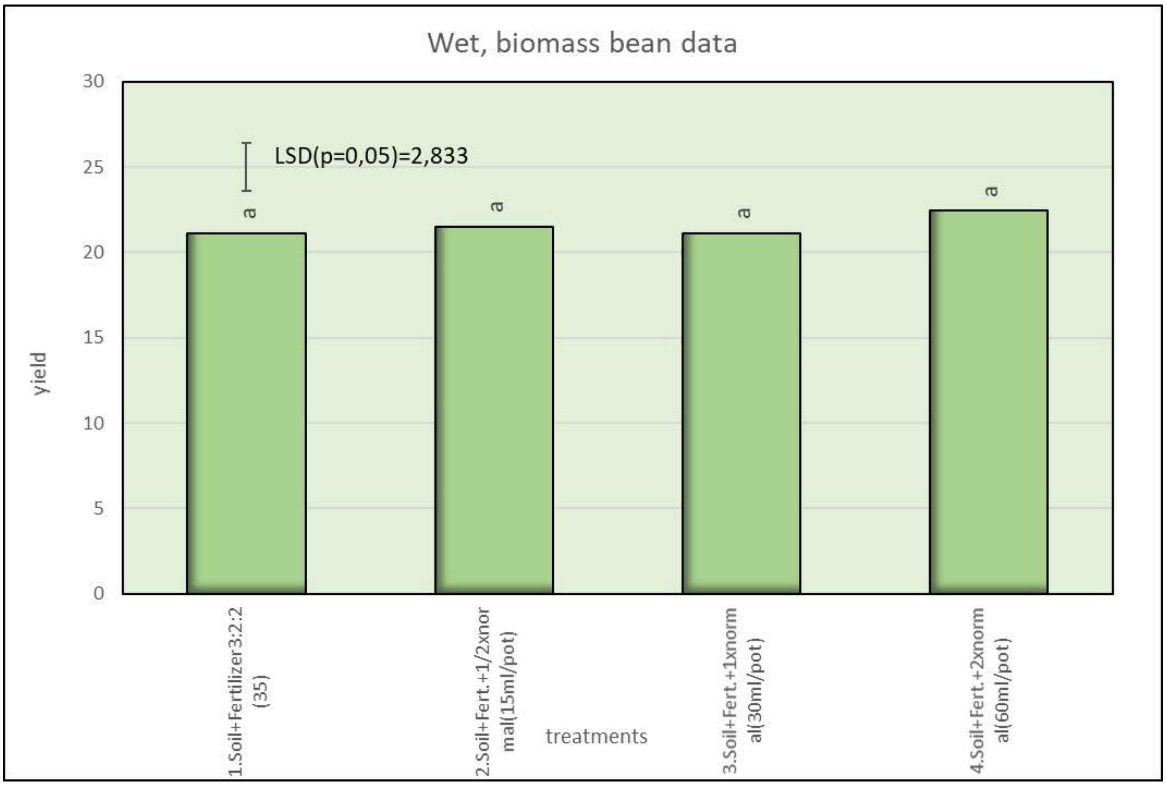
Where DF = Degrees of freedom, MS = Means Square and Fprob= Significant level of F-Ratio
A significant level less than 0.05 is considered as a significant effect and indicated in bold

Table 2.2 - T groupings and means for yield over the 4 treatments

Tmt no	yield	t grouping
1.Soil+Fertilizer3:2:2(35)	21.14	a
2.Soil+Fert.+1/2xnormal(15ml/pot)	21.52	a
3.Soil+Fert.+1xnormal(30ml/pot)	21.14	a
4.Soil+Fert.+2xnormal(60ml/pot)	22.44	a
LSD(p=0.05)=2.833		

Means with the same letters do not differ significantly at the 5% significant level

Graph 2



3. Table 3.1: ANOVA on dry maize biomass data

ANOVA for maize, dry biomass data			
Source	**DF**	**MS**	**Fprob**
Tmt	3	0.086	0.2471
Error	16	0.057	
Total Corrected	19		

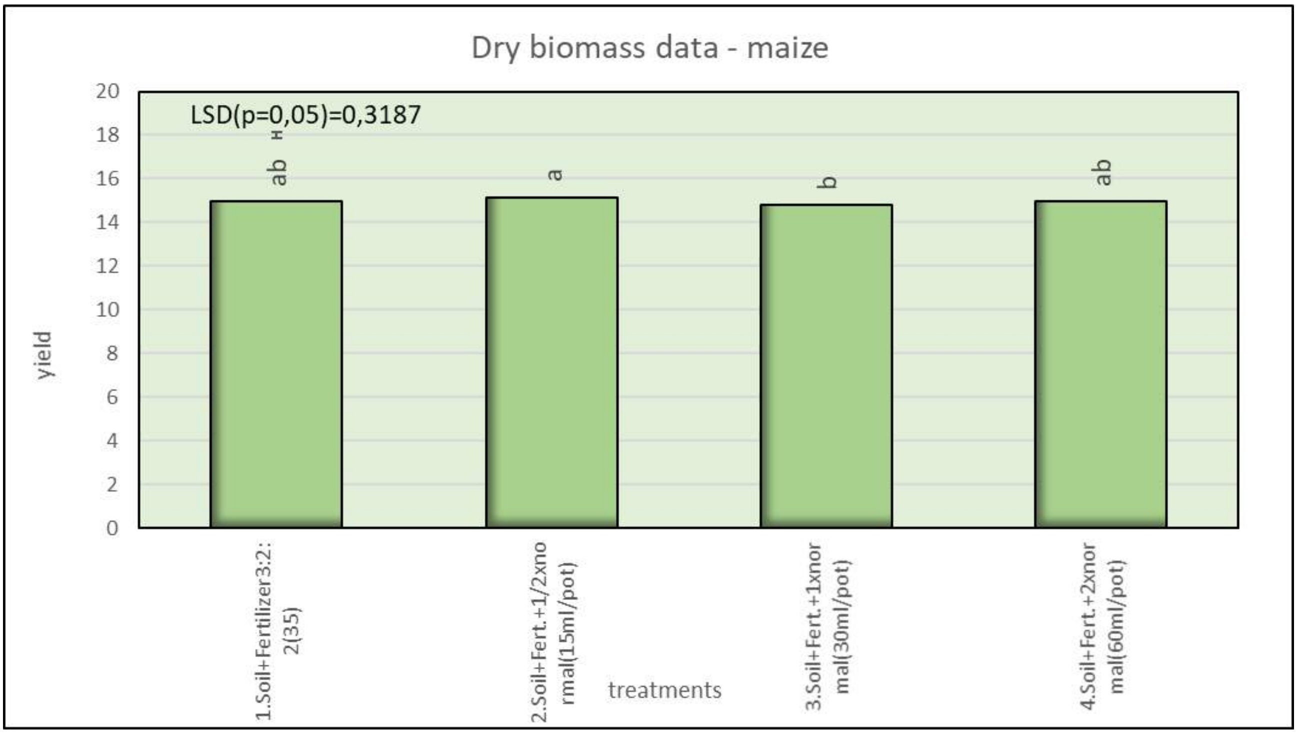
Where DF = Degrees of freedom, MS = Means Square and Fprob= Significant level of F-Ratio
A significant level less than 0.05 is considered as a significant effect and indicated in bold

Table 3.2 - T groupings and means for yield over the 4 treatments

Tmt no	yield	t grouping
1.Soil+Fertilizer3:2:2(35)	14.96	ab
2.Soil+Fert.+1/2xnormal(15ml/pot)	15.14	a
3.Soil+Fert.+1xnormal(30ml/pot)	14.82	b
4.Soil+Fert.+2xnormal(60ml/pot)	14.96	ab
LSD(p=0.05)=0.3187		

Means with the same letters do not differ significantly at the 5% significant level

Graph 3



4. Table 4.1: ANOVA on wet maize data

ANOVA for maize,wet, biomass data			
Source	**DF**	**MS**	**Fprob**
Tmt	3	18.370	0.031
Error	16	4.830	
Total Corrected	19		

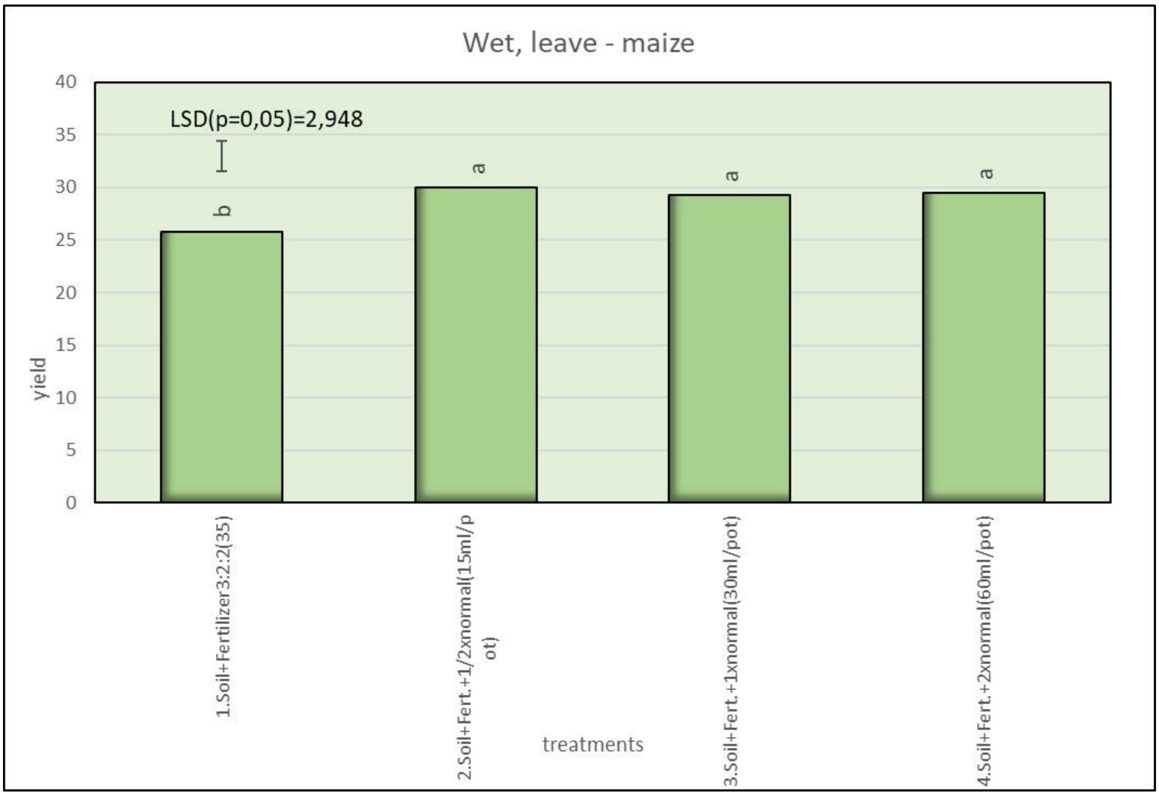
Where DF = Degrees of freedom, MS = Means Square and Fprob= Significant level of F-Ratio
A significant level less than 0.05 is considered as a significant effect and indicated in bold

Table 4.2 - T groupings and means for yield over the 8 treatments

Tmt no	yield	t grouping
1.Soil+Fertilizer3:2:2(35)	25.82	b
2.Soil+Fert.+1/2xnormal(15ml/pot)	30.02	a
3.Soil+Fert.+1xnormal(30ml/pot)	29.32	a
4.Soil+Fert.+2xnormal(60ml/pot)	29.48	a
LSD(p=0.05)=2.948		

Means with the same letters do not differ significantly at the 5% significant level

Graph 4



References

1) Microsoft Excell 2016
2) Levene, H. (1960) "Robust test in the equality of variance" in *Contributions to Probability and Statistics*, ed. I. Olkin, Palo Alto, CA: Stanford University Press pp 278-292.
3) SAS Institute, Inc. (2014), SAS/STAT User's Guide, Version 9.4, Volume 2. SAS Institute Inc, SAS Campus Drive, Cary, North Carolina 27513.
4) Shapiro, S. S. and Wilk, M. B. (1965); An Analysis of Variance Test for Normality (complete samples)., Biometrika, 52, 591-611.
5) Snedecor G.W. and Cochran W.G. (1967) Statistical Methods, Sixth Edition, The Iowa State University Press, AMES, IOWA USA.

DATA

waterwise trial.sas - prof Andries Claassens : Green house trial; private client 1
09:33 Thursday, July 26, 2018

Obs	Crop	WDmass	Tmtno	Rep	yield
1	Beans	Dry	1.Soil+Fertilizer3:2:2(35)	a	13.9
2	Beans	Dry	1.Soil+Fertilizer3:2:2(35)	b	14.8
3	Beans	Dry	1.Soil+Fertilizer3:2:2(35)	c	14.9
4	Beans	Dry	1.Soil+Fertilizer3:2:2(35)	d	14.9
5	Beans	Dry	1.Soil+Fertilizer3:2:2(35)	e	14.7
6	Beans	Dry	2.Soil+Fert.+1/2xnormal(15ml/pot)	a	14.6
7	Beans	Dry	2.Soil+Fert.+1/2xnormal(15ml/pot)	b	15.0
8	Beans	Dry	2.Soil+Fert.+1/2xnormal(15ml/pot)	c	15.2
9	Beans	Dry	2.Soil+Fert.+1/2xnormal(15ml/pot)	d	15.9
10	Beans	Dry	2.Soil+Fert.+1/2xnormal(15ml/pot)	e	14.7
11	Beans	Dry	3.Soil+Fert.+1xnormal(30ml/pot)	a	14.5
12	Beans	Dry	3.Soil+Fert.+1xnormal(30ml/pot)	b	14.6
13	Beans	Dry	3.Soil+Fert.+1xnormal(30ml/pot)	c	15.2
14	Beans	Dry	3.Soil+Fert.+1xnormal(30ml/pot)	d	14.9
15	Beans	Dry	3.Soil+Fert.+1xnormal(30ml/pot)	e	14.7
16	Beans	Dry	4.Soil+Fert.+2xnormal(60ml/pot)	a	14.6
17	Beans	Dry	4.Soil+Fert.+2xnormal(60ml/pot)	b	15.0
18	Beans	Dry	4.Soil+Fert.+2xnormal(60ml/pot)	c	15.5
19	Beans	Dry	4.Soil+Fert.+2xnormal(60ml/pot)	d	15.3
20	Beans	Dry	4.Soil+Fert.+2xnormal(60ml/pot)	e	15.0
21	Beans	Wet	1.Soil+Fertilizer3:2:2(35)	a	20.1
22	Beans	Wet	1.Soil+Fertilizer3:2:2(35)	b	20.1
23	Beans	Wet	1.Soil+Fertilizer3:2:2(35)	c	23.9
24	Beans	Wet	1.Soil+Fertilizer3:2:2(35)	d	20.9
25	Beans	Wet	1.Soil+Fertilizer3:2:2(35)	e	20.7
26	Beans	Wet	2.Soil+Fert.+1/2xnormal(15ml/pot)	a	19.6
27	Beans	Wet	2.Soil+Fert.+1/2xnormal(15ml/pot)	b	20.2
28	Beans	Wet	2.Soil+Fert.+1/2xnormal(15ml/pot)	c	21.8
29	Beans	Wet	2.Soil+Fert.+1/2xnormal(15ml/pot)	d	25.0
30	Beans	Wet	2.Soil+Fert.+1/2xnormal(15ml/pot)	e	21.0
31	Beans	Wet	3.Soil+Fert.+1xnormal(30ml/pot)	a	20.0
32	Beans	Wet	3.Soil+Fert.+1xnormal(30ml/pot)	b	19.2
33	Beans	Wet	3.Soil+Fert.+1xnormal(30ml/pot)	c	23.4
34	Beans	Wet	3.Soil+Fert.+1xnormal(30ml/pot)	d	21.8
35	Beans	Wet	3.Soil+Fert.+1xnormal(30ml/pot)	e	21.3
36	Beans	Wet	4.Soil+Fert.+2xnormal(60ml/pot)	a	19.8
37	Beans	Wet	4.Soil+Fert.+2xnormal(60ml/pot)	b	21.3
38	Beans	Wet	4.Soil+Fert.+2xnormal(60ml/pot)	c	26.8
39	Beans	Wet	4.Soil+Fert.+2xnormal(60ml/pot)	d	23.8
40	Beans	Wet	4.Soil+Fert.+2xnormal(60ml/pot)	e	20.5
41	Maize	Dry	1.Soil+Fertilizer3:2:2(35)	a	14.9
42	Maize	Dry	1.Soil+Fertilizer3:2:2(35)	b	15.1
43	Maize	Dry	1.Soil+Fertilizer3:2:2(35)	c	15.1
44	Maize	Dry	1.Soil+Fertilizer3:2:2(35)	d	15.0
45	Maize	Dry	1.Soil+Fertilizer3:2:2(35)	e	14.7
46	Maize	Dry	2.Soil+Fert.+1/2xnormal(15ml/pot)	a	15.0
47	Maize	Dry	2.Soil+Fert.+1/2xnormal(15ml/pot)	b	15.2
48	Maize	Dry	2.Soil+Fert.+1/2xnormal(15ml/pot)	c	15.5
49	Maize	Dry	2.Soil+Fert.+1/2xnormal(15ml/pot)	d	14.9
50	Maize	Dry	2.Soil+Fert.+1/2xnormal(15ml/pot)	e	15.1
51	Maize	Dry	3.Soil+Fert.+1xnormal(30ml/pot)	a	14.7
52	Maize	Dry	3.Soil+Fert.+1xnormal(30ml/pot)	b	14.7

53	Maize	Dry	3.Soil+Fert.+1xnormal(30ml/pot)	c	15.2
54	Maize	Dry	3.Soil+Fert.+1xnormal(30ml/pot)	d	14.8
55	Maize	Dry	3.Soil+Fert.+1xnormal(30ml/pot)	e	14.7
56	Maize	Dry	4.Soil+Fert.+2xnormal(60ml/pot)	a	14.7
57	Maize	Dry	4.Soil+Fert.+2xnormal(60ml/pot)	b	14.9
58	Maize	Dry	4.Soil+Fert.+2xnormal(60ml/pot)	c	14.8
59	Maize	Dry	4.Soil+Fert.+2xnormal(60ml/pot)	d	15.5
60	Maize	Dry	4.Soil+Fert.+2xnormal(60ml/pot)	e	14.9
61	Maize	Wet	1.Soil+Fertilizer3:2:2(35)	a	26.1
62	Maize	Wet	1.Soil+Fertilizer3:2:2(35)	b	24.7
63	Maize	Wet	1.Soil+Fertilizer3:2:2(35)	c	28.6
64	Maize	Wet	1.Soil+Fertilizer3:2:2(35)	d	28.3
65	Maize	Wet	1.Soil+Fertilizer3:2:2(35)	e	21.4
66	Maize	Wet	2.Soil+Fert.+1/2xnormal(15ml/pot)	a	28.0
67	Maize	Wet	2.Soil+Fert.+1/2xnormal(15ml/pot)	b	30.8
68	Maize	Wet	2.Soil+Fert.+1/2xnormal(15ml/pot)	c	32.1
69	Maize	Wet	2.Soil+Fert.+1/2xnormal(15ml/pot)	d	29.3
70	Maize	Wet	2.Soil+Fert.+1/2xnormal(15ml/pot)	e	29.9
71	Maize	Wet	3.Soil+Fert.+1xnormal(30ml/pot)	a	27.4
72	Maize	Wet	3.Soil+Fert.+1xnormal(30ml/pot)	b	28.2
73	Maize	Wet	3.Soil+Fert.+1xnormal(30ml/pot)	c	29.1
74	Maize	Wet	3.Soil+Fert.+1xnormal(30ml/pot)	d	30.8
75	Maize	Wet	3.Soil+Fert.+1xnormal(30ml/pot)	e	31.1
76	Maize	Wet	4.Soil+Fert.+2xnormal(60ml/pot)	a	26.0
77	Maize	Wet	4.Soil+Fert.+2xnormal(60ml/pot)	b	29.8
78	Maize	Wet	4.Soil+Fert.+2xnormal(60ml/pot)	c	29.2
79	Maize	Wet	4.Soil+Fert.+2xnormal(60ml/pot)	d	32.7
80	Maize	Wet	4.Soil+Fert.+2xnormal(60ml/pot)	e	29.7

waterwise trial.sas - prof Andries Claassens : Green house trial; private client 2
ANOVA over trials for wet and dry as well as two Crop systems
09:33 Thursday, July 26, 2018

------------------------------------ Crop=Beans WDmass=Dry ------------------------------------

The GLM Procedure

Class Level Information

Class	Levels	Values
Tmtno	4	1.Soil+Fertilizer3:2:2(35) 2.Soil+Fert.+1/2xnormal(15ml/pot) 3.Soil+Fert.+1xnormal(30ml/pot) 4.Soil+Fert.+2xnormal(60ml/pot)
Rep	5	a b c d e

Number of Observations Read	20
Number of Observations Used	20

waterwise trial.sas - prof Andries Claassens : Green house trial; private client 3
ANOVA over trials for wet and dry as well as two Crop systems
09:33 Thursday, July 26, 2018

------------------------------------ Crop=Beans WDmass=Dry ------------------------------------

The GLM Procedure

Dependent Variable: yield

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	0.73350000	0.24450000	1.53	0.2450
Error	16	2.55600000	0.15975000		
Corrected Total	19	3.28950000			

R-Square	Coeff Var	Root MSE	yield Mean
0.222982	2.683366	0.399687	14.89500

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Tmtno	3	0.73350000	0.24450000	1.53	0.2450

waterwise trial.sas - prof Andries Claassens : Green house trial; private client 4
ANOVA over trials for wet and dry as well as two Crop systems
09:33 Thursday, July 26, 2018

----------------------------------- Crop=Beans WDmass=Dry -----------------------------------

The GLM Procedure

Level of Tmtno	N	yield Mean	yield Std Dev
1.Soil+Fertilizer3:2:2(35)	5	14.6400000	0.42190046
2.Soil+Fert.+1/2xnormal(15ml/pot)	5	15.0800000	0.51672043
3.Soil+Fert.+1xnormal(30ml/pot)	5	14.7800000	0.27748874
4.Soil+Fert.+2xnormal(60ml/pot)	5	15.0800000	0.34205263

waterwise trial.sas - prof Andries Claassens : Green house trial; private client 5
ANOVA over trials for wet and dry as well as two Crop systems
09:33 Thursday, July 26, 2018

----------------------------------- Crop=Beans WDmass=Dry -----------------------------------

The GLM Procedure

t Tests (LSD) for yield

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	16
Error Mean Square	0.15975
Critical Value of t	2.11991
Least Significant Difference	0.5359

Means with the same letter are not significantly different.

t Grouping	Mean	N	Tmtno
A	15.0800	5	4.Soil+Fert.+2xnormal(60ml/pot)
A			
A	15.0800	5	2.Soil+Fert.+1/2xnormal(15ml/pot)
A			
A	14.7800	5	3.Soil+Fert.+1xnormal(30ml/pot)
A			
A	14.6400	5	1.Soil+Fertilizer3:2:2(35)

waterwise trial.sas - prof Andries Claassens : Green house trial; private client 6
ANOVA over trials for wet and dry as well as two Crop systems
09:33 Thursday, July 26, 2018

----------------------------------- Crop=Beans WDmass=Wet -----------------------------------

The GLM Procedure

Class Level Information

Class	Levels	Values
Tmtno	4	1.Soil+Fertilizer3:2:2(35) 2.Soil+Fert.+1/2xnormal(15ml/pot) 3.Soil+Fert.+1xnormal(30ml/pot) 4.Soil+Fert.+2xnormal(60ml/pot)
Rep	5	a b c d e

Number of Observations Read	20
Number of Observations Used	20

waterwise trial.sas - prof Andries Claassens : Green house trial; private client 7
ANOVA over trials for wet and dry as well as two Crop systems
09:33 Thursday, July 26, 2018

----------------------------------- Crop=Beans WDmass=Wet -----------------------------------

The GLM Procedure

Dependent Variable: yield

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	5.64400000	1.88133333	0.42	0.7402
Error	16	71.44400000	4.46525000		
Corrected Total	19	77.08800000			

R-Square	Coeff Var	Root MSE	yield Mean
0.073215	9.801084	2.113114	21.56000

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Tmtno	3	5.64400000	1.88133333	0.42	0.7402

waterwise trial.sas - prof Andries Claassens : Green house trial; private client 8
ANOVA over trials for wet and dry as well as two Crop systems
09:33 Thursday, July 26, 2018

------------------------------------ Crop=Beans WDmass=Wet ------------------------------------

The GLM Procedure

Level of Tmtno	N	yield Mean	yield Std Dev
1.Soil+Fertilizer3:2:2(35)	5	21.1400000	1.58366663
2.Soil+Fert.+1/2xnormal(15ml/pot)	5	21.5200000	2.11471038
3.Soil+Fert.+1xnormal(30ml/pot)	5	21.1400000	1.63033739
4.Soil+Fert.+2xnormal(60ml/pot)	5	22.4400000	2.86757737

waterwise trial.sas - prof Andries Claassens : Green house trial; private client 9
ANOVA over trials for wet and dry as well as two Crop systems
09:33 Thursday, July 26, 2018

------------------------------------ Crop=Beans WDmass=Wet ------------------------------------

The GLM Procedure

t Tests (LSD) for yield

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	16
Error Mean Square	4.46525
Critical Value of t	2.11991
Least Significant Difference	2.8331

Means with the same letter are not significantly different.

t Grouping	Mean	N	Tmtno
A	22.440	5	4.Soil+Fert.+2xnormal(60ml/pot)
A			
A	21.520	5	2.Soil+Fert.+1/2xnormal(15ml/pot)
A			
A	21.140	5	1.Soil+Fertilizer3:2:2(35)
A			
A	21.140	5	3.Soil+Fert.+1xnormal(30ml/pot)

waterwise trial.sas - prof Andries Claassens : Green house trial; private client 10
ANOVA over trials for wet and dry as well as two Crop systems
09:33 Thursday, July 26, 2018

------------------------------------ Crop=Maize WDmass=Dry ------------------------------------

The GLM Procedure

Class Level Information

Class	Levels	Values
Tmtno	4	1.Soil+Fertilizer3:2:2(35) 2.Soil+Fert.+1/2xnormal(15ml/pot) 3.Soil+Fert.+1xnormal(30ml/pot) 4.Soil+Fert.+2xnormal(60ml/pot)
Rep	5	a b c d e

Number of Observations Read	20
Number of Observations Used	20

------------------------------------ Crop=Maize WDmass=Dry ------------------------------------

The GLM Procedure

Dependent Variable: yield

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	0.25800000	0.08600000	1.52	0.2471
Error	16	0.90400000	0.05650000		
Corrected Total	19	1.16200000			

R-Square	Coeff Var	Root MSE	yield Mean
0.222031	1.587824	0.237697	14.97000

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Tmtno	3	0.25800000	0.08600000	1.52	0.2471

------------------------------------ Crop=Maize WDmass=Dry ------------------------------------

The GLM Procedure

Level of Tmtno	N	------------yield------------ Mean	Std Dev
1.Soil+Fertilizer3:2:2(35)	5	14.9600000	0.16733201
2.Soil+Fert.+1/2xnormal(15ml/pot)	5	15.1400000	0.23021729
3.Soil+Fert.+1xnormal(30ml/pot)	5	14.8200000	0.21679483
4.Soil+Fert.+2xnormal(60ml/pot)	5	14.9600000	0.31304952

------------------------------------ Crop=Maize WDmass=Dry ------------------------------------

The GLM Procedure

t Tests (LSD) for yield

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	16
Error Mean Square	0.0565
Critical Value of t	2.11991
Least Significant Difference	0.3187

```
                 Means with the same letter are not significantly different.


           t Grouping          Mean      N    Tmtno

                    A       15.1400      5    2.Soil+Fert.+1/2xnormal(15ml/pot)
                    A
               B    A       14.9600      5    4.Soil+Fert.+2xnormal(60ml/pot)
               B    A
               B    A       14.9600      5    1.Soil+Fertilizer3:2:2(35)
               B
               B            14.8200      5    3.Soil+Fert.+1xnormal(30ml/pot)
```



```
------------------------------------ Crop=Maize WDmass=Wet ------------------------------------

                                          The GLM Procedure


                                       Class Level Information

Class       Levels  Values

Tmtno            4  1.Soil+Fertilizer3:2:2(35) 2.Soil+Fert.+1/2xnormal(15ml/pot)
                    3.Soil+Fert.+1xnormal(30ml/pot) 4.Soil+Fert.+2xnormal(60ml/pot)

Rep              5  a b c d e


                           Number of Observations Read          20
                           Number of Observations Used          20
```



```
------------------------------------ Crop=Maize WDmass=Wet ------------------------------------

                                          The GLM Procedure

                                    Dependent Variable: yield

                                                Sum of
      Source                      DF          Squares     Mean Square    F Value    Pr > F

      Model                        3       55.1160000      18.3720000       3.80    0.0312

      Error                       16       77.3520000       4.8345000

      Corrected Total             19      132.4680000


                    R-Square     Coeff Var      Root MSE    yield Mean

                    0.416070      7.671841      2.198750      28.66000


      Source                      DF        Type I SS     Mean Square    F Value    Pr > F

      Tmtno                        3      55.11600000     18.37200000       3.80    0.0312
```



```
------------------------------------ Crop=Maize WDmass=Wet ------------------------------------

                                          The GLM Procedure

           Level of                                      ------------yield------------
           Tmtno                                 N             Mean          Std Dev

           1.Soil+Fertilizer3:2:2(35)            5       25.8200000       2.94737171
           2.Soil+Fert.+1/2xnormal(15ml/pot)     5       30.0200000       1.54499191
```

3.Soil+Fert.+1xnormal(30ml/pot)	5	29.3200000	1.60841537
4.Soil+Fert.+2xnormal(60ml/pot)	5	29.4800000	2.38264559

waterwise trial.sas - prof Andries Claassens : Green house trial; private client 17
ANOVA over trials for wet and dry as well as two Crop systems
09:33 Thursday, July 26, 2018

------------------------------------ Crop=Maize WDmass=Wet ------------------------------------

The GLM Procedure

t Tests (LSD) for yield

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	16
Error Mean Square	4.8345
Critical Value of t	2.11991
Least Significant Difference	2.948

Means with the same letter are not significantly different.

t Grouping	Mean	N	Tmtno
A	30.020	5	2.Soil+Fert.+1/2xnormal(15ml/pot)
A			
A	29.480	5	4.Soil+Fert.+2xnormal(60ml/pot)
A			
A	29.320	5	3.Soil+Fert.+1xnormal(30ml/pot)
B	25.820	5	1.Soil+Fertilizer3:2:2(35)

waterwise trial.sas - prof Andries Claassens : Green house trial; private client 1
Normality test for Crops, Irrigate and Locality seperate
09:33 Thursday, July 26, 2018

--------------------------------- Crop=Beans WDmass=Dry ---------------------------------

The UNIVARIATE Procedure
Variable: ryield

Moments

N	20	Sum Weights	20
Mean	0.00372106	Sum Observations	0.07442125
Std Deviation	1.11126914	Variance	1.2349191
Skewness	0.17878474	Kurtosis	1.0913167
Uncorrected SS	23.4637398	Corrected SS	23.4634629
Coeff Variation	29864.2961	Std Error Mean	0.24848733

Basic Statistical Measures

Location		Variability	
Mean	0.00372	Std Deviation	1.11127
Median	-0.02718	Variance	1.23492
Mode	-0.21702	Range	5.05321
		Interquartile Range	1.29197

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	0.014975	Pr > |t|	0.9882
Sign	M	0	Pr >= |M|	1.0000
Signed Rank	S	1	Pr >= |S|	0.9782

Tests for Normality

Test --Statistic--- -----p Value------

```
            Shapiro-Wilk          W     0.973099    Pr < W      0.8185
            Kolmogorov-Smirnov    D     0.121274    Pr > D     >0.1500
            Cramer-von Mises      W-Sq  0.040504    Pr > W-Sq  >0.2500
            Anderson-Darling      A-Sq  0.273523    Pr > A-Sq  >0.2500

    waterwise trial.sas - prof Andries Claassens :  Green house trial; private client    2
                 Normality test for Crops, Irrigate and Locality seperate
                                                   09:33 Thursday, July 26, 2018

-------------------------------- Crop=Beans WDmass=Dry ----------------------------------

                                The UNIVARIATE Procedure
                                   Variable:  ryield

                                Quantiles (Definition 5)

                                Level           Quantile

                                100% Max       2.7109351
                                99%            2.7109351
                                95%            1.9504854
                                90%            1.1900357
                                75% Q3         0.6595854
                                50% Median    -0.0271828
                                25% Q1        -0.6323822
                                10%           -1.3801311
                                5%            -1.8612019
                                1%            -2.3422726
                                0% Min        -2.3422726


                                  Extreme Observations

                      ------Lowest------        ------Highest-----

                          Value      Obs            Value      Obs

                      -2.342273        1         0.716133        3
                      -1.380131       16         0.716133        4
                      -1.380131        6         1.190036       13
                      -1.067595       10         1.190036       18
                      -0.773335       11         2.710935        9


                    Stem Leaf                     #             Boxplot
                       2 7                        1                0
                       1 22                       2                |
                       0 2334677                  7             +--+--+
                      -0 852222                   6             *-----*
                      -1 441                      3                |
                      -2 3                        1                |
                         ----+----+----+----+


    waterwise trial.sas - prof Andries Claassens :  Green house trial; private client    3
                 Normality test for Crops, Irrigate and Locality seperate
                                                   09:33 Thursday, July 26, 2018

-------------------------------- Crop=Beans WDmass=Dry ----------------------------------

                                The UNIVARIATE Procedure
                                   Variable:  ryield

                                     Normal Probability Plot
                     2.5+                                           +*++++++
                        |                                   +++*+++++
                        |                          +*****+++*
                        |                 ++**+****
                        |        ++++++++*+*
                    -2.5+++++++*
                        +----+----+----+----+----+----+----+----+----+----+
                            -2        -1         0        +1        +2


    waterwise trial.sas - prof Andries Claassens :  Green house trial; private client    4
                 Normality test for Crops, Irrigate and Locality seperate
                                                   09:33 Thursday, July 26, 2018
```

```
--------------------------------- Crop=Beans WDmass=Wet ----------------------------------

                          The UNIVARIATE Procedure
                             Variable:  ryield

                                  Moments

             N                          20    Sum Weights                 20
             Mean               0.03353616    Sum Observations    0.67072325
             Std Deviation      1.10086128    Variance            1.21189555
             Skewness           1.07799605    Kurtosis            0.62813226
             Uncorrected SS      23.048509    Corrected SS        23.0260155
             Coeff Variation    3282.60956    Std Error Mean      0.24616007


                         Basic Statistical Measures

                  Location                    Variability

              Mean      0.03354     Std Deviation            1.10086
              Median   -0.24641     Variance                 1.21190
              Mode     -1.02828     Range                    4.17738
                                    Interquartile Range      1.16261

          Note: The mode displayed is the smallest of 3 modes with a count of 2.


                         Tests for Location: Mu0=0

                 Test           -Statistic-    -----p Value------

                 Student's t    t  0.136237    Pr > |t|    0.8931
                 Sign           M        -2    Pr >= |M|   0.5034
                 Signed Rank    S       -10    Pr >= |S|   0.7216


                            Tests for Normality

            Test                  --Statistic---    -----p Value------

            Shapiro-Wilk          W     0.905621    Pr < W      0.0526
            Kolmogorov-Smirnov    D     0.160202    Pr > D     >0.1500
            Cramer-von Mises      W-Sq  0.129418    Pr > W-Sq   0.0424
            Anderson-Darling      A-Sq  0.737734    Pr > A-Sq   0.0464
```



```
--------------------------------- Crop=Beans WDmass=Wet ----------------------------------

                          The UNIVARIATE Procedure
                             Variable:  ryield

                          Quantiles (Definition 5)

                          Level          Quantile

                          100% Max       2.734072
                          99%            2.734072
                          95%            2.371126
                          90%            1.763466
                          75% Q3         0.523840
                          50% Median    -0.246408
                          25% Q1        -0.638772
                          10%           -1.028279
                          5%            -1.235795
                          1%            -1.443311
                          0% Min        -1.443311


                            Extreme Observations

                ------Lowest------        ------Highest-----

                    Value      Obs            Value      Obs

                -1.443311       36         0.708272       39
```

```
              -1.028279       40         1.213260       33
              -1.028279       32         1.518753       23
              -1.016943       26         2.008180       29
              -0.686775       27         2.734072       38


    waterwise trial.sas - prof Andries Claassens :  Green house trial; private client    6
                 Normality test for Crops, Irrigate and Locality seperate
                                                           09:33 Thursday, July 26, 2018

--------------------------------- Crop=Beans WDmass=Wet ----------------------------------

                             The UNIVARIATE Procedure
                                Variable:  ryield

                  Stem Leaf                     #             Boxplot
                     2 7                        1                0
                     2 0                        1                |
                     1 5                        1                |
                     1 2                        1                |
                     0 7                        1             +-----+
                     0 113                      3             |  +  |
                    -0 321                      3             *-----*
                    -0 76655                    5             +-----+
                    -1 4000                     4                |
                       ----+----+----+----+


                                Normal Probability Plot
                2.75+                                                 *   +++
                    |                                            *   +++++
                    |                                         *  ++++
                    |                                       *++++
                0.75+                                   ++*+
                    |                              +++** *
                    |                          ++++* **
                    |                     ++***+***
               -1.25+      *    ++*+*+
                    +----+----+----+----+----+----+----+----+----+----+
                        -2        -1         0        +1        +2


    waterwise trial.sas - prof Andries Claassens :  Green house trial; private client    7
                 Normality test for Crops, Irrigate and Locality seperate
                                                           09:33 Thursday, July 26, 2018

--------------------------------- Crop=Maize WDmass=Dry ----------------------------------

                             The UNIVARIATE Procedure
                                Variable:  ryield

                                     Moments

          N                          20    Sum Weights                 20
          Mean               0.04551886    Sum Observations    0.91037711
          Std Deviation      1.13774358    Variance            1.29446045
          Skewness           1.43172297    Kurtosis            1.98616623
          Uncorrected SS     24.6361879    Corrected SS        24.5947485
          Coeff Variation    2499.49952    Std Error Mean       0.2544072


                            Basic Statistical Measures

                 Location                    Variability

               Mean      0.04552    Std Deviation            1.13774
               Median   -0.27394    Variance                 1.29446
               Mode     -0.55203    Range                    4.42711
                                    Interquartile Range      1.05940

       Note: The mode displayed is the smallest of 2 modes with a count of 3.


                            Tests for Location: Mu0=0

                  Test           -Statistic-    -----p Value------
```

```
                Student's t    t  0.178921    Pr > |t|    0.8599
                Sign           M        -3    Pr >= |M|   0.2632
                Signed Rank    S       -16    Pr >= |S|   0.5636


                              Tests for Normality

           Test                  --Statistic---    -----p Value------

           Shapiro-Wilk          W     0.860704    Pr < W      0.0081
           Kolmogorov-Smirnov    D     0.197793    Pr > D      0.0395
           Cramer-von Mises      W-Sq  0.176295    Pr > W-Sq   0.0094
           Anderson-Darling      A-Sq  1.014376    Pr > A-Sq   0.0091
```



```
--------------------------------- Crop=Maize WDmass=Dry ----------------------------------

                            The UNIVARIATE Procedure
                               Variable:  ryield

                            Quantiles (Definition 5)

                            Level          Quantile

                            100% Max       3.183455
                            99%            3.183455
                            95%            2.558969
                            90%            1.872080
                            75% Q3         0.460176
                            50% Median    -0.273937
                            25% Q1        -0.599223
                            10%           -1.191493
                            5%            -1.243654
                            1%            -1.243654
                            0% Min        -1.243654


                              Extreme Observations

                  ------Lowest------        ------Highest-----

                      Value      Obs            Value      Obs

                  -1.243654       56         0.646414       42
                  -1.243654       45         0.646414       43
                  -1.139332       49         1.809677       48
                  -0.741929       58         1.934483       53
                  -0.646414       46         3.183455       59
```



```
--------------------------------- Crop=Maize WDmass=Dry ----------------------------------

                            The UNIVARIATE Procedure
                               Variable:  ryield

                Stem Leaf                  #             Boxplot
                   3 2                     1                0
                   2
                   2
                   1 89                    2                |
                   1                                        |
                   0 66                    2             +-----+
                   0 23                    2             |  +  |
                  -0 33321                 5             *-----*
                  -0 76666                 5             +-----+
                  -1 221                   3                |
                     ----+----+----+----+


                              Normal Probability Plot
              3.25+                                         *
```

```
       |                                                  ++++
       |                                              ++++
   1.75+                                    * +*+++
       |                                  ++++
       |                             +++++*
   0.25+                        ++++* *
       |                    ++** ***
       |               *+**+**
  -1.25+      *    *+++*
        +----+----+----+----+----+----+----+----+----+----+
            -2        -1         0        +1        +2
```

```
    waterwise trial.sas - prof Andries Claassens :  Green house trial; private client   10
                 Normality test for Crops, Irrigate and Locality seperate
                                                         09:33 Thursday, July 26, 2018

-------------------------------- Crop=Maize WDmass=Wet ---------------------------------

                              The UNIVARIATE Procedure
                                 Variable:  ryield

                                      Moments

            N                          20    Sum Weights                 20
            Mean               -0.0169902    Sum Observations    -0.3398048
            Std Deviation      1.09694481    Variance            1.20328792
            Skewness           -0.5988397    Kurtosis            0.51102493
            Uncorrected SS     22.8682439    Corrected SS        22.8624705
            Coeff Variation    -6456.3233    Std Error Mean      0.24528432


                             Basic Statistical Measures

                 Location                    Variability

             Mean     -0.01699     Std Deviation            1.09694
             Median    0.02463     Variance                 1.20329
             Mode     -0.55710     Range                    4.36824
                                   Interquartile Range      1.37790


                             Tests for Location: Mu0=0

                Test           -Statistic-    -----p Value------

                Student's t    t  -0.06927    Pr > |t|    0.9455
                Sign           M         0    Pr >= |M|   1.0000
                Signed Rank    S         5    Pr >= |S|   0.8623


                                Tests for Normality

           Test                  --Statistic---    -----p Value------

           Shapiro-Wilk          W     0.965305    Pr < W      0.6543
           Kolmogorov-Smirnov    D     0.111228    Pr > D     >0.1500
           Cramer-von Mises      W-Sq  0.036997    Pr > W-Sq  >0.2500
           Anderson-Darling      A-Sq  0.256384    Pr > A-Sq  >0.2500

    waterwise trial.sas - prof Andries Claassens :  Green house trial; private client   11
                 Normality test for Crops, Irrigate and Locality seperate
                                                         09:33 Thursday, July 26, 2018

-------------------------------- Crop=Maize WDmass=Wet ---------------------------------

                              The UNIVARIATE Procedure
                                 Variable:  ryield

                              Quantiles (Definition 5)

                              Level           Quantile

                              100% Max       1.7375697
                              99%            1.7375697
                              95%            1.6003422
                              90%            1.3748641
                              75% Q3         0.8208059
```

```
                  50% Median     0.0246347
                  25% Q1        -0.5570958
                  10%           -1.4697409
                  5%            -2.2705586
                  1%            -2.6306666
                  0% Min        -2.6306666


                   Extreme Observations

              ------Lowest------        -----Highest-----

                  Value      Obs           Value      Obs

              -2.630667       65         0.89970       75
              -1.910451       76         1.06186       68
              -1.029031       66         1.28661       64
              -0.974773       71         1.46311       63
              -0.557096       72         1.73757       79


    waterwise trial.sas - prof Andries Claassens :  Green house trial; private client   12
                 Normality test for Crops, Irrigate and Locality seperate
                                                             09:33 Thursday, July 26, 2018

--------------------------------- Crop=Maize WDmass=Wet ---------------------------------

                          The UNIVARIATE Procedure
                             Variable:  ryield

                   Stem Leaf                     #             Boxplot
                      1 57                       2                |
                      1 13                       2                |
                      0 79                       2             +-----+
                      0 1124                     4             *-----*
                     -0 4111                     4             |  +  |
                     -0 66                       2             +-----+
                     -1 00                       2                |
                     -1 9                        1                |
                     -2
                     -2 6                        1                0
                        ----+----+----+----+


                               Normal Probability Plot
                  1.75+                                    +++++*
                      |                               *+*+++
                      |                           +****+
                  0.25+                       ****
                      |                  ****+
                      |             *+***+
                 -1.25+         +++++
                      |     +++++*
                      |  ++++
                 -2.75++++   *
                       +----+----+----+----+----+----+----+----+----+----+
                           -2        -1         0        +1        +2


    waterwise trial.sas - prof Andries Claassens :  Green house trial; private client   13
                 Normality test for Crops, Irrigate and Locality seperate
                                                             09:33 Thursday, July 26, 2018

                          The UNIVARIATE Procedure
                             Variable:  ryield

                              Schematic Plots

                |
              4 +
                |
                |
                |                                  0
              3 +
                |            0           0
                |
                |
```

```
     2 +                        |           |
       |                        |           |           |
       |                        |           |           |
       |            |           |           |           |
     1 +            |           |           |           |
       |         +-----+        |           |        +-----+
       |         |     |     +-----+     +-----+     |     |
       |         |     |     |     |     |     |     |     |
     0 +         *--+--*     |  +  |     |  +  |     *--+--*
       |         |     |     *-----*     *-----*     |     |
       |         |     |     |     |     +-----+     +-----+
       |         +-----+     +-----+        |           |
    -1 +            |           |           |           |
       |            |           |           |           |
       |            |           |                       |
       |            |                                   |
    -2 +            |                                   |
       |            |
       |
       |                                                0
    -3 +
        ------------+-----------+-----------+-----------+-----------
WDmass               Dry         Wet         Dry         Wet
  Crop             Beans       Beans       Maize       Maize
```

Water Retainer in Chilies & Groundnut

In-house Field Trials - Pakistan

By

Technical & Development
Jaffer Agro Services (Pvt) Ltd

Complete Trial Data / Report

Water Retainer in Chilies
In-house Trial Review-2018

JAFFER

Trial Protocol :

Objective	"To study the impact of using ***"Water Retainer"*** on water retention, crop growth, development and yield in Chilies (under irrigated conditions)"

Trial Locations	**Kunri (Sind)**
Layout Design	RCBD
Plot Size	255 sq. meter
Replicates	Three

Treatments:

S.#	Treatment / Product	Dose / sq. meter (ml)		Remarks
		1st Appli	2nd Appli	
T1	Control / UTC	-	-	Follow farmer practice for irrigations
T2	Water Retainer – (application with sprayer)	**1.0**	-	**Chilies (Irrigated):** 1st application at "wattar" after first irrigation to crop. 2nd application 45 days after 1st application (spray in between lines, preventing crop. If spray drift falls on crop then wash with water just after application)
T3	Water Retainer – (application with sprayer)	**1.5**	-	
T4	Water Retainer – (application with sprayer)	**2.0**	-	
T5	Water Retainer – (application with sprayer)	**1.0**	**0.5**	
T6	Water Retainer – (application with sprayer)	**1.5**	**0.5**	
T7	Water Retainer – (application with sprayer)	**2.0**	**0.5**	

Water Retainer in Chilies
In-house Trial Review-2018

JAFFER

Application Methodology :	
No. of Applications? Appli Instructions?	• T2 – T4: ONE applications to be done • T5 – T7: TWO applications to be done (2nd application to be done at 45 days after 1st application • Dilute the concentrate in 20 times volume of water for preparing to spray it. • Spray the diluted water Retainer to the surface of the soil (at "wattar condition" or irrigate the field just after spraying. • Reduce the number of irrigations (25-30%) in treated plots i.e., in case of T2-T7, skip one irrigation after two consecutive irrigations. (To be followed very STRICTLY)

Note:
Use very same products (herbicide, insecticides, fertilizers etc) at same dose rates for the control (T1) and the Water Retainer treated plots (T2-T7) in order to get the clear comparison of using water retainer treatment.

Assessment required at Post treatment :

At	Assessment criteria / Target
2, 4, 6, 8, 10, 12, 14, 16 Weeks after 1st application	• Note the physical condition of plants (Normal, Good, Excellent) • Also compare wilting of the plants in high temperatures in each treatment at a scale of 1-5 (5 means complete wilting, 1 means least or No wilting). • Record the soil moisture contents (using gravimetric method) before application and then 4, 8 & 12 weeks after application. **Sampling protocol is given below separately.** • Record the field temperature, the relative humidity of the air at each observation • Measure the height of the plants, the number of leaves, number of flowers/fruiting bodies at each observation (5 plants each from three spots in each treatment in each Rep.).
Harvest	• Yield to be recorded very carefully

- Evaluate the differences of all the recoded data in comparison to UTC / Control
- Rainfall data to be recorded very accurately

Project Summary:

Project	*Water Retainer*
Supplier	Water & Soil - Budapest, Hungary
Target Crop	Chilies (irrigated conditions), Groundnut (Rainfed conditions)
Target	Water retention, saving in irrigations, crop growth & development, yield
Trial Season	Kharif 2018
Total Trial Conducted	2

Trial Details :

Trial #.	Crop	Location	Trial Design / Replicates	D. O. Appli.	No. of Appli.
Trial-1	Chilies (irrigated)	Kunri - Sind	RCBD / Three	01-05-2018	One vs Two
Trial-2	Peanut (Rainfed)	Tala Gang – Punjab	RCBD / Three	14-05-2018	One vs Two

General Notes of Trials :

Station		→	Trial-1 (Chilies)	Trial-2 (Peanut)
Location / Area		→	Kunri – Hyderabad (Sind)	Tala Gang – (Punjab)
Name of Farmer		→	Mr. Shakeel Bajwa	Mr. Fayaz Shabir
Crop / Variety		→	Chilies / Sanam(hybrid)	Peanut / local
D. O. Sowing		→	30-Apr-2018	14-May-2018
D. O. Application		→	**01-May-2018**	**14-May-2018**
Design / Replicates		→	RCBD / Three replicates	RCBD / Three Replicates
Plot Size		→	255 sq. meter	150 sq. meter
Sprayer Used		→	Matabi Knapsack	Matabi Knapsack
Weather Info:				
Temperature	(Min.)	→	28°C	26°C
	(Max.)	→	42°C	31°C
Humidity	(Min.)	→	19 %	76 %
	(Max.)	→	34 %	n/a
Wind Velocity (km/h)		→	N/A	2.5
Rainfall		→	Nil	15.05.18 (4 mm),

JAFFER

Trial-1

Location: Kunri (Sind)

Crop: Chilies

Date of Appli. : 01-May-2018

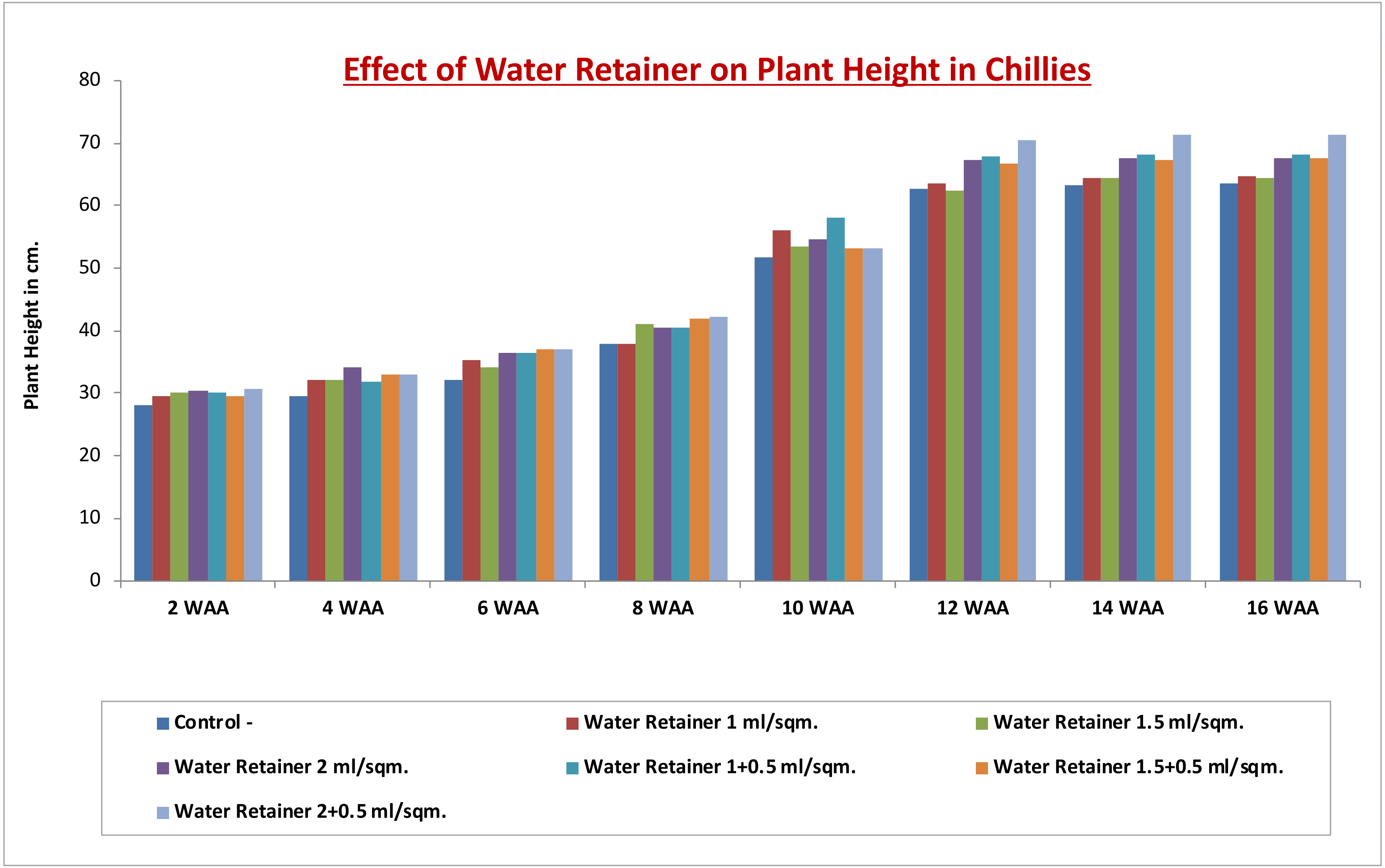
Trialist : SG – (AMT, HYD)

Water Retainer in Chilies
In-house Trial Review-2018

JAFFER

Trial-1
Crop : Chilies
D.O. Application : 1st : 01-May-2018 2nd : 13-June-2018

S.#	Treatment / Product	Dose / sq. meter (ml)		Avg. Plant Height (cm)							
		1st Appli	2nd Appli	2 WAA	4 WAA	6 WAA	8 WAA	10 WAA	12 WAA	14 WAA	16 WAA
T1	Control / UTC	-	-	28	30	32	38	52	63	63	64
T2	Water Retainer – (application with sprayer)	**1.0**	-	30	32	35	38	56	64	64	65
T3	Water Retainer – (application with sprayer)	**1.5**	-	30	32	34	41	54	63	64	64
T4	Water Retainer – (application with sprayer)	**2.0**	-	30	34	37	41	55	67	68	68
T5	Water Retainer – (application with sprayer)	**1.0**	**0.5**	30	32	36	40	58	68	68	68
T6	Water Retainer – (application with sprayer)	**1.5**	**0.5**	30	33	37	42	53	67	67	68
T7	Water Retainer – (application with sprayer)	**2.0**	**0.5**	31	33	37	42	53	71	71	72

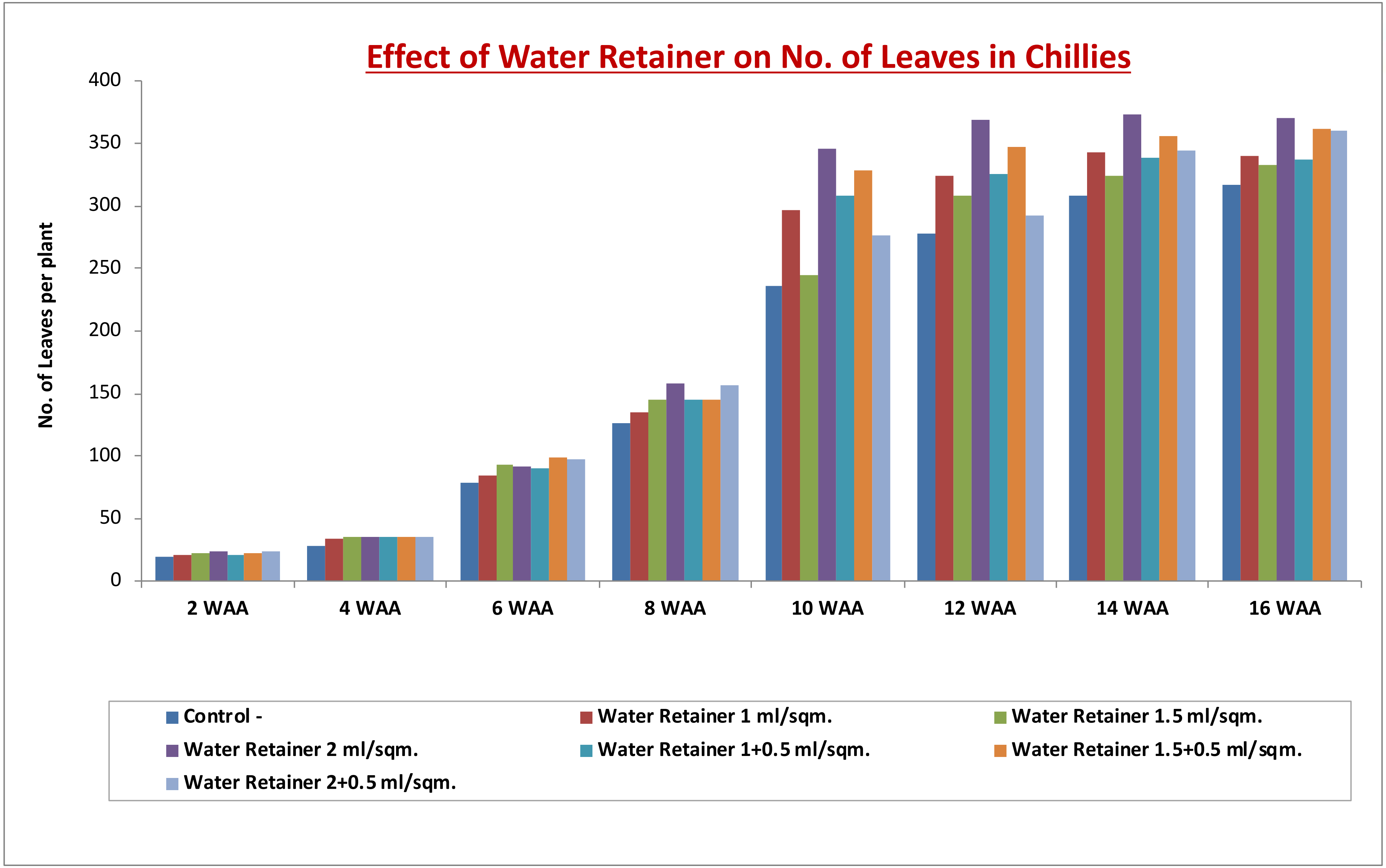

Effect of Water Retainer on Plant Height in Chillies
Plant Height in cm.
80
70
60
50
40
30
20
10
0
2 WAA
4 WAA
6 WAA
8 WAA
10 WAA
12 WAA
14 WAA
16 WAA
Control -
Water Retainer 1 ml/sqm.
Water Retainer 1.5 ml/sqm.
Water Retainer 2 ml/sqm.
Water Retainer 1+0.5 ml/sqm.
Water Retainer 1.5+0.5 ml/sqm.
Water Retainer 2+0.5 ml/sqm.

Water Retainer in Chilies
In-house Trial Review-2018

JAFFER

Trial-1
Crop : Chilies
D.O. Application : 1st : 01-May-2018 2nd : 13-June-2018

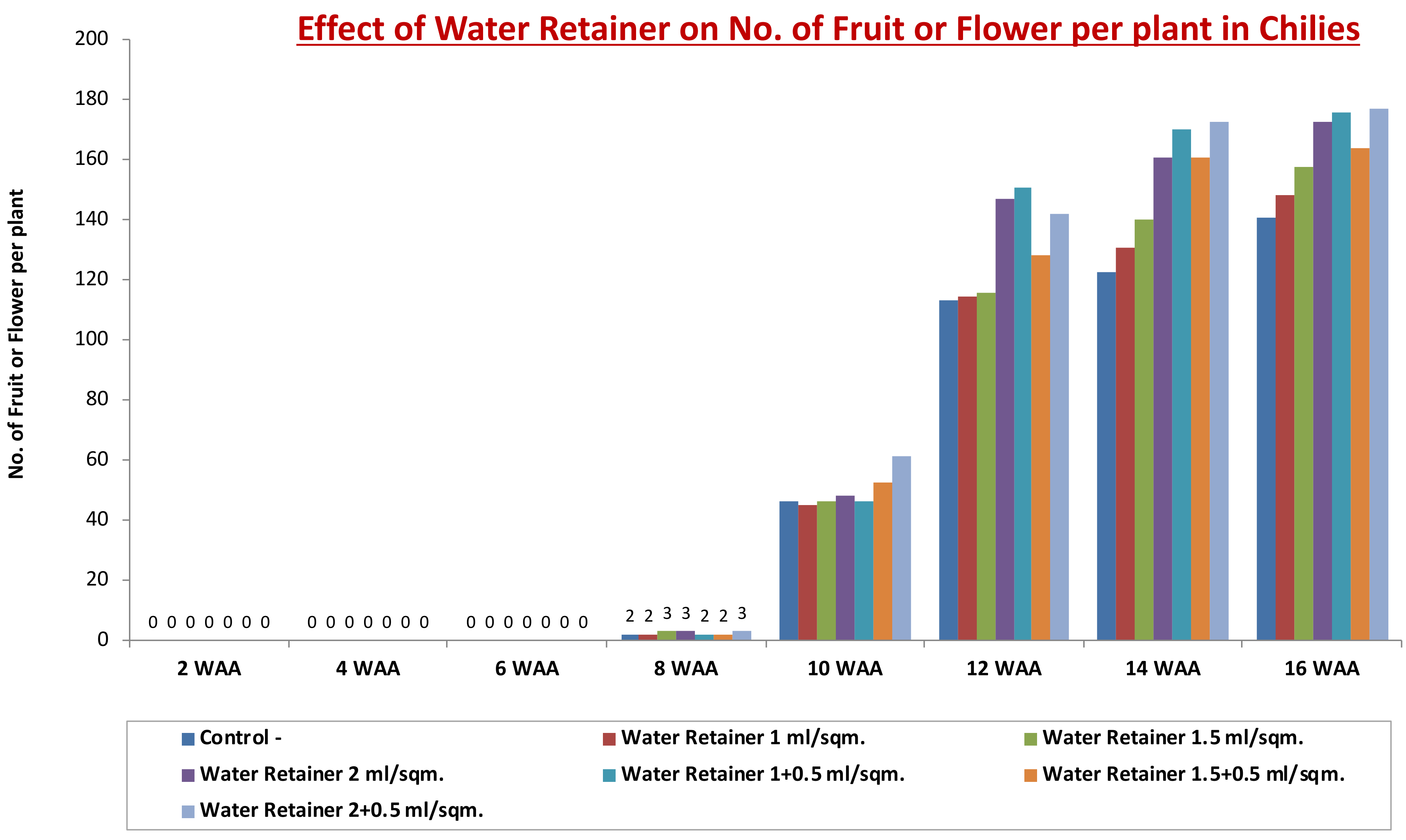
S.#	Treatment / Product	Dose / sq. meter (ml)		Avg. number of leaves / Plant							
		1st Appli	2nd Appli	2 WAA	4 WAA	6 WAA	8 WAA	10 WAA	12 WAA	14 WAA	16 WAA
T1	Control / UTC	-	-	20	28	78	126	236	278	309	317
T2	Water Retainer – (application with sprayer)	**1.0**	-	21	34	84	135	296	324	342	340
T3	Water Retainer – (application with sprayer)	**1.5**	-	23	35	93	145	245	308	324	332
T4	Water Retainer – (application with sprayer)	**2.0**	-	23	35	92	158	345	369	373	370
T5	Water Retainer – (application with sprayer)	**1.0**	**0.5**	21	35	90	145	308	326	339	337
T6	Water Retainer – (application with sprayer)	**1.5**	**0.5**	22	35	99	145	329	347	356	362
T7	Water Retainer – (application with sprayer)	**2.0**	**0.5**	23	36	98	156	276	292	345	360


Effect of Water Retainer on No. of Leaves in Chillies
No. of Leaves per plant
400
350
300
250
200
150
100
50
0
2 WAA
4 WAA
6 WAA
8 WAA
10 WAA
12 WAA
14 WAA
16 WAA
Control -
Water Retainer 1 ml/sqm.
Water Retainer 1.5 ml/sqm.
Water Retainer 2 ml/sqm.
Water Retainer 1+0.5 ml/sqm.
Water Retainer 1.5+0.5 ml/sqm.
Water Retainer 2+0.5 ml/sqm.

Water Retainer in Chilies
In-house Trial Review-2018

Trial-1
Crop : Chilies
D.O. Application : 1st : 01-May-2018 2nd : 13-June-2018

S.#	Treatment / Product	Dose / sq. meter (ml)		Avg. number of fruit or flowers / Plant							
		1st Appli	2nd Appli	2 WAA	4 WAA	6 WAA	8 WAA	10 WAA	12 WAA	14 WAA	16 WAA
T1	Control / UTC	-	-	0	0	0	2	46	113	122	141
T2	Water Retainer – (application with sprayer)	1.0	-	0	0	0	2	45	114	130	148
T3	Water Retainer – (application with sprayer)	1.5	-	0	0	0	3	46	116	140	158
T4	Water Retainer – (application with sprayer)	2.0	-	0	0	0	3	48	147	161	172
T5	Water Retainer – (application with sprayer)	1.0	0.5	0	0	0	2	46	151	170	176
T6	Water Retainer – (application with sprayer)	1.5	0.5	0	0	0	2	52	128	160	164
T7	Water Retainer – (application with sprayer)	2.0	0.5	0	0	0	3	61	142	172	177


Effect of Water Retainer on No. of Fruit or Flower per plant in Chilies
No. of Fruit or Flower per plant
200
180
160
140
120
100
80
60
40
20
0
0 0 0 0 0 0 0
0 0 0 0 0 0 0
0 0 0 0 0 0 0
2 2 3 3 2 2 3
2 WAA
4 WAA
6 WAA
8 WAA
10 WAA
12 WAA
14 WAA
16 WAA
Control -
Water Retainer 1 ml/sqm.
Water Retainer 1.5 ml/sqm.
Water Retainer 2 ml/sqm.
Water Retainer 1+0.5 ml/sqm.
Water Retainer 1.5+0.5 ml/sqm.
Water Retainer 2+0.5 ml/sqm.

Water Retainer in Chilies
In-house Trial Review-2018

JAFFER

Irrigation schedule :

Treatments	Date of Transplanting	1st Irrigation 30/4/2018	2nd Irrigation 5/5/2018	3rd Irrigation 14/5/2018	4th Irrigation 29/5/2018	5th Irrigation 14/6/2018	6th Irrigation 20/6/2018	7th Irrigation 26/6/2018	8th Irrigation 01/08/2018	9th Irrigation 11/08/18	10th Irrigation 26/08/18
T1 : Control / UTC	30/04/2018	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
T2 : Water Retainer 1 ml/Sqm.		Yes +	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes
T3 : Water Retainer 1.5 ml/Sqm.		Yes +	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes
T4 : Water Retainer 2 ml/Sqm.		Yes +	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes
T5 : Water Retainer 1+0.5 ml/Sqm.		Yes +	Yes	No	Yes	Yes +	No	Yes	Yes	No	Yes
T6 : Water Retainer 1.5+0.5 ml/Sqm.		Yes +	Yes	No	Yes	Yes +	No	Yes	Yes	No	Yes
T7 : Water Retainer 2+0.5 ml/Sqm.		Yes +	Yes	No	Yes	Yes +	No	Yes	Yes	No	Yes

Yes	Irrigation
Yes +	Irrigation+Application
No	No irrigation

Water Retainer in Chilies
In-house Trial Review-2018

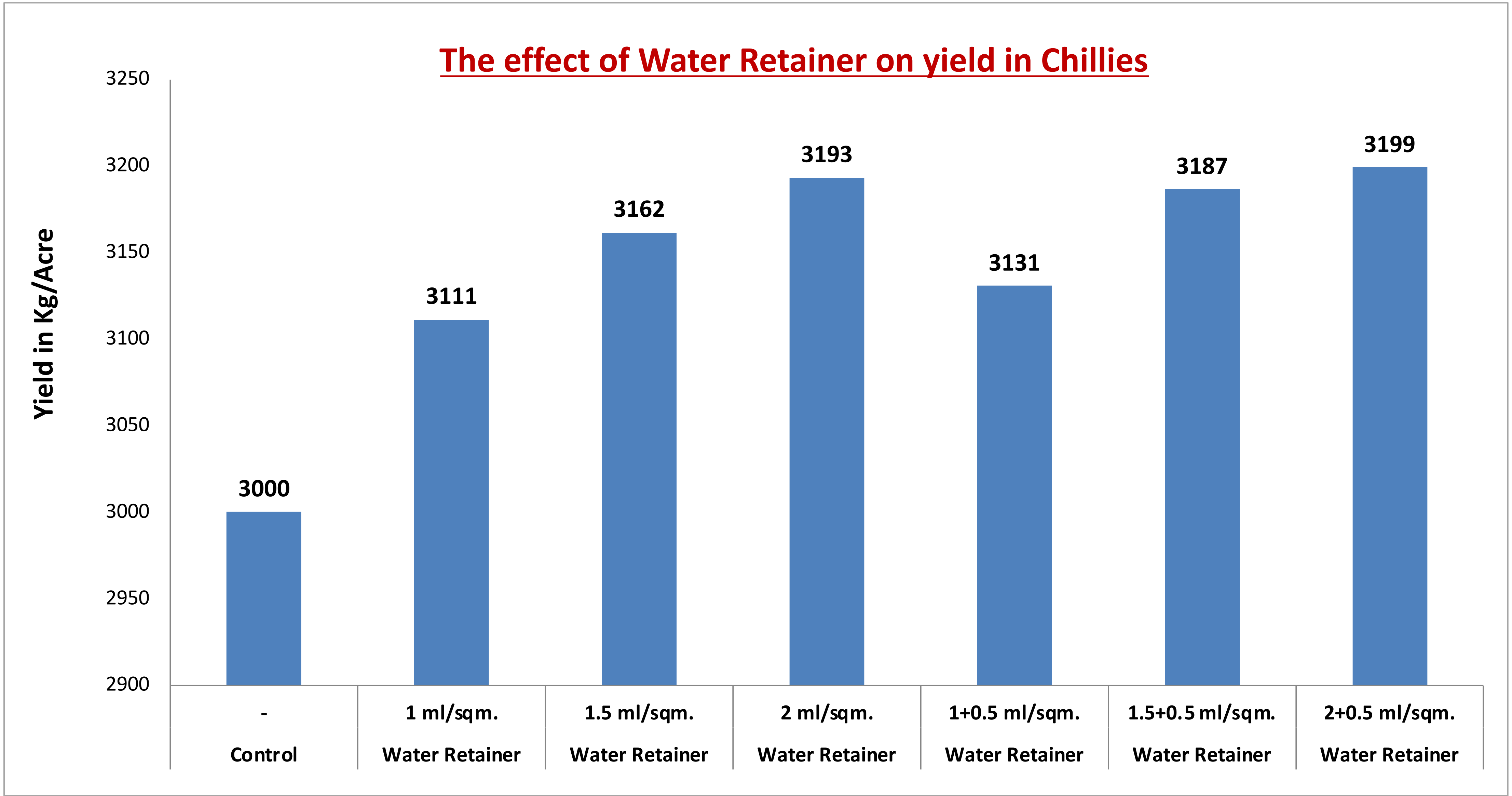
JAFFER

Trial-1
Crop : Chilies
D.O. Application : 1st : 01-May-2018 2nd : 13-June-2018

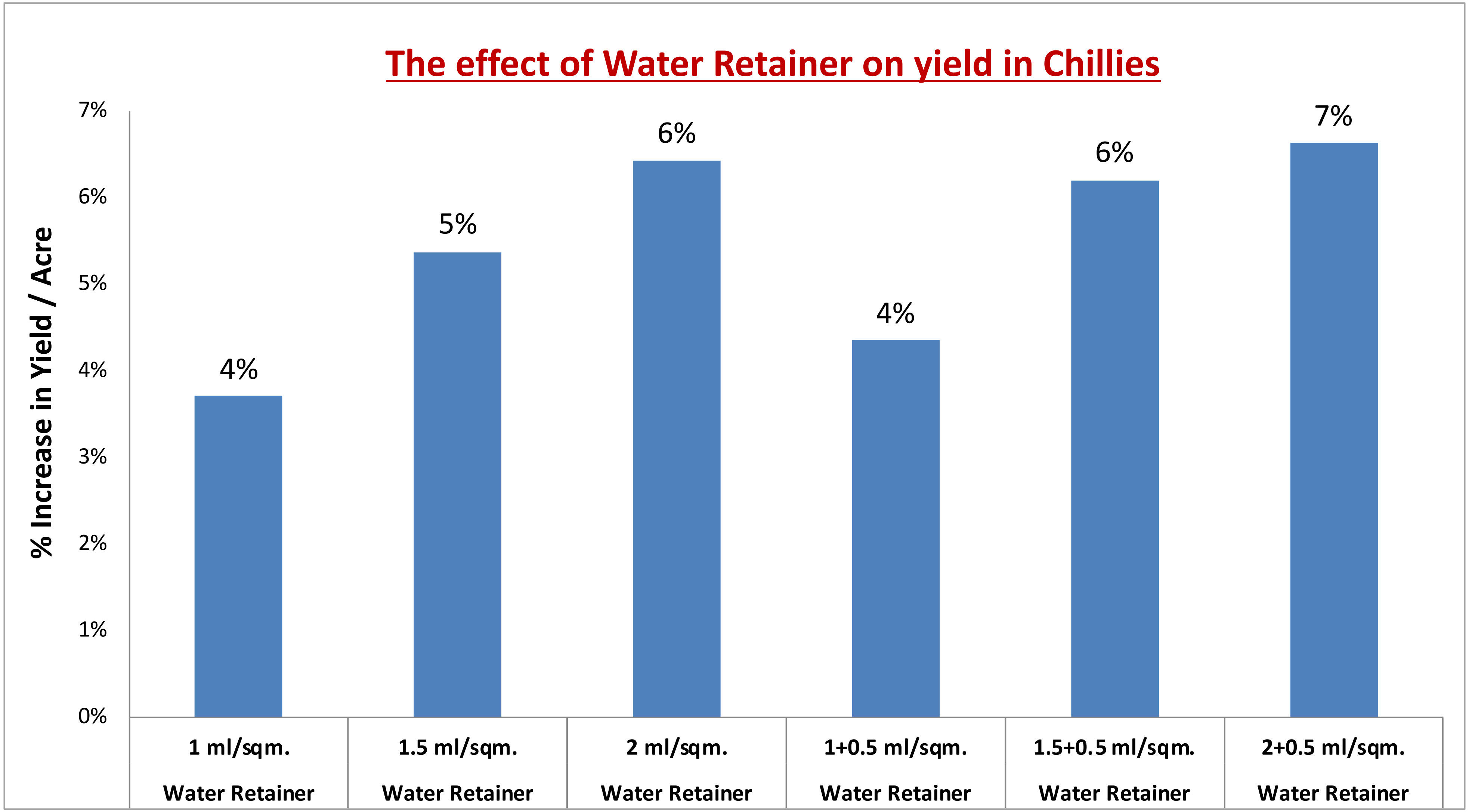
S.#	Treatment / Product	Dose / sq. meter (ml)		Soil Moisture Content (%)					
		1st Appli	2nd Appli	Before Application (01-05-2018)		4 WAA (29-05-2018)		8 WAA (26-06-2018)	
				A (0-12 inch)	B (12-18 inch)	A (0-12 inch)	B (12-18 inch)	A (0-12 inch)	B (12-18 inch)
T1	Control / UTC	-	-	18.3	16.5	25.0	23.4	26.4	24.6
T2	Water Retainer – (application with sprayer)	**1.0**	**-**	23.4	21.6	28.3	26.8	30.3	28.4
T3	Water Retainer – (application with sprayer)	**1.5**	**-**	24.0	21.4	32.9	30.1	34.9	32.3
T4	Water Retainer – (application with sprayer)	**2.0**	**-**	23.6	21.9	34.3	32.1	36.2	33.9
T5	Water Retainer – (application with sprayer)	**1.0**	**0.5**	23.8	21.8	27.6	27.5	32.5	29.7
T6	Water Retainer – (application with sprayer)	**1.5**	**0.5**	25.4	21.2	33.7	31.6	36.2	33.1
T7	Water Retainer – (application with sprayer)	**2.0**	**0.5**	24.4	19.9	36.4	34.8	37.9	36.4

Water Retainer in Chilies
In-house Trial Review-2018

JAFFER



Water Retainer in Chilies In-house Trial Review-2018



Water Retainer in Chilies
In-house Trial Review-2018

JAFFER

Pictures of activities during trial conduction / assessments……

Sampling for soil moisture analysis - Chilies

Plant mapping - Chilies

Plant mapping - Chilies

Trial-2

Location: Talagang (Pb)

Crop: Peanut

Date of Appli. : 14-May-2018

Trialist : MHH – (AMT, FSD)

Water Retainer in Groundnut
In-house Trial Review-2018

JAFFER

Trial Protocol :

Objective	"To study the impact of using ***"Water Retainer"*** on water retention, crop growth, development and yield in Groundnut (under rainfed conditions)"

Trial Locations	**Talagang (Punjab)**
Layout Design	RCBD
Plot Size	150 sq. meter
Replicates	Three

Treatments:

S.#	Treatment / Product	Dose / sq. meter (ml)		Remarks
		1st Appli	2nd Appli	
T1	Control / UTC	-	-	Follow farmer practice for irrigations
T2	Water Retainer – (application with sprayer)	**1.0**	-	**Groundnut (rainfed):** 1st application just after sowing 2nd application 30-40 days after 1st appli. (spray in between lines, preventing crop. If spray drift falls on crop then wash with clean water using sprayer, just after application)
T3	Water Retainer – (application with sprayer)	**1.5**	-	
T4	Water Retainer – (application with sprayer)	**2.0**	-	
T5	Water Retainer – (application with sprayer)	**1.0**	**0.5**	
T6	Water Retainer – (application with sprayer)	**1.5**	**0.5**	
T7	Water Retainer – (application with sprayer)	**2.0**	**0.5**	

Water Retainer in Groundnut
In-house Trial Review-2018

JAFFER

Application Methodology :	
No. of Applications? Appli Instructions?	• T2 – T4: ONE applications to be done • T5 – T7: TWO applications to be done (2nd application to be done 30-40 days after 1st application • Dilute the concentrate in 20 times volume of water for preparing to spray it. Spray the diluted water Retainer to the surface of the soil (just after the sowing of crop, preferably at "wattar condition"
Note: Use very same products (herbicide, insecticides, fertilizers etc.) at same dose rates for the control (T1) and the Water Retainer treated plots (T2-T7) in order to get the clear comparison of using water retainer treatment.	

Assessment required at Post treatment :

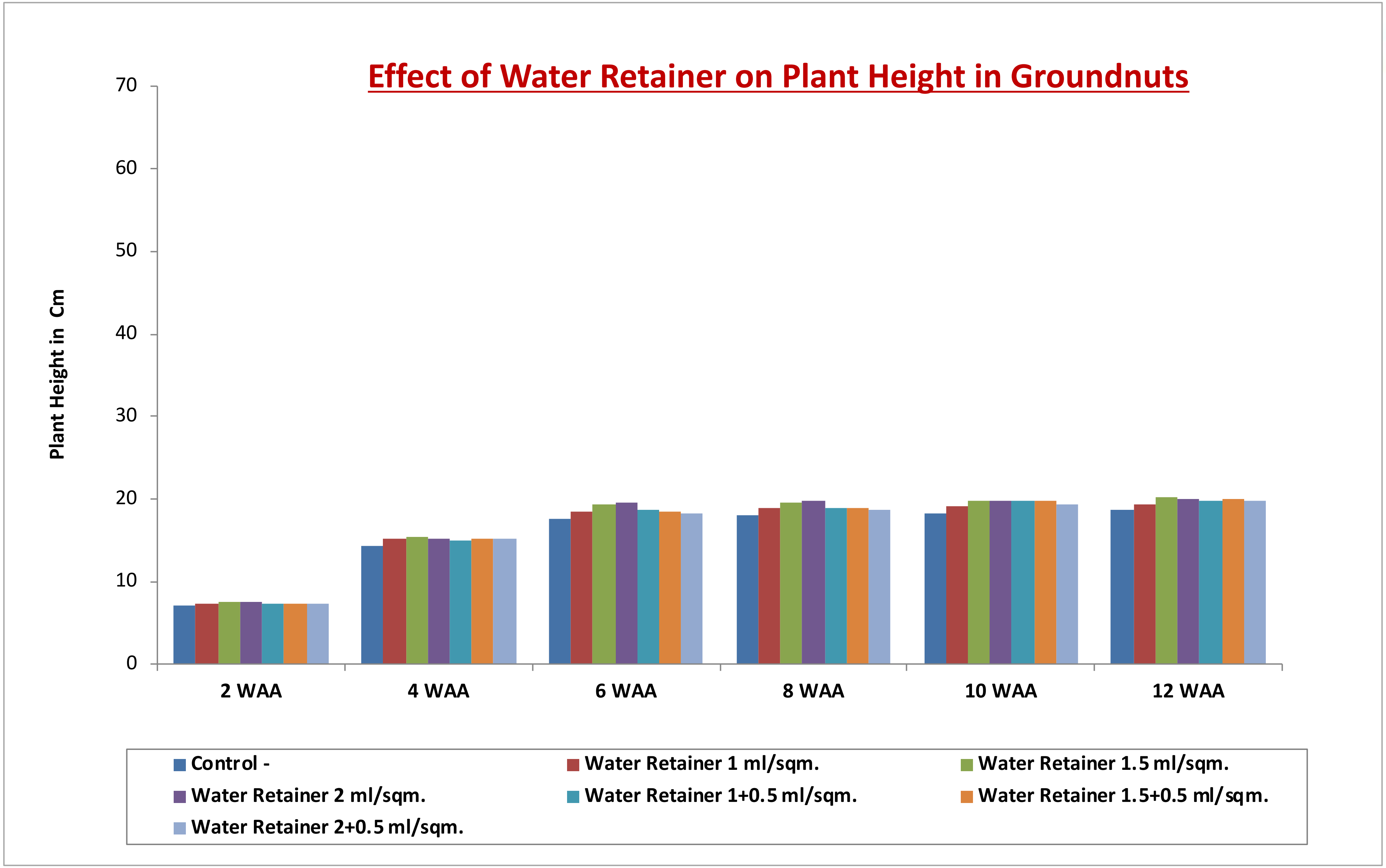
At	Assessment criteria / Target
2, 4, 6, 8, 10, 12, 14, 16 Weeks after 1st application	• Note the physical condition of plants (Normal, Good, Excellent) • Also compare wilting of the plants in high temperatures in each treatment at a scale of 1-5 (5 means complete wilting, 1 means least or No wilting). • Record the soil moisture contents (using gravimetric method) before application and then 4, 8 & 12 weeks after application. **Sampling protocol is given below separately.** • Record the field temperature, the relative humidity of the air at each observation • Measure the height of the plants, the number of leaf, number of flowers etc. at each observation
Harvest	• Yield to be recorded very carefully

- Evaluate the differences of all the recoded data in comparison to UTC / Control
- Rainfall data to be recorded very accurately

Water Retainer in Groundnut
In-house Trial Review-2018

Trial-2
Crop : Groundnuts
D.O. Application : 1st : 14-May-2018   2nd : 17-July-2018

S.#	Treatment / Product	Dose / sq. meter (ml)		Avg. Plant Height (cm)					
		1st Appli	2nd Appli	2 WAA	4 WAA	6 WAA	8 WAA	10 WAA	12 WAA
T1	Control / UTC	-	-	7.11	14.33	17.66	17.99	18.33	18.66
T2	Water Retainer – (application with sprayer)	**1.0**	-	7.33	15.23	18.55	18.88	19.11	19.33
T3	Water Retainer – (application with sprayer)	**1.5**	-	7.49	15.45	19.33	19.46	19.77	20.11
T4	Water Retainer – (application with sprayer)	**2.0**	-	7.62	15.24	19.66	19.77	19.87	19.98
T5	Water Retainer – (application with sprayer)	**1.0**	**0.5**	7.29	15.01	18.66	18.99	19.76	19.88
T6	Water Retainer – (application with sprayer)	**1.5**	**0.5**	7.33	15.22	18.49	18.99	19.88	20.01
T7	Water Retainer – (application with sprayer)	**2.0**	**0.5**	7.39	15.11	18.29	18.78	19.33	19.77

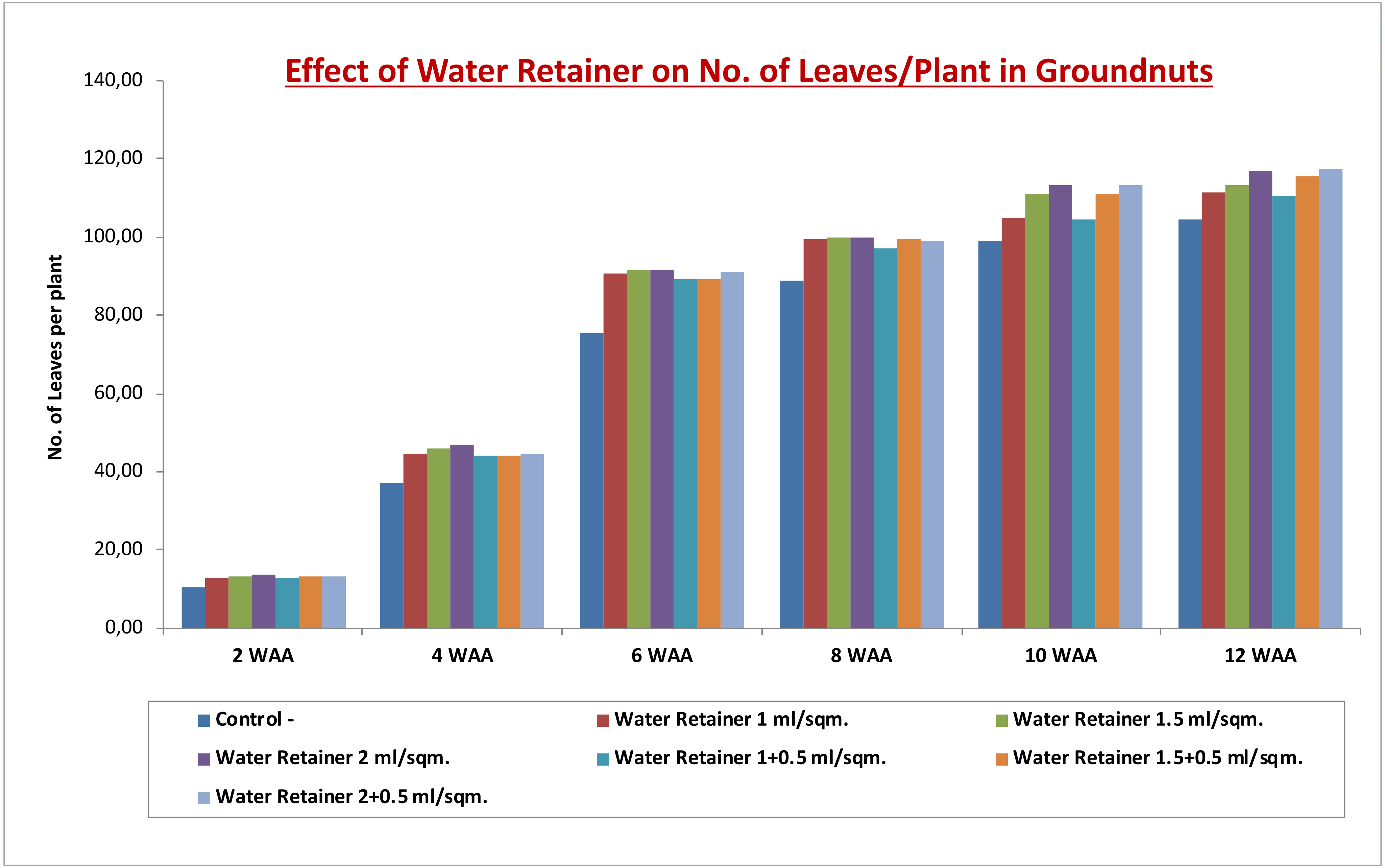

Effect of Water Retainer on Plant Height in Groundnuts
Plant Height in Cm
70
60
50
40
30
20
10
0
2 WAA
4 WAA
6 WAA
8 WAA
10 WAA
12 WAA
Control -
Water Retainer 1 ml/sqm.
Water Retainer 1.5 ml/sqm.
Water Retainer 2 ml/sqm.
Water Retainer 1+0.5 ml/sqm.
Water Retainer 1.5+0.5 ml/sqm.
Water Retainer 2+0.5 ml/sqm.

Water Retainer in Groundnut
In-house Trial Review-2018

JAFFER

Trial-2
Crop : Groundnuts
D.O. Application : 1st : 14-May-2018 2nd : 17-July-2018

S.#	Treatment / Product	Dose / sq. meter (ml)		Avg. No. of leaves / Plant					
		1st Appli	2nd Appli	2 WAA	4 WAA	6 WAA	8 WAA	10 WAA	12 WAA
T1	Control / UTC	-	-	10.33	37.22	75.66	88.8	99.0	104.7
T2	Water Retainer – (application with sprayer)	**1.0**	-	12.99	44.51	90.77	99.3	105.2	111.5
T3	Water Retainer – (application with sprayer)	**1.5**	-	13.33	45.98	91.66	100.0	111.2	113.4
T4	Water Retainer – (application with sprayer)	**2.0**	-	13.66	46.77	91.66	100.1	113.2	116.9
T5	Water Retainer – (application with sprayer)	**1.0**	**0.5**	12.89	44.10	89.33	97.0	104.8	110.3
T6	Water Retainer – (application with sprayer)	**1.5**	**0.5**	13.11	44.33	89.44	99.4	111.2	115.7
T7	Water Retainer – (application with sprayer)	**2.0**	**0.5**	13.39	44.39	91.33	99.2	113.2	117.3


Effect of Water Retainer on No. of Leaves/Plant in Groundnuts
No. of Leaves per plant
140,00
120,00
100,00
80,00
60,00
40,00
20,00
0,00
2 WAA
4 WAA
6 WAA
8 WAA
10 WAA
12 WAA
Control -
Water Retainer 1 ml/sqm.
Water Retainer 1.5 ml/sqm.
Water Retainer 2 ml/sqm.
Water Retainer 1+0.5 ml/sqm.
Water Retainer 1.5+0.5 ml/sqm.
Water Retainer 2+0.5 ml/sqm.

Water Retainer in Groundnut
In-house Trial Review-2018

JAFFER

Trial-2
Crop : Groundnuts
D.O. Application : 1st : 14-May-2018 2nd : 17-July-2018

S.#	Treatment / Product	Dose / sq. meter (ml)		Soil Moisture Content (%)			
		1st Appli	2nd Appli	Before Application (14-05-2018)	4 WAA (13-06-2018)	8 WAA (17-07-2018)	12 WAA (11-08-2018)
T1	Control / UTC	-	-	10.4 %	12.3 %	14.5 %	17.2 %
T2	Water Retainer – (application with sprayer)	**1.0**	-	11 %	12.6 %	14.8 %	17.8 %
T3	Water Retainer – (application with sprayer)	**1.5**	-	9.5 %	13.3 %	14.5 %	17.3 %
T4	Water Retainer – (application with sprayer)	**2.0**	-	11 %	12.9 %	15.1 %	17.9 %
T5	Water Retainer – (application with sprayer)	**1.0**	**0.5**	11.5 %	12.8 %	14.8 %	18.2 %
T6	Water Retainer – (application with sprayer)	**1.5**	**0.5**	10 %	13.1 %	15.2 %	18 %
T7	Water Retainer – (application with sprayer)	**2.0**	**0.5**	11.4 %	12.5 %	14.9 %	18.4 %

Water Retainer in Groundnut
In-house Trial Review-2018

JAFFER

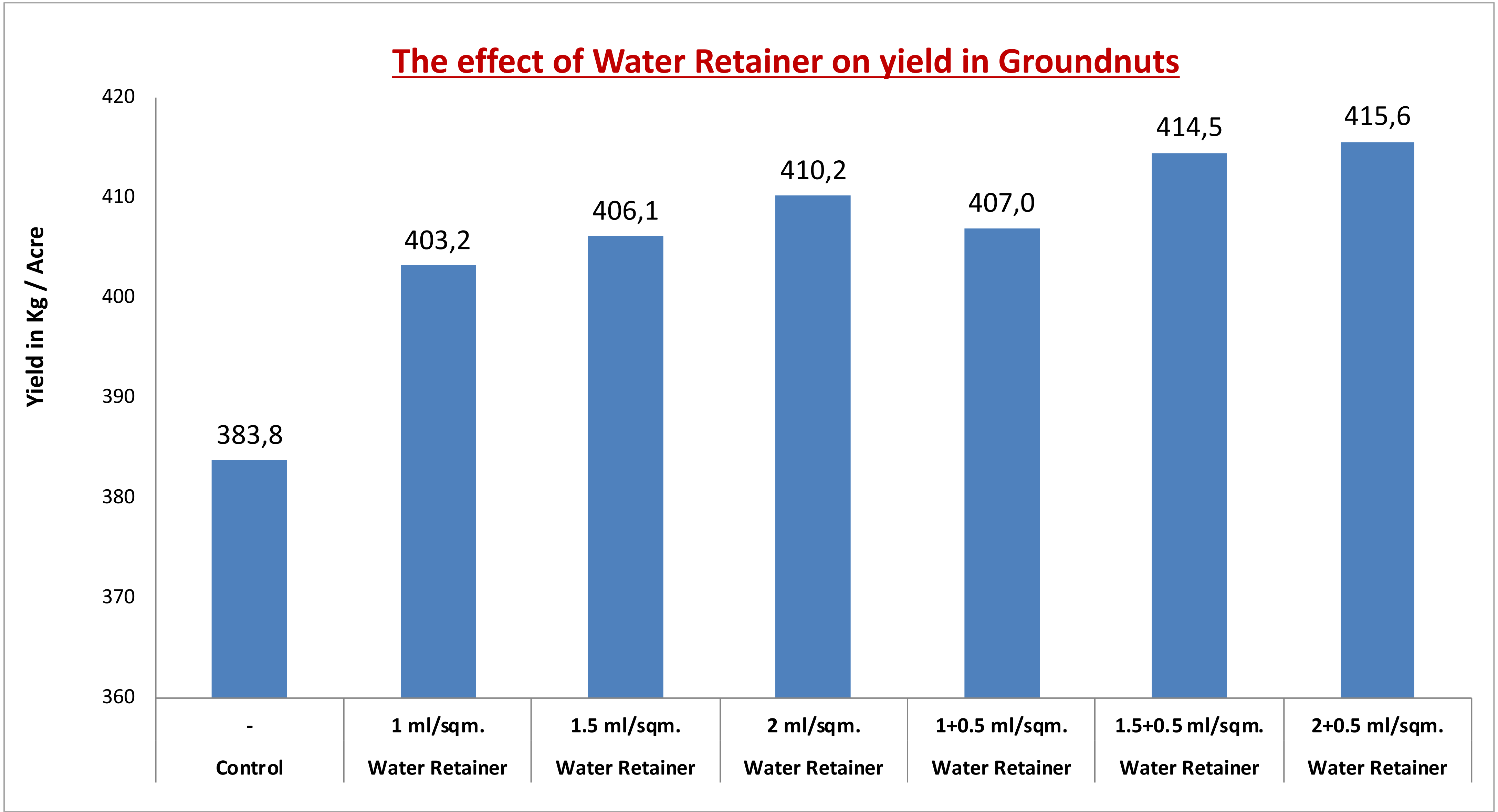
Rainfall schedule (Rainfed area)

Treatments	Date of Sowing	1st Appli. of WR	2nd Appli. of WR	Rainfall									
				1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
T1 : Control / UTC	14/05/2018	14/05/2018	-	11/05/20 18 (M)*	15/05/201 8 (M)	06/06/201 8 (L)	12/07/201 8 (RS)	16/07/201 8 (M)	23/07/201 8 (L)	01/08/201 8 (L)	08/08/201 8 (M)	19/08/201 8 (M)	-
T2 : Water Retainer 1 ml/Sqm.			-										
T3 : Water Retainer 1.5 ml/Sqm.			-										
T4 : Water Retainer 2 ml/Sqm.			-										
T5 : Water Retainer 1+0.5 ml/Sqm.			17/07/2018										
T6 : Water Retainer 1.5+0.5 ml/Sqm.													
T7 : Water Retainer 2+0.5 ml/Sqm.													

L : Low
M : Medium
H : High

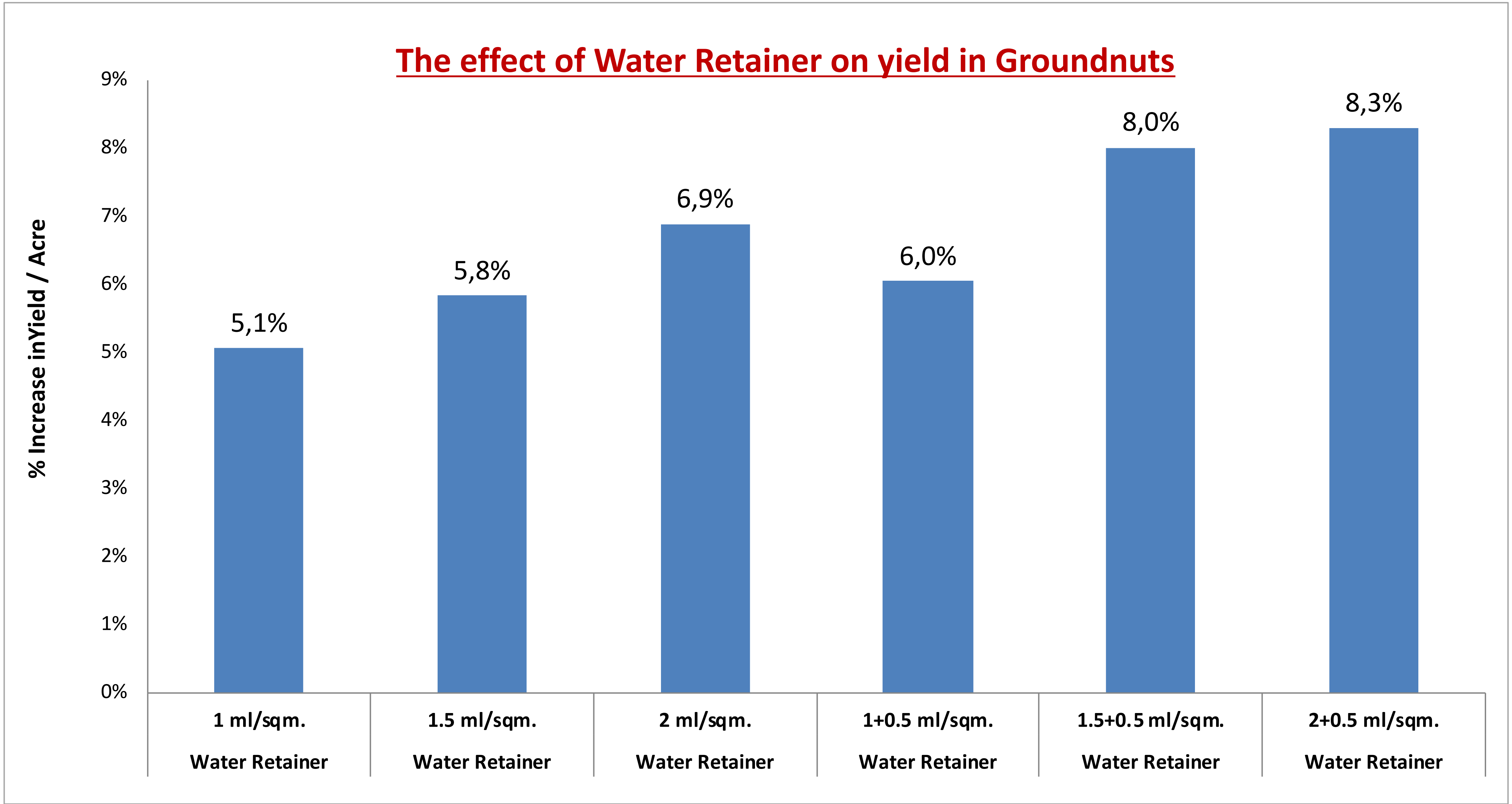
Water Retainer in Groundnut
In-house Trial Review-2018

JAFFER



Water Retainer in Groundnut
In-house Trial Review-2018

JAFFER



Water Retainer in Groundnut
In-house Trial Review-2018

JAFFER

Pictures of activities during trial conduction / assessments……

Layout/Plot view at the time of trial conduction

Soil sampling before WR application/Sowing

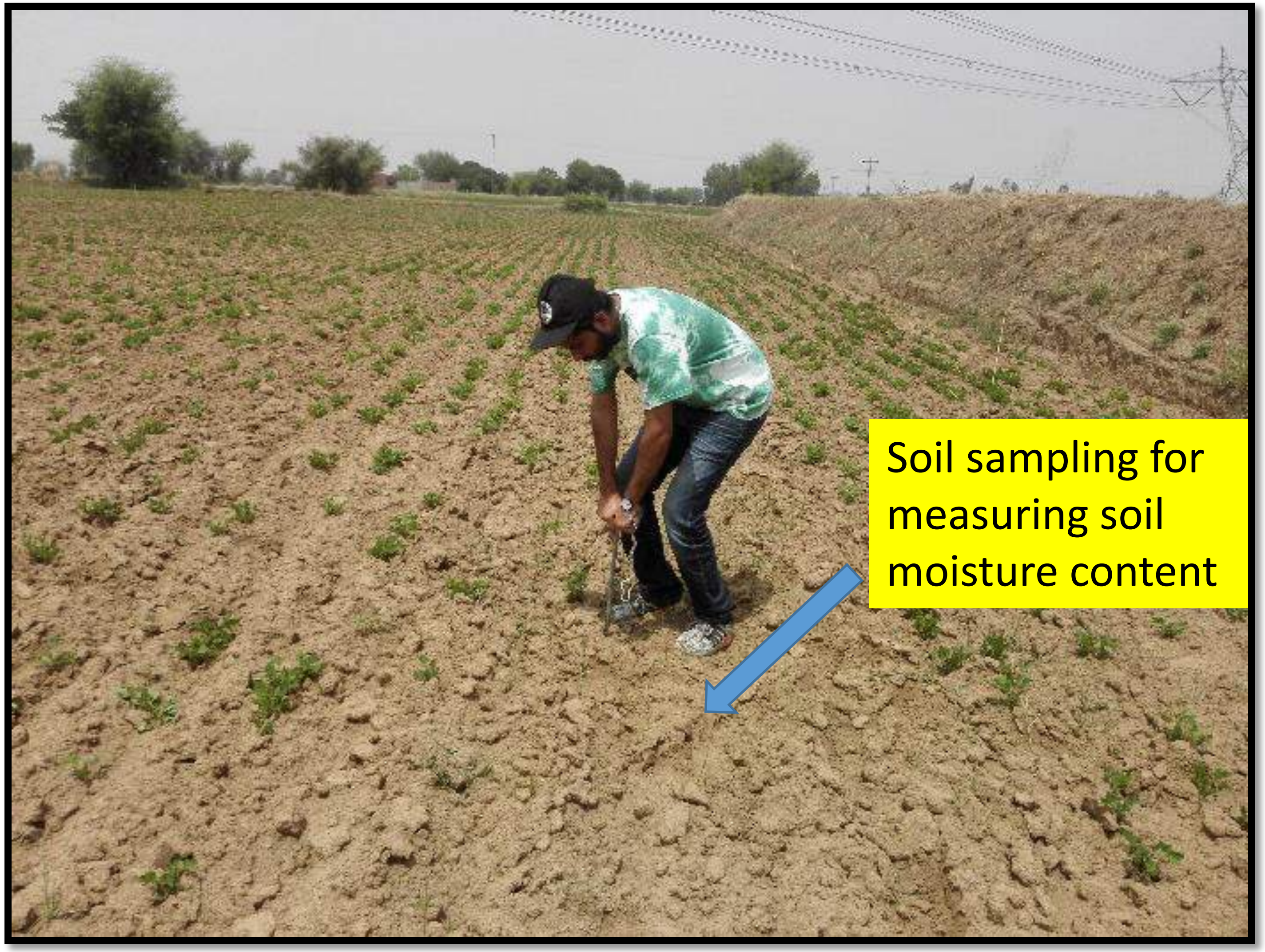
Sowing/drilling of Groundnut seed

Application of Water Retainer in Groundnuts

Crop view treated with Water Retainer (14 DAA-1)

Excellent germination & plants health was observed

Soil sampling prior to 2nd application of Water Retainer (28 DAA-1)



Crop view of Untreated Vs Water Retainer treated plots (42 DAA-1)

Untreated/Control Plot

Treated plot - 1 application of Water retainer, Excellent plant growth & lush green foliage with more bio-mass

Treated plot - 2 application of Water retainer, Excellent plant growth & lush green foliage with more bio-mass

Use of Water Retainer in Groundnut & Chilies In-house Trial Review-2018

Comments / Conclusions:

- "Water Retainer" was studied through replicated field trials, one each for Groundnut (under rainfed conditions) and Chilies (under irrigated conditions) in Pakistan, during 2018 kharif season.
- Three different doses in two set of application were studied (viz., 1.0, 1.5 & 2.0 ml/sq.m. as single application in set-1 while in set-2 two applications were made where same doses were followed by a second application of 0.5 ml/sq.m. in each treatment)
- Product found quite effective as compare to the control (UTC), as a significant increase in plant structure/bio-mass & fruiting as well as yield was noted in all treatments
- The data revealed that application water retainer @ 1.5 + 0.5 ml/sq. m. and 2.0+0.5 ml/sq.m found almost equally good and better than other treatments.
- **Keeping in view the overall performance and application economics, we can conclude that water retainer @ 1.5 + 0.5 ml/sq.m. seems to be the most suitable treatment.**

JAFFER

water&soil

WATER RETAINER

ORGANIC BASE SOIL CONDITIONER

Budapest, 1027 Hungary

Water Retainer in Cotton

In-house Field Trials in Pakistan

By

Technical & Development
Jaffer Agro Services (Pvt) Ltd

An update as of 01.12.2017

Water Retainer in Cotton
In-house Trial Review

JAFFER

Objective :

- To study the impact of using "Water Retainer" in cotton crop on following aspects :
  - Water retention in soil and number of irrigations
  - The impact on herbicidal activity

Water Retainer in Cotton
In-house Trial Review

Trial Protocol No. 1 :

S.#	Treatment / Product (and	Dose / Acre		Remarks
		1st Appli	2nd Appli	
T1	Control	-	-	Follow farmer practice
T2	Water Retainer – (application with sprayer)	4 L	-	Spray the product at "wattar" after first irrigation to crop
T3	Water Retainer – (application with sprayer)	4 L	2 L	1st application at "wattar" after first irrigation to crop 2nd application 30 DAA-1

Water Retainer in Cotton
In-house Trial Review

Trial Protocol

Application Methodology:	
No. of Applications? Application Instructions?	• T2 : ONE applications to be done • T3 : TWO applications to be done (2nd application to be done 30 days after 1st application • **Dilute the concentrate in 20 times volume of water for preparing to spray it.** • Spray the diluted water Retainer to the surface of the soil covering the sowing lines (Spraying should preferably be done at “wattar condition” or irrigate the field just after spraying.) • Reduce the number of irrigations in treated i.e., in case of T2-T3, skip one irrigation after two consecutive irrigations.

NOTE :

- Use very same products (herbicide, insecticides, fertilizers etc) at same dose rates for the control (T1) and the Water Retainer treated plots (T2-T3) in order to get the clear comparison of using water retainer treatment.
- Use “Panida Grande (Pendimethalin)” as pre- emergence herbicide in all three treatments and observe the herbicidal activity (speed of action & residual control) at each observation

Observations / Assessments:

At	Assessment criteria / Target
Before each Irrigation (from application to 12 weeks) OR 2, 4, 6, 8, 10 & 12 Weeks after application-1	• Note the physical condition of plants (Normal, Good, Excellent) • Record the humidity of soil at each observation and workout the soil moisture content by using gravimetric method. • Record the temperature, the relative humidity of the air • Measure the height of the plants, the number of leaf, number of flowers/fruiting bodies in each treatment • Note the residual control of weeds in each treatment
Harvest	• Yield to be recorded

Project Summary:

Project	***Water Retainer***
Supplier	Budapest, Hungary
Target Crop	Cotton
Target	Water Retention
Trial Season	Kharif 2017
Total Trial Conducted	2

Trial Details :

Trial #.	Trialist	Location	Trial Design / Replicates	D. O. Appli.	No. of Appli.
Trial-1	HMA, AMT-Mtn.	Bootywala, Vehari Road Multan	LPT	26-05-2017	Two
Trial-2	HMA, AMT-Mtn.	06 Tarpai, Jahania Multan	LPT	01-06-2017	Two

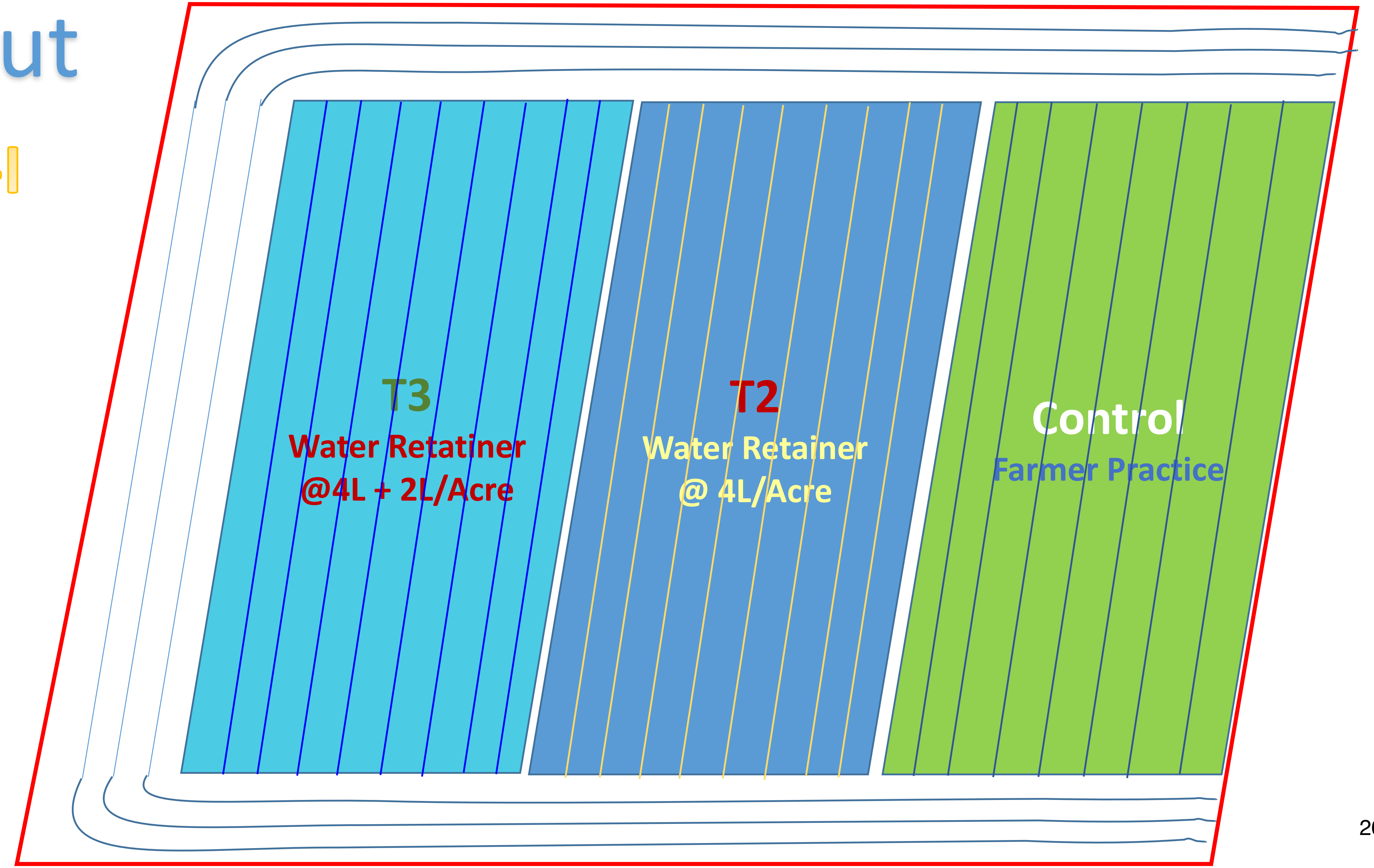
General Notes of Trials :

Station		→	Multan	
			Trial-1	Trial-2
Location / Area		→	Bootywala, Vehari Road Multan	06 Tarpai, Jahania, Multan
Name of Farmer		→	Ch. Asghar	Sheikh Sajjad
Crop / Variety		→	Cotton/IUB-2015	Cotton/FH-142
D. O. Sowing		→	25-05-2017	31-05-2017
D. O. Application		→	**26-05-2017**	**01-06-2017**
Design / Replicates		→	LPT	LPT
Plot Size		→	500 sq. meter	500 sq. meter
Sprayer Used		→	Matabi Knapsack	Matabi Knapsack
Water Vol. Used		→	120 L / Acre	120 L / Acre
Previous Sprays		→	Panida Grande	Panida Grande
Weather Info:				
Temperature	(Min.)	→	30^{o}C	29^{o}C
	(Max.)	→	42^{o}C	37^{o}C
Humidity	(Min.)	→	59 %	46 %
	(Max.)	→	66 %	68 %
Wind Velocity (km/h)		→	3.10	5.0
Rainfall		→	10.6.17(16.0mm), 12.6.17(3.3mm), 16.6.17(6.0mm), 20.6.17(12.0mm), 21.6.17(8.30mm), 12.7.17(1.6mm), 28.8.17(13.0mm), 31.7.17 (17.0mm), 1.9.17(10.0mm)	10.6.17(16.0mm), 12.6.17(3.3mm), 16.6.17(6.0mm), 20.6.17(12.0mm), 21.6.17(8.30mm), 12.7.17(1.6mm), 28.8.17(13.0mm), 31.7.17 (17.0mm), 1.9.17(10.0mm)

JAFFER

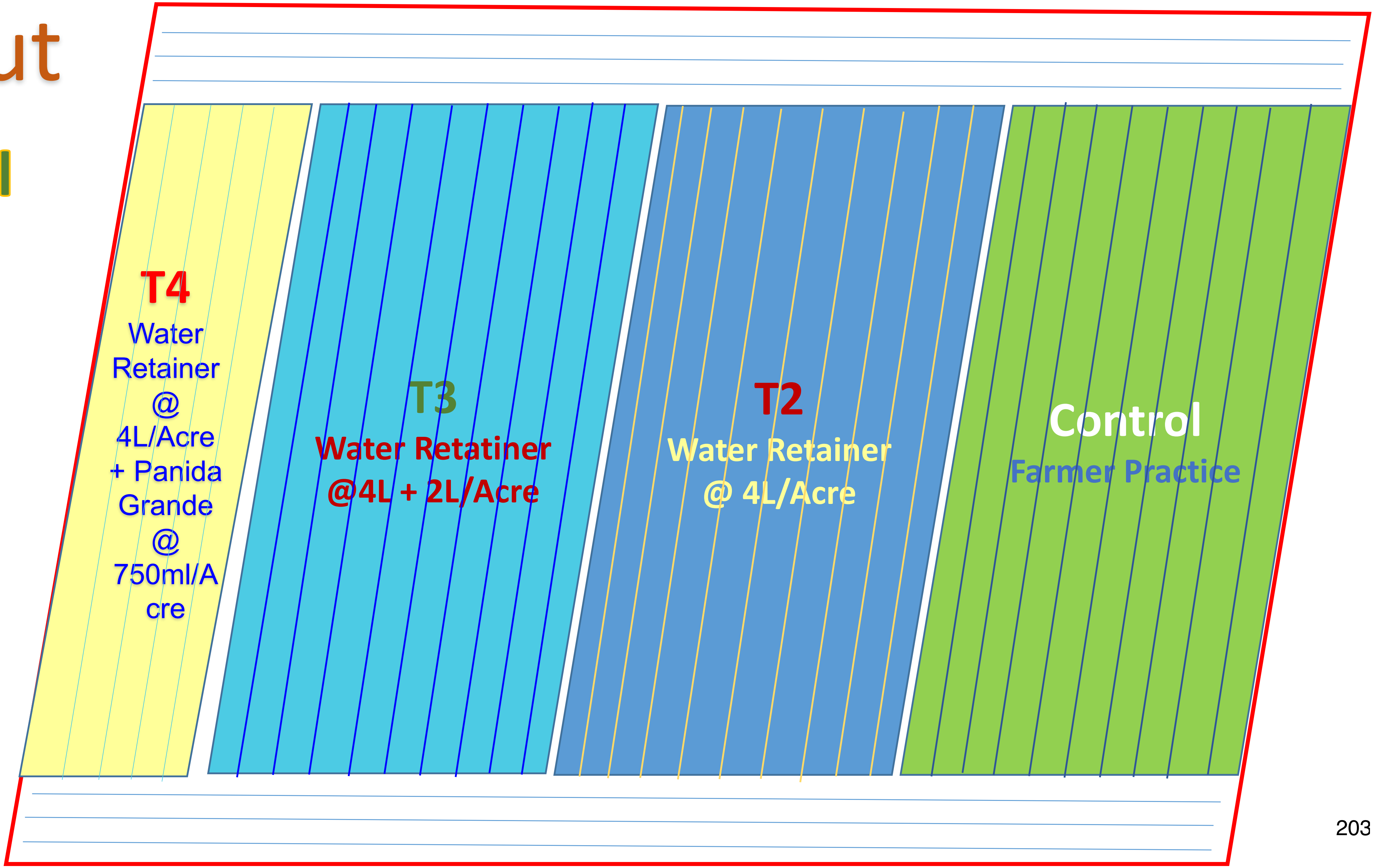
Layout

Trial-I



Layout

Trial-II



Water Retainer (Activities...on cotton...) Multan

Trial #	Date of Application	Date of Observation	Activity	Remarks
Trial-I	**26-05-2017**	02-06-2017	1st irrigation was applied and germination was observed	Trial completed
		09-06-2017	2nd irrigation was applied and gap filling was done (09-06-17)	
		17-06-2017	Heavy rainfall was observed (16.0mm) after 2nd irrigation	
		25-06-2017	Dibbling was done after rainfall	
		03-07-2017	Weeds were removed manually by hoeing and insecticides was applied for control of jassid.	
		10-07-2017	3rd irrigation was applied on 05-07-2017 with DAP 01bag/Ac. The **gaps were observed which may affect crop yield.**	
		17-07-2017	Gaps were observed as showing significant difference. Spray regarding Jassid & Army worms were applied.	
		24-07-2017	Crop Stand was good but with Gaps which are significant.	
		31-07-2017	Light rainfall was observed and spray regarding Jassid, WF & Army worms were applied.	
		07-08-2017	Spray regarding Jassid and WF were applied.	
		15-08-2017	Spray regarding WF was applied.	

Water Retainer (Activities…on cotton…) Multan

Trial #	Date of Application	Date of Observation	Activity	Remarks
Trial-I	**26-05-2017**	28-08-2017	Crop was good and spray regarding WF was applied.	Trial completed
		05-09-2017	Heavy rainfall was observed	
		12-09-2017	Crops stand was good	
			Yield data expected be recorded during 2nd week of Oct (1st Picking and 2nd week of Nov (2nd Picking)	

Water Retainer (Activities...on cotton...) Multan

Trial #	Date of Application	Date of Observation	Activity	Remarks
Trial-II	01-06-2017	08-06-2017	1st irrigation was applied and germination started	Trial completed
		17-06-2017	Heavy Rainfall was observed after 2nd irrigation. 2nd irrigation was applied on 15.6.17	
		25-06-2017	Rainfall was observed	
		03-07-2017	Weeds were removed manually by hoeing and insecticides was applied for control of Jassid & Armyworms	
		10-07-2017	3rd irrigation was applied on 05-07-2017 with DAP 0.75bag/Ac	
		17-07-2017	Crop stand is good and spray regarding Jassid & Army worms was applied.	
		24-07-2017	Heavy rainfall was observed	
		31-07-2017	Crop stand was good and spray regarding WF was applied	
		07-08-2017	Heavy rainfall was observed	
		15-08-2017	Spray regarding WF and Mealybug was applied	
		21-08-2017	Spray regarding WF was applied	

Water Retainer (Activities...on cotton...) Multan

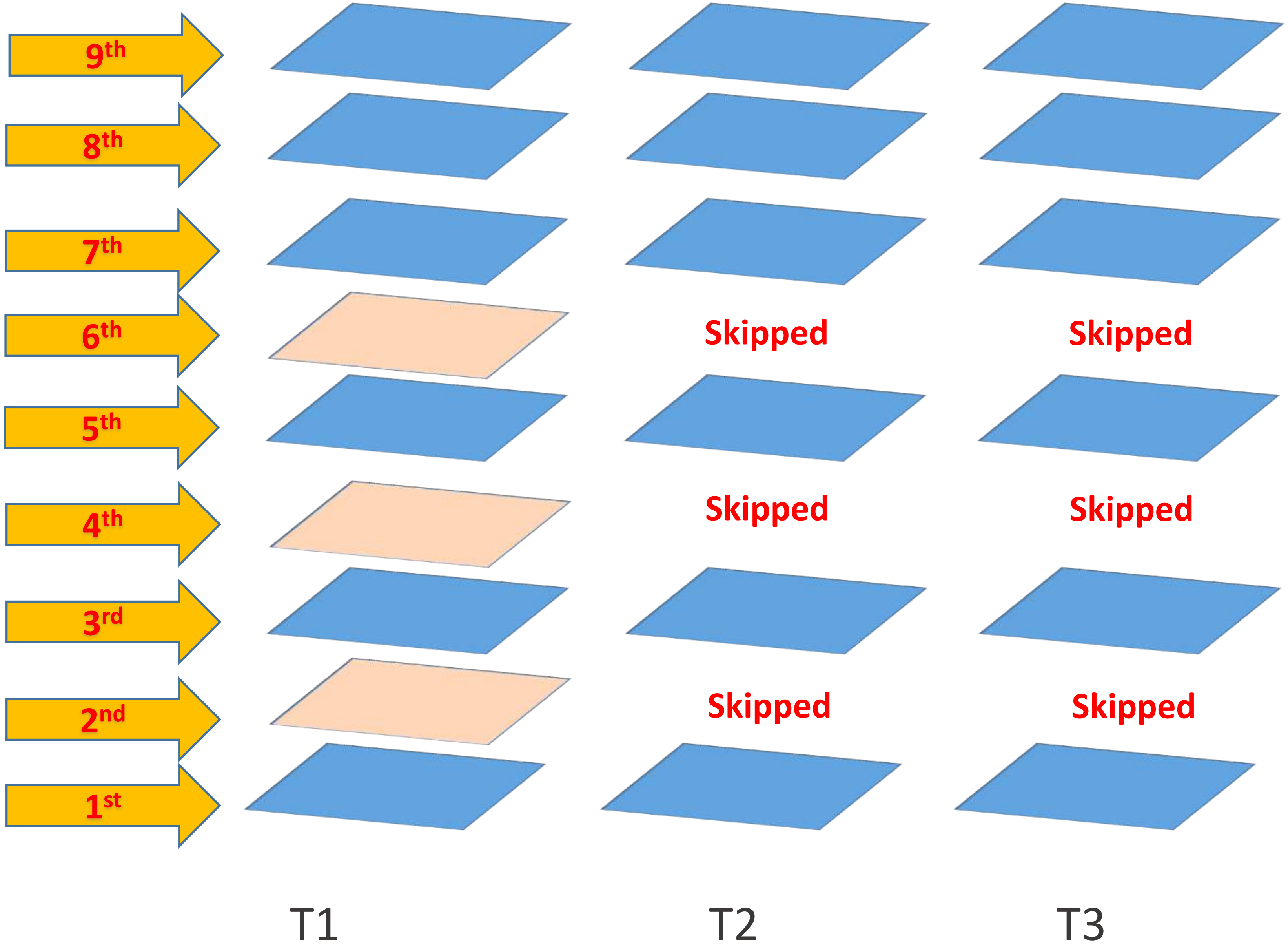
Trial #	Date of Application	Date of Observation	Activity	Remarks
Trial-II	**01-06-2017**	28-08-2017	Crop was good and spray regarding WF was applied.	Trial completed
		05-09-2017	Heavy rainfall was observed	
		12-09--2017	Mealy bug attack was observed	
			Yield data expected be recorded during 2nd week of Oct (1st Picking and 2nd week of Nov (2nd Picking)	

Irrigations & Observations Schedule

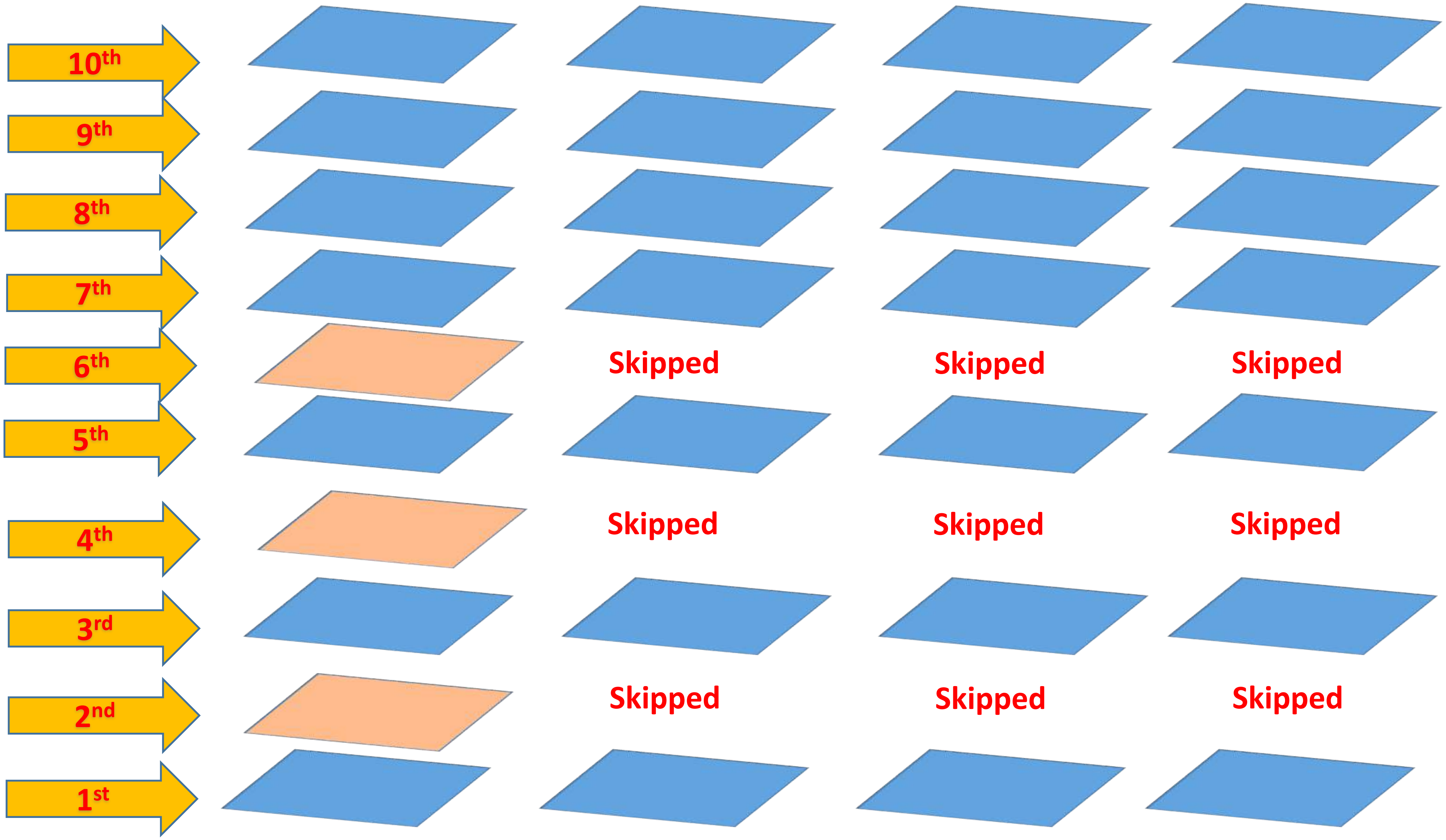
Trial –I		
Irrigations	Date of Irrigation	Date of Observations
1st	30-05-2017	02-06-2017
2nd	09-06-2017	09-06-2017
3rd	05-07-2017	17-06-2017
4th	15-07-2017	25-06-2017
5th	28-07-2017	03-07-2017
6th	10-08-2017	10-07-2017
7th	25-08-2017	17-07-2017
8th	10-09-2017	24-07-2017
9th	15-09-2017	31-07-2017
10th		07-08-2017
11th		15-08-2017
12th		21-08-2017
13th		28-08-2017
14th		05-09-2017
14th		

Trial -II		
Irrigations	Date of Irrigation	Date of Observations
1st	05-06-2017	08-06-2017
2nd	15-06-2017	17-06-2017
3rd	25-06-2017	25-06-2017
4th	05-07-2017	03-07-2017
5th	13-07-2017	10-07-2017
6th	28-07-2017	17-07-2017
7th	12-08-2017	24-07-2017
8th	28-08-2017	31-07-2017
9th	08-09-2017	07-08-2017
10th	15-09-2017	15-08-2017
11th		21-08-2017
12th		28-08-2017
13th		05-09-2017
14th		

Irrigation schedule Trial-1



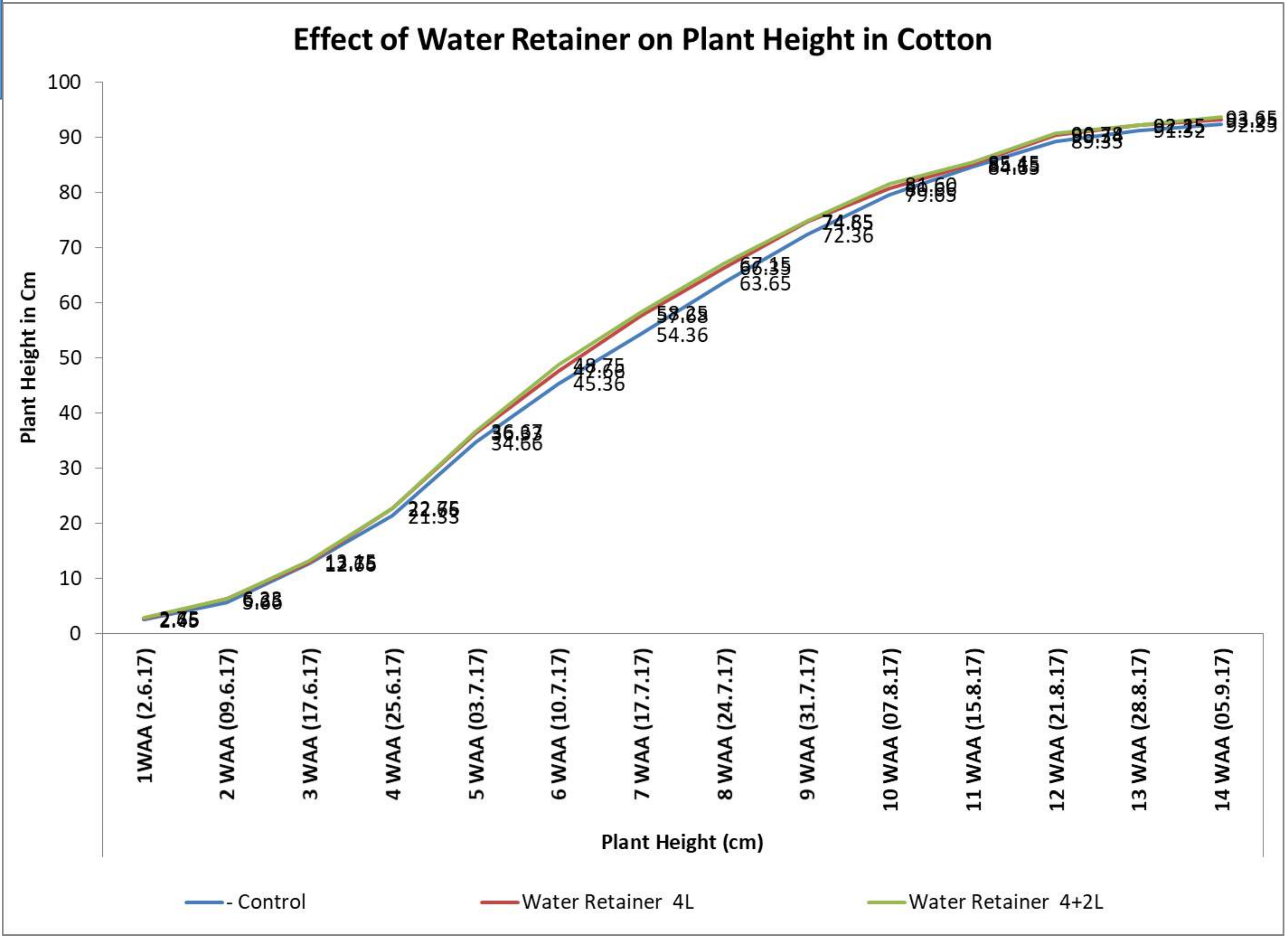
Irrigation schedule Trial-II



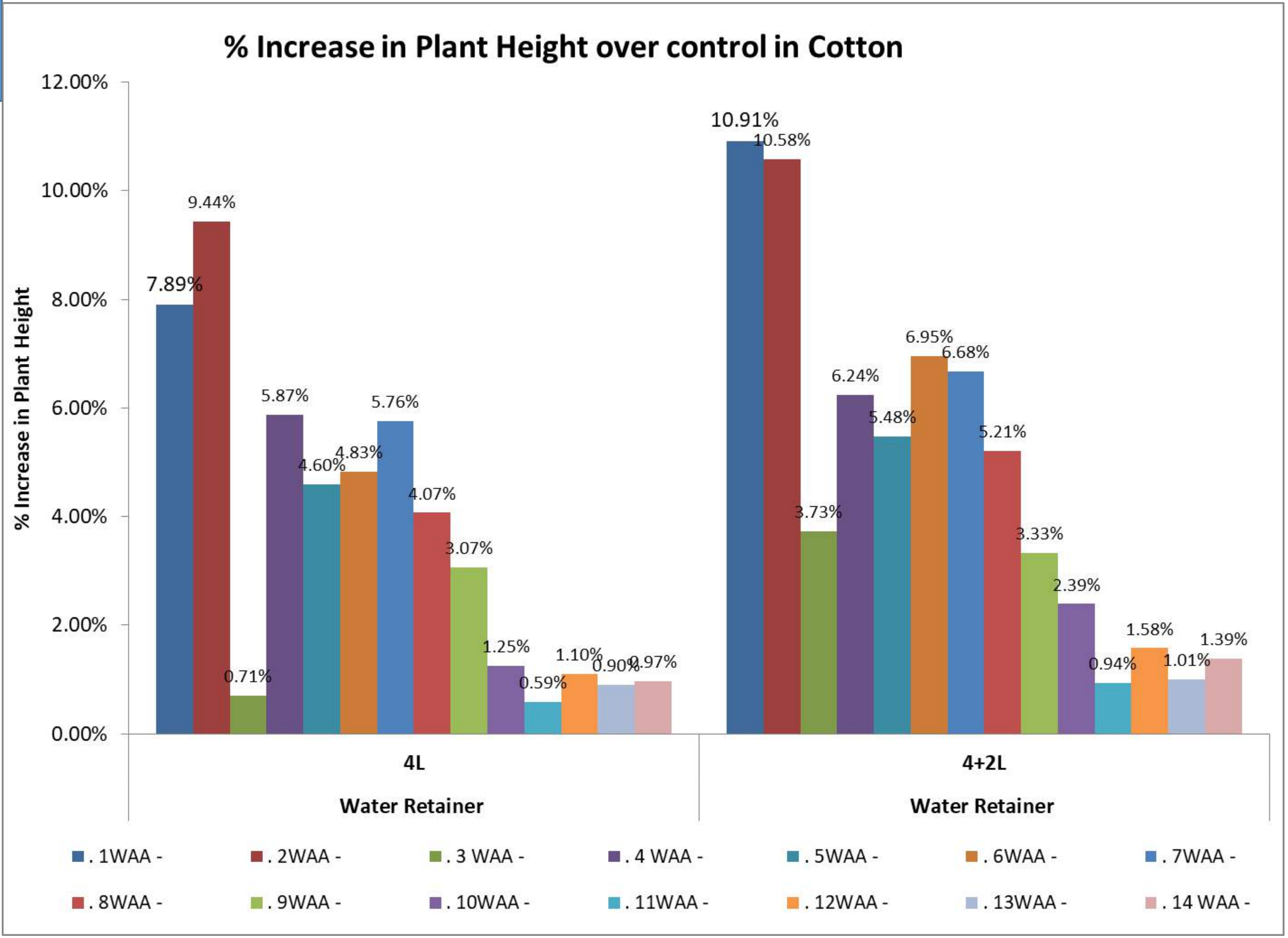
No. of Irrigations

Treatments	Trial-1		Trial -2	
	Applied	Skipped	Applied	Skipped
T1 = Control	9	Nil	10	Nil
T2 = Water Retainer @ 4L (Single Application)	6	3	7	3
T3= Water Retainer @ 4L + 2L (Repeated application)	6	3	7	3

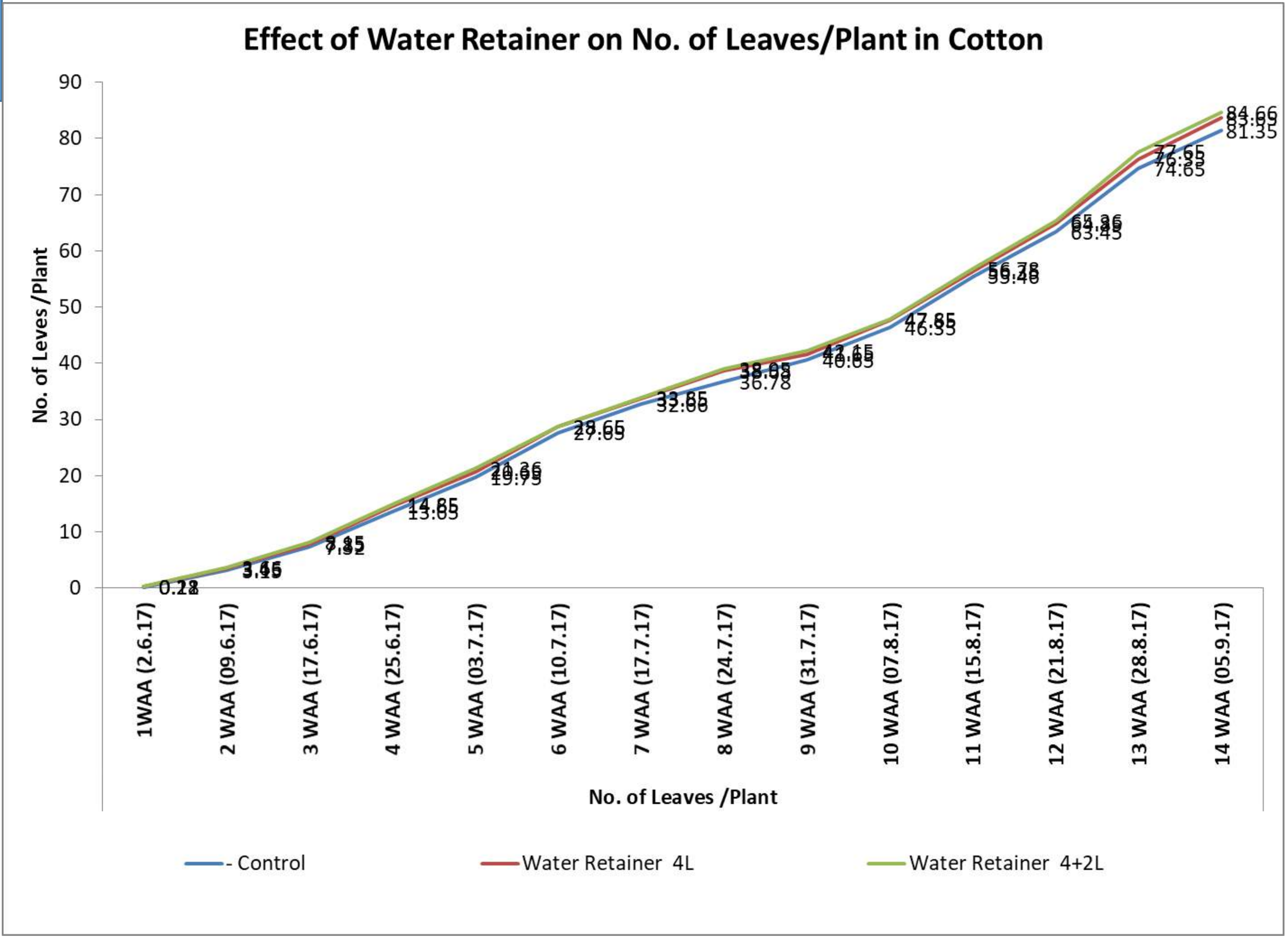
Trial –I
Bootywala, Multan
DOA:26-05-2017



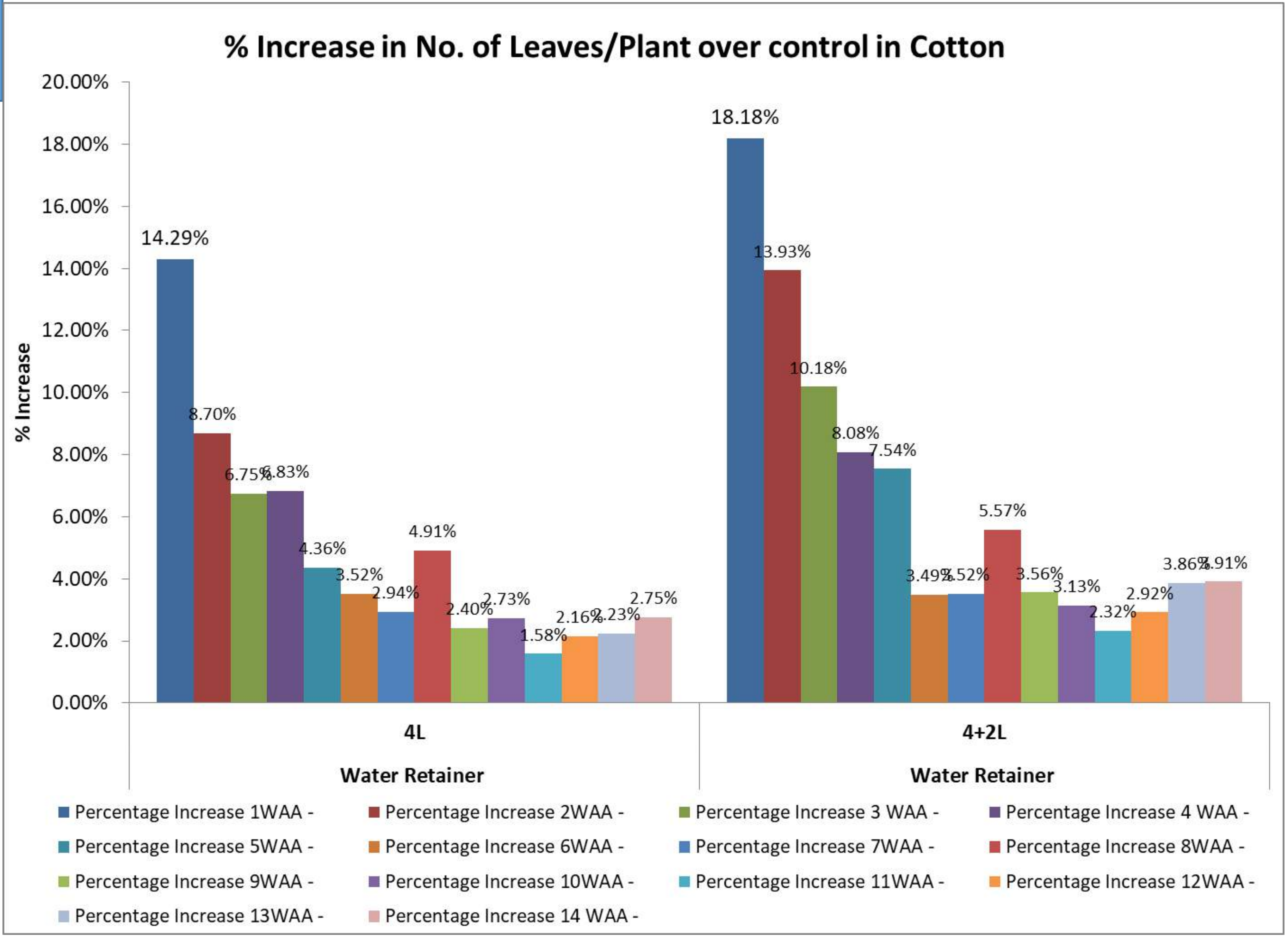
Trial –I
Bootywala, Multan
DOA:26-05-2017



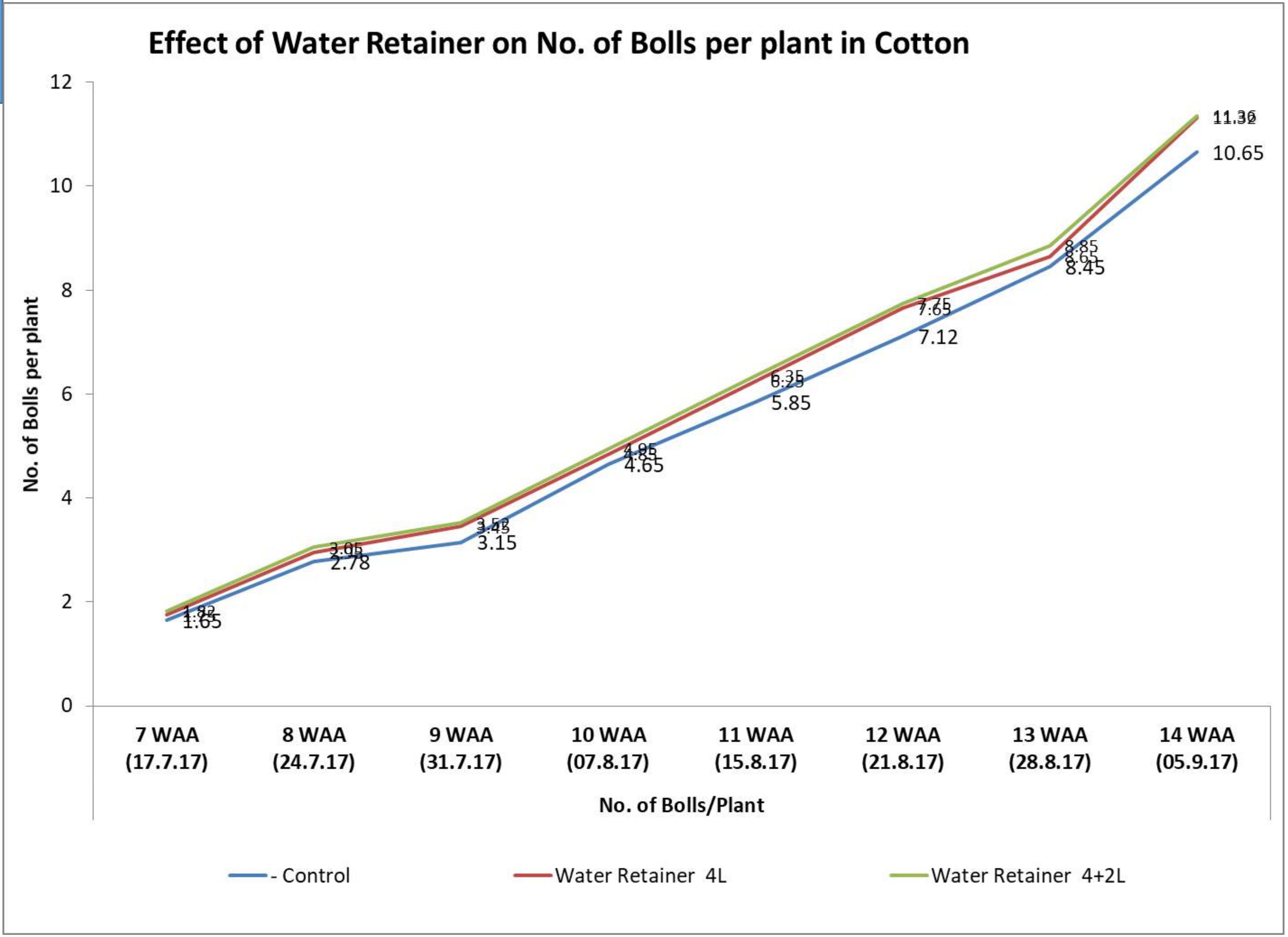
Trial –I
Bootywala, Multan
DOA:26-05-2017



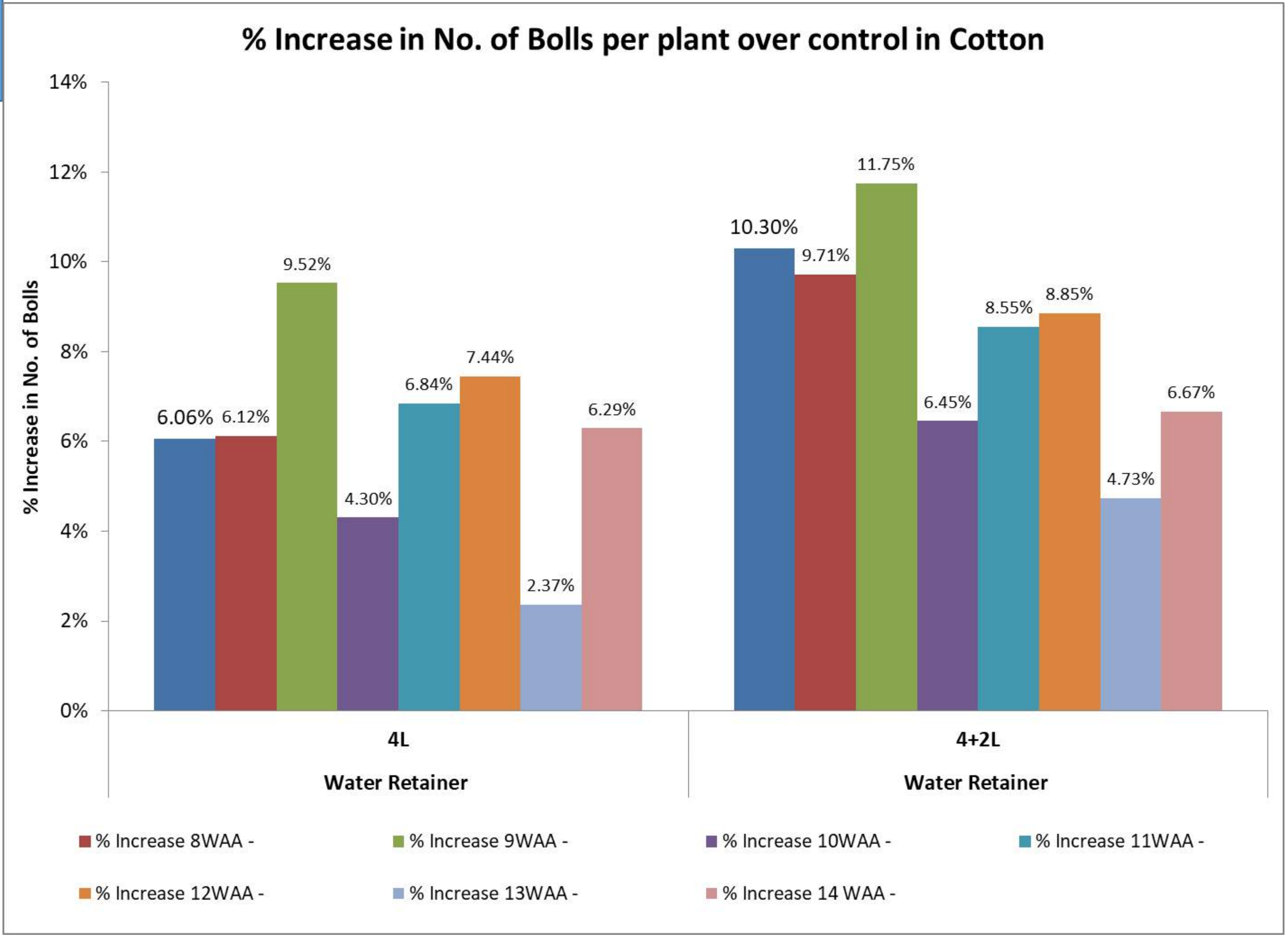
Trial –I
Bootywala, Multan
DOA:26-05-2017



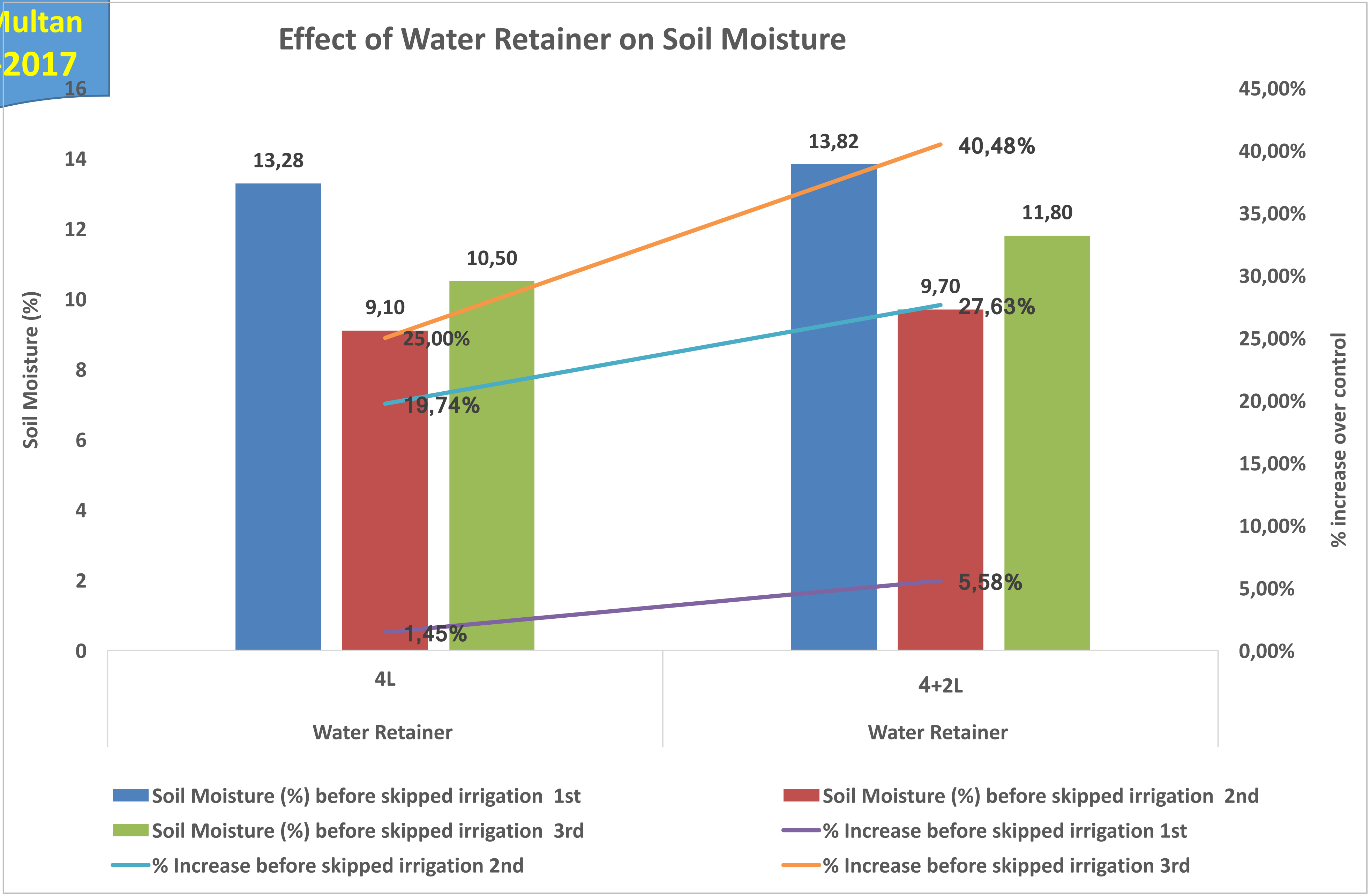
Trial –I
Bootywala, Multan
DOA:26-05-2017



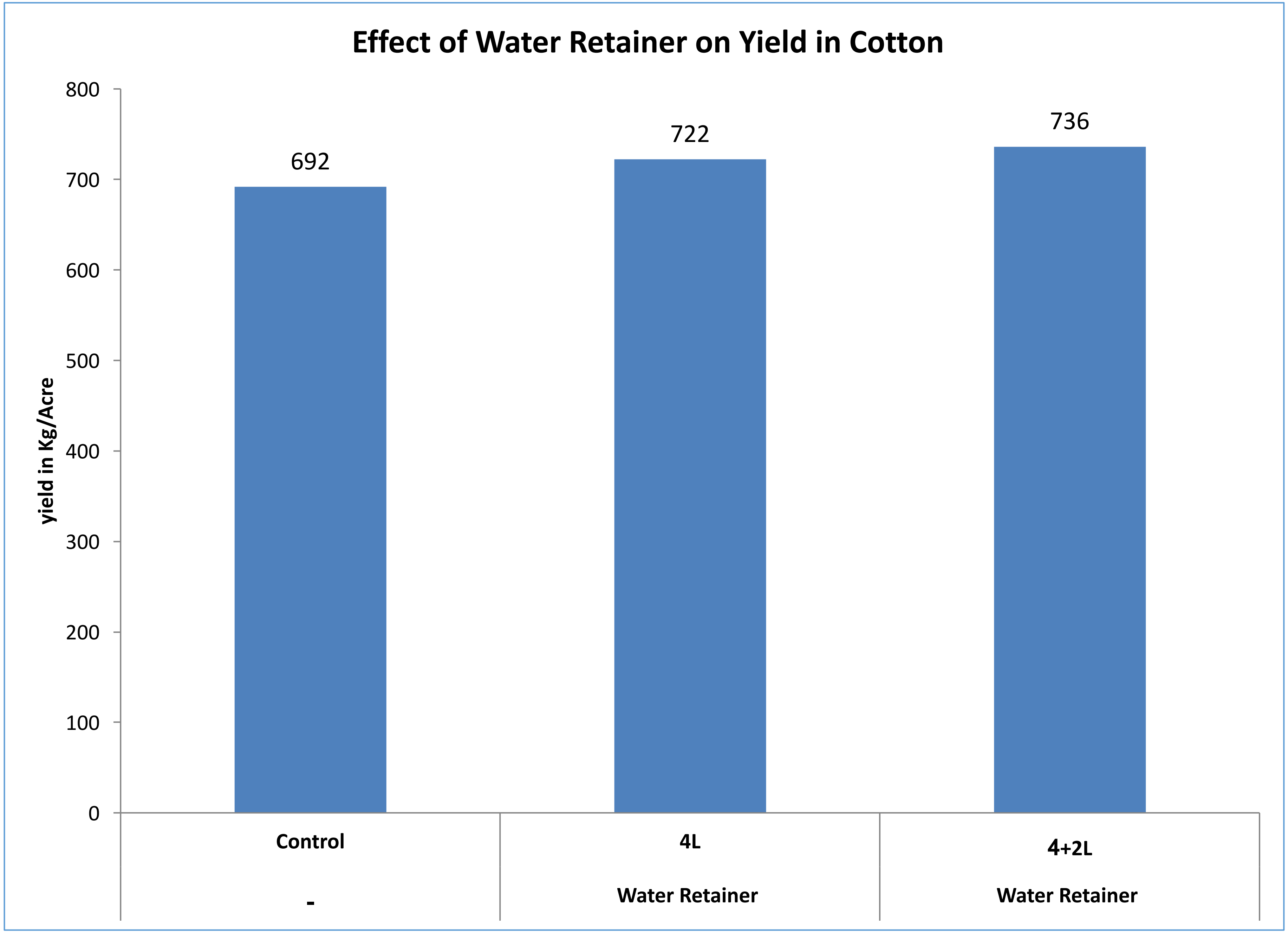
Trial –I
Bootywala, Multan
DOA:26-05-2017



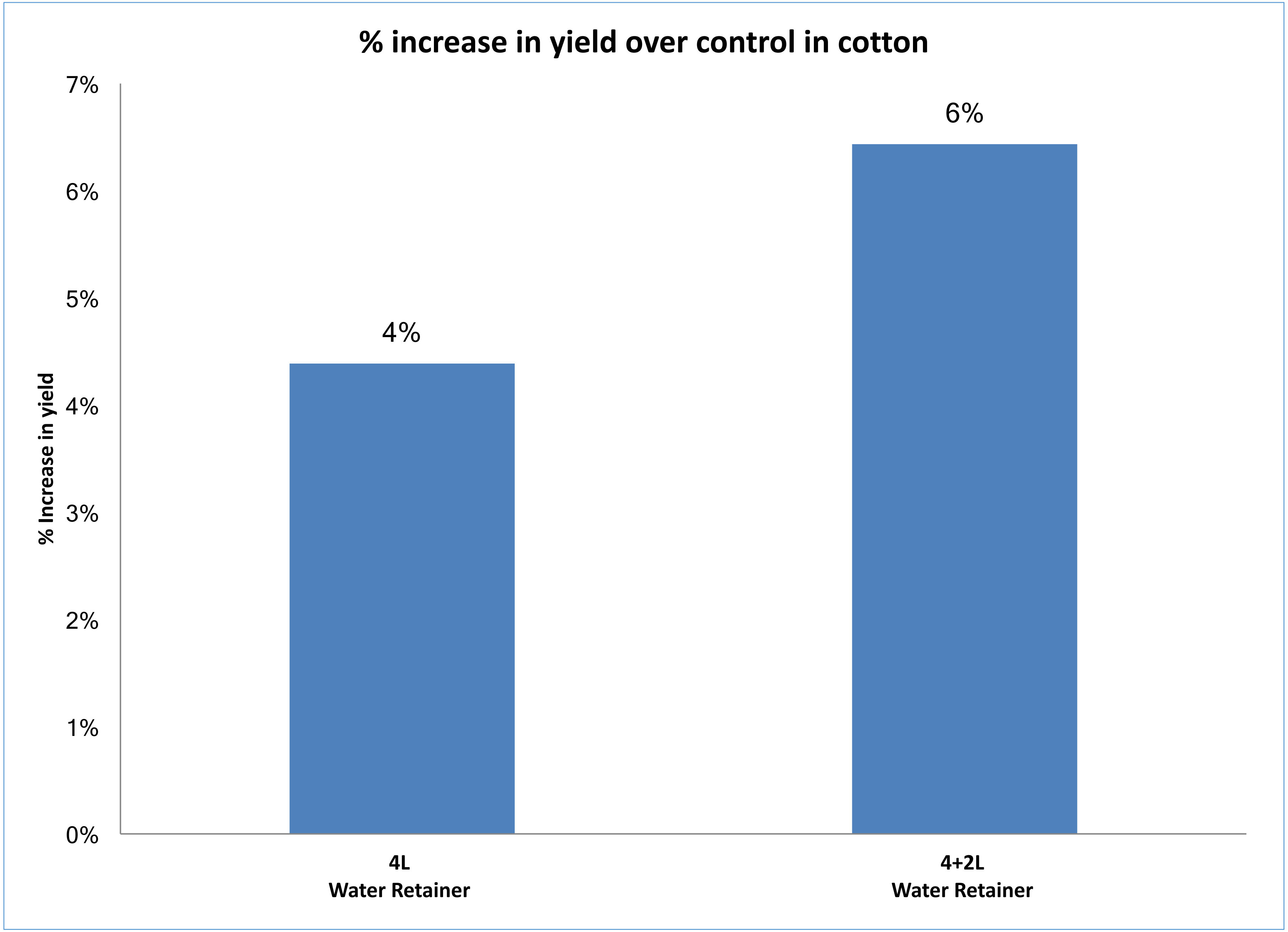
Trial –I
Bootywala, Multan
DOA:26-05-2017



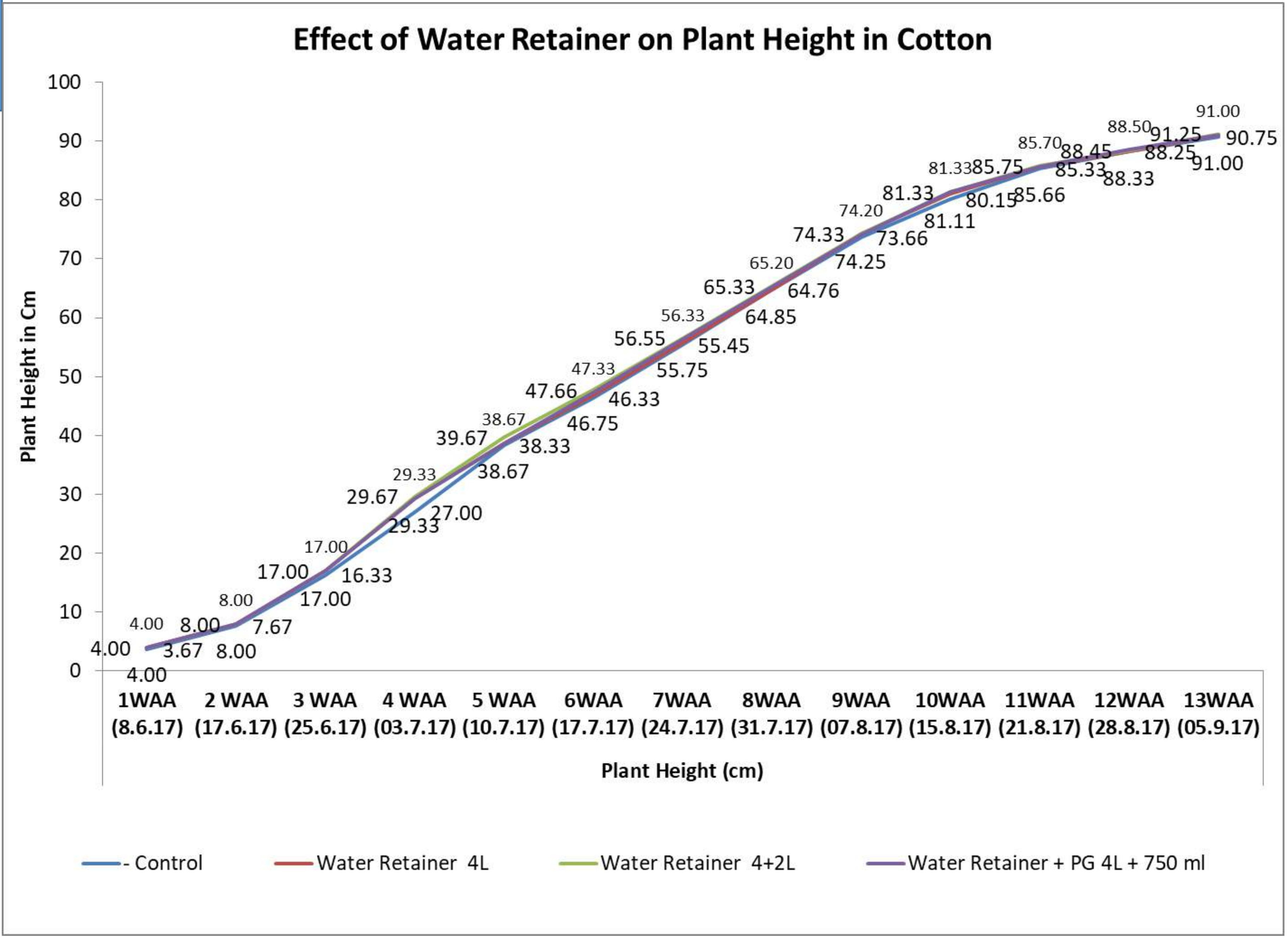
Trial –I
Bootywala, Multan
DOA:26-05-2017



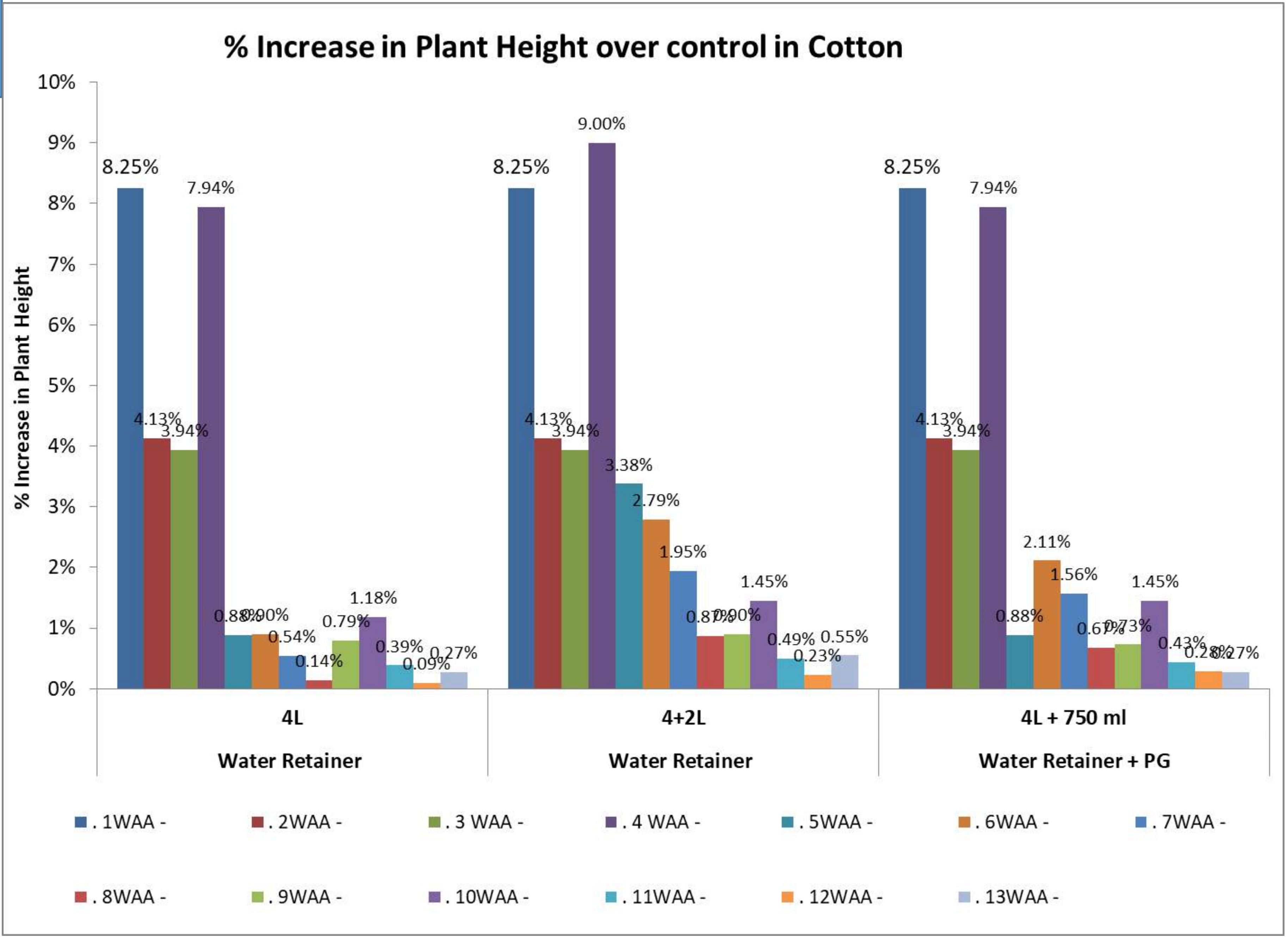
Trial –I
Bootywala, Multan
DOA:26-05-2017



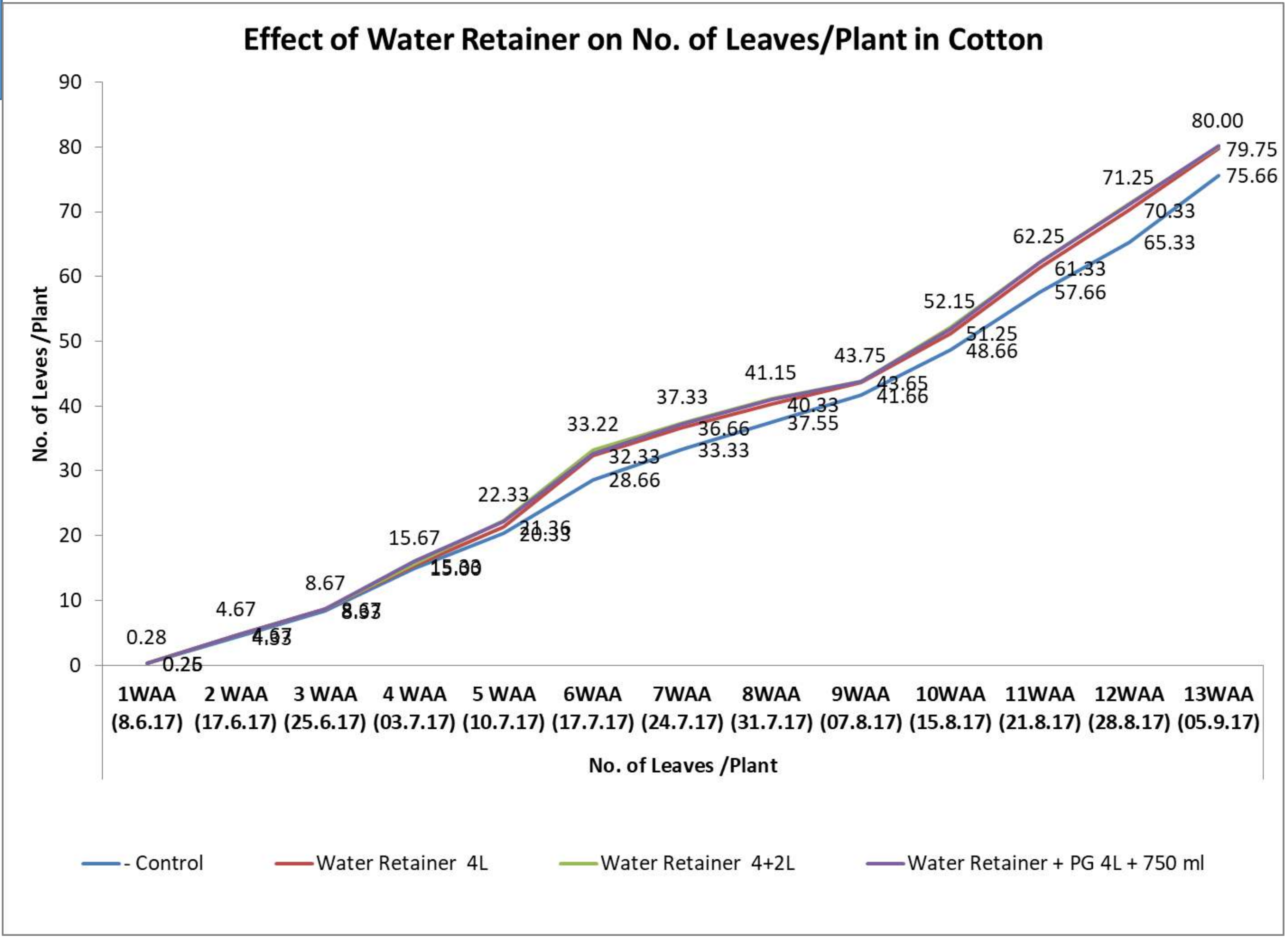
Trial –II
06 Tarpai, Multan
DOA:01-06-2017



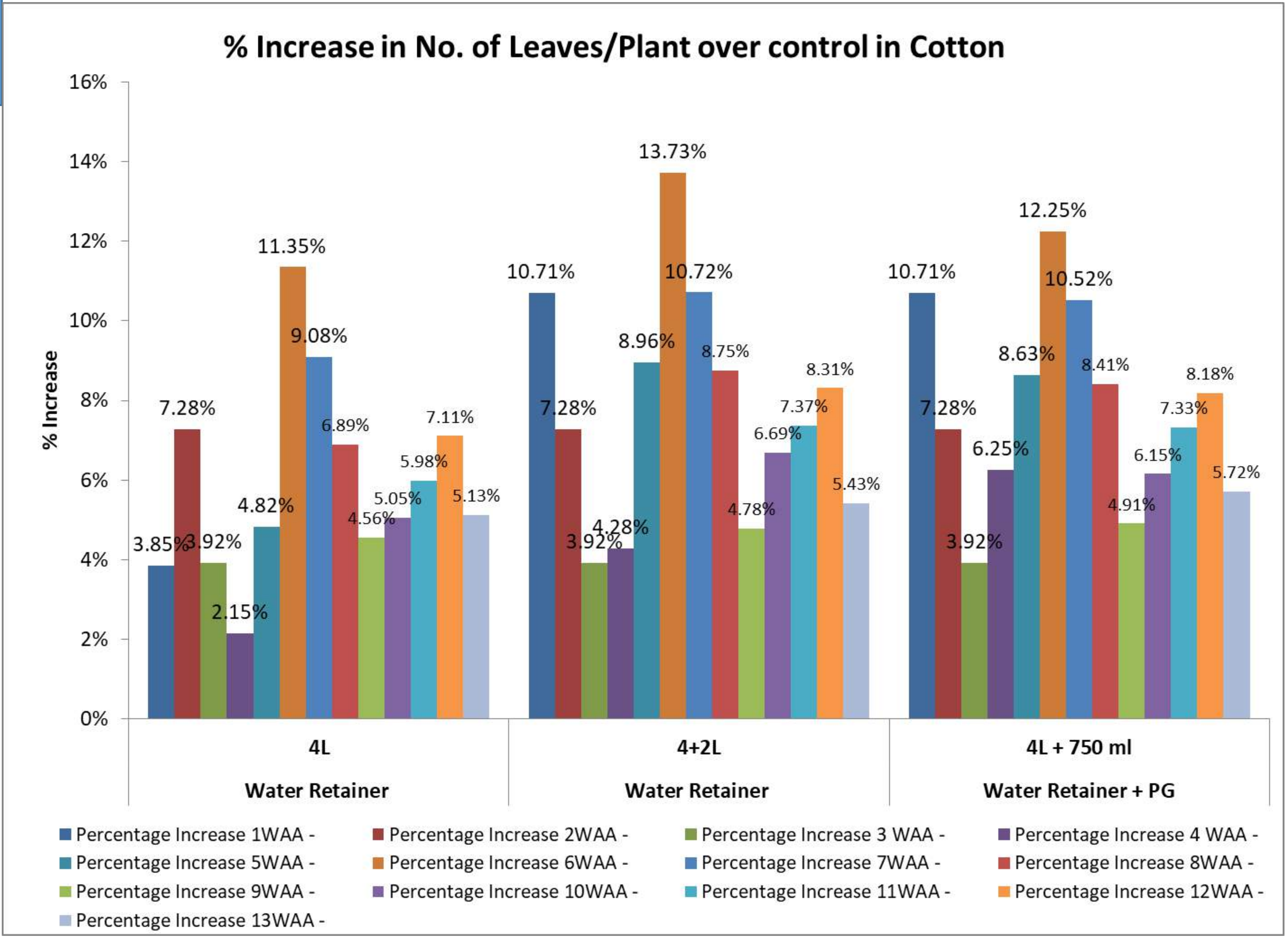
Trial –II
06 Tarpai, Multan
DOA:01-06-2017



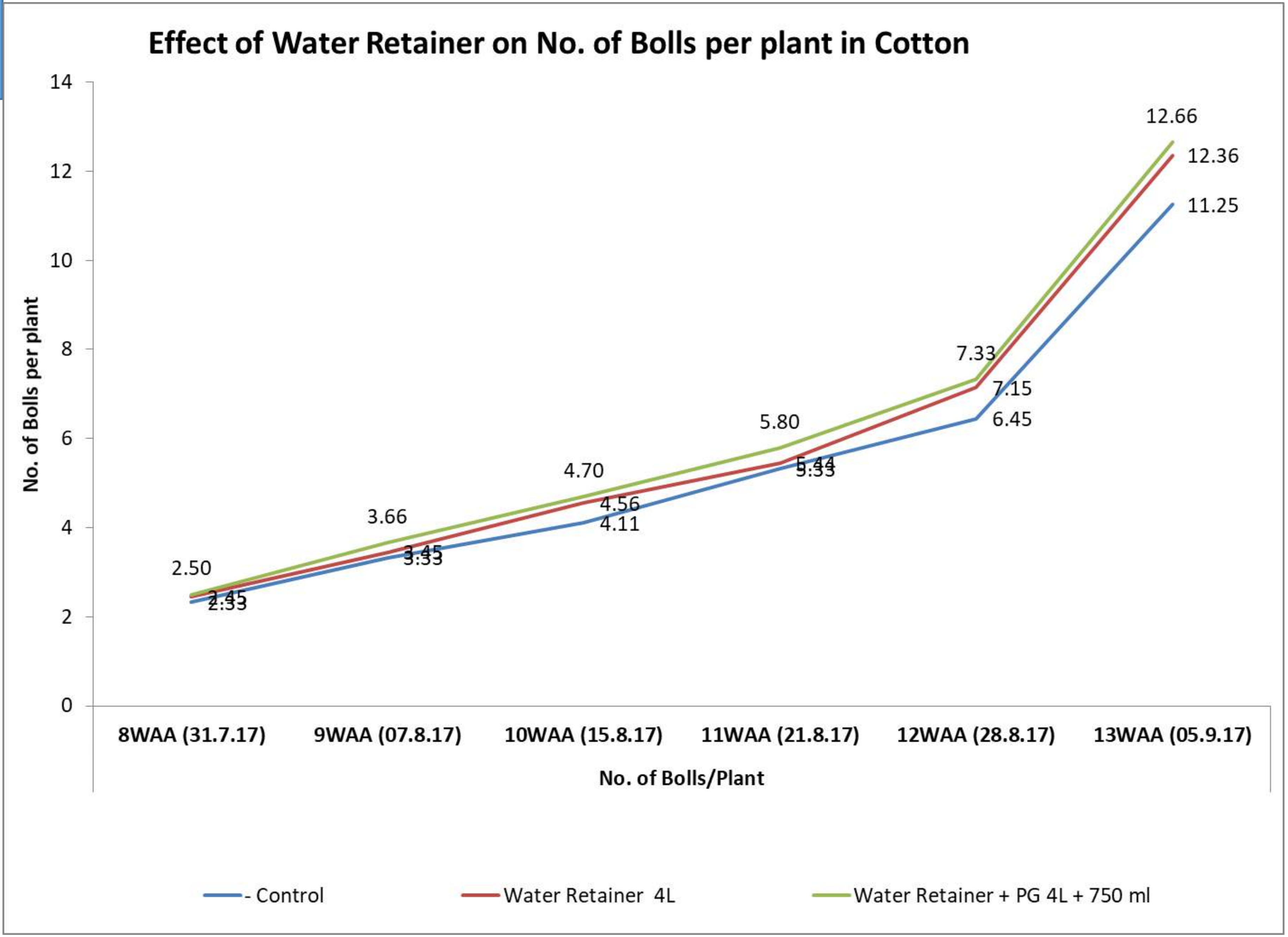
Trial –II
06 Tarpai, Multan
DOA:01-06-2017



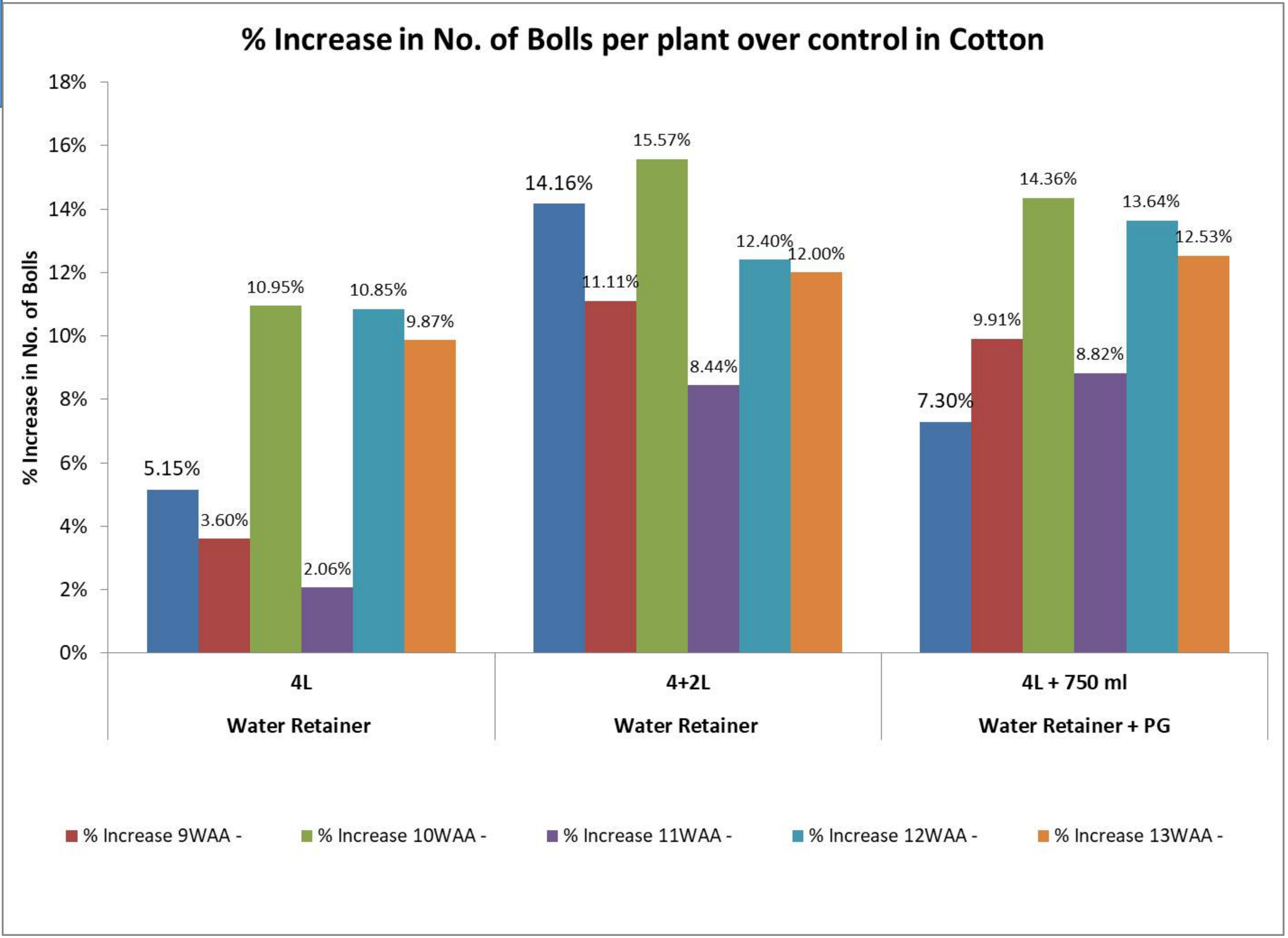
Trial –II
06 Tarpai, Multan
DOA:01-06-2017



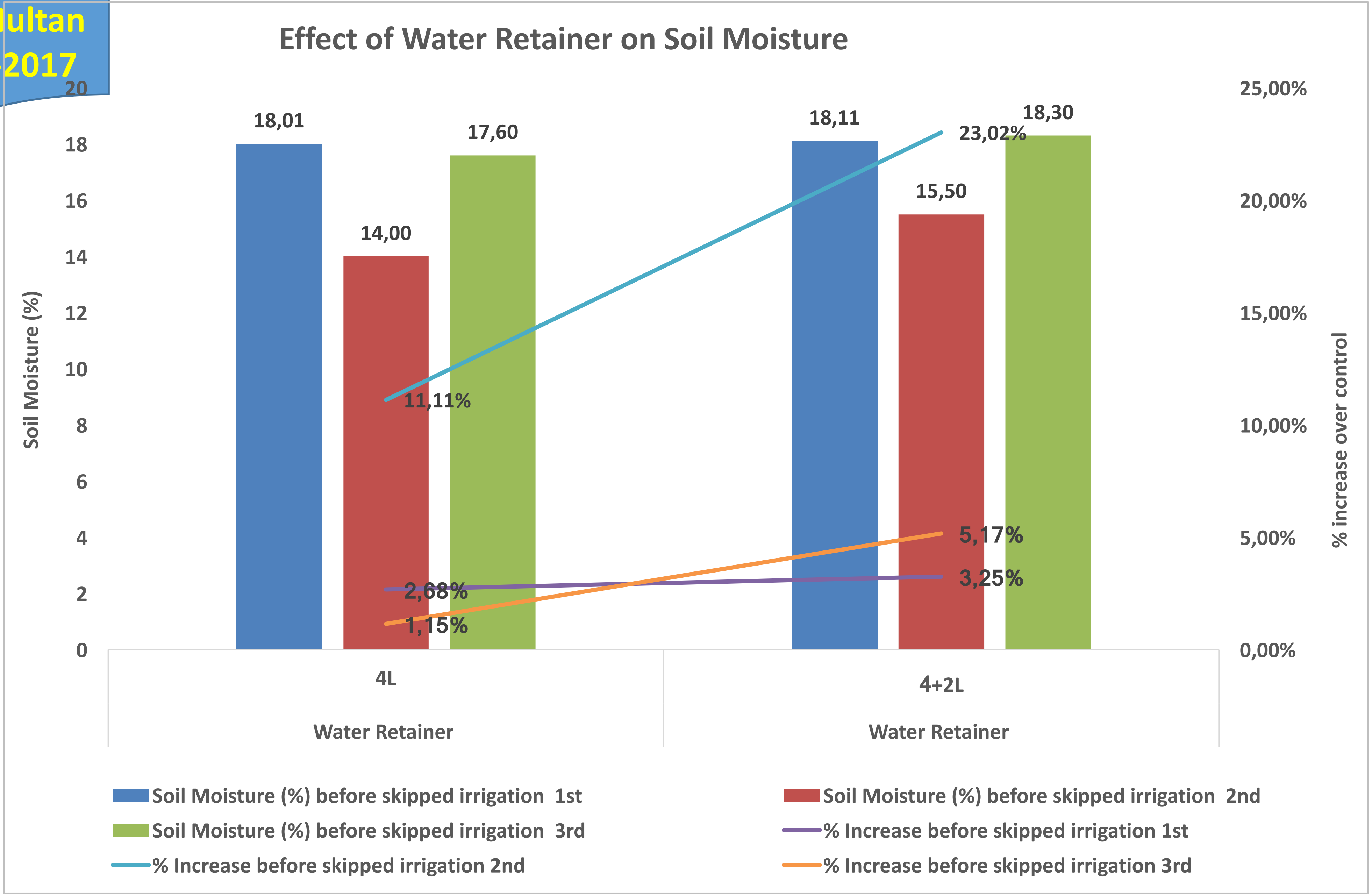
Trial –II
06 Tarpai, Multan
DOA:01-06-2017



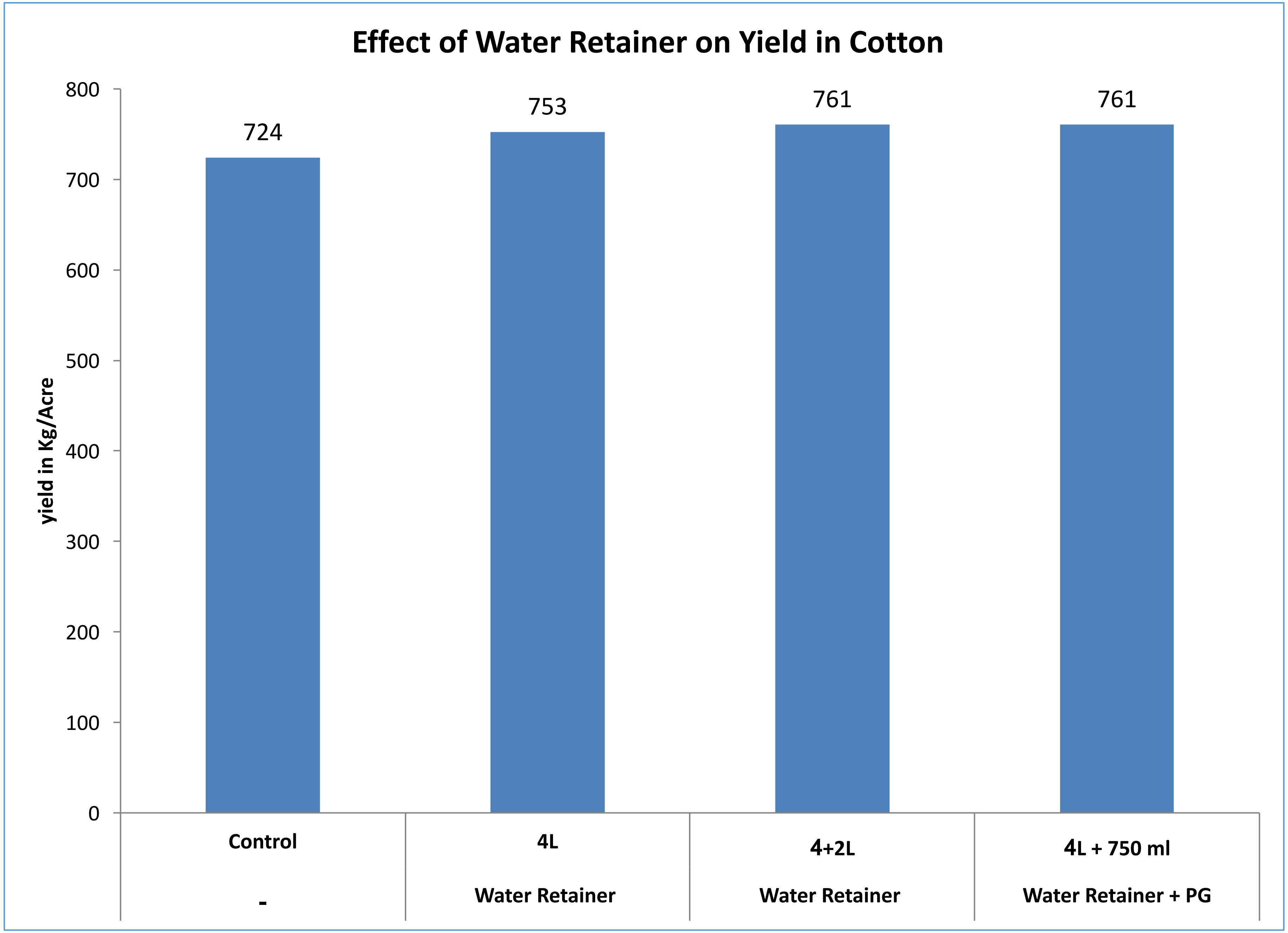
Trial –II
06 Tarpai, Multan
DOA:01-06-2017



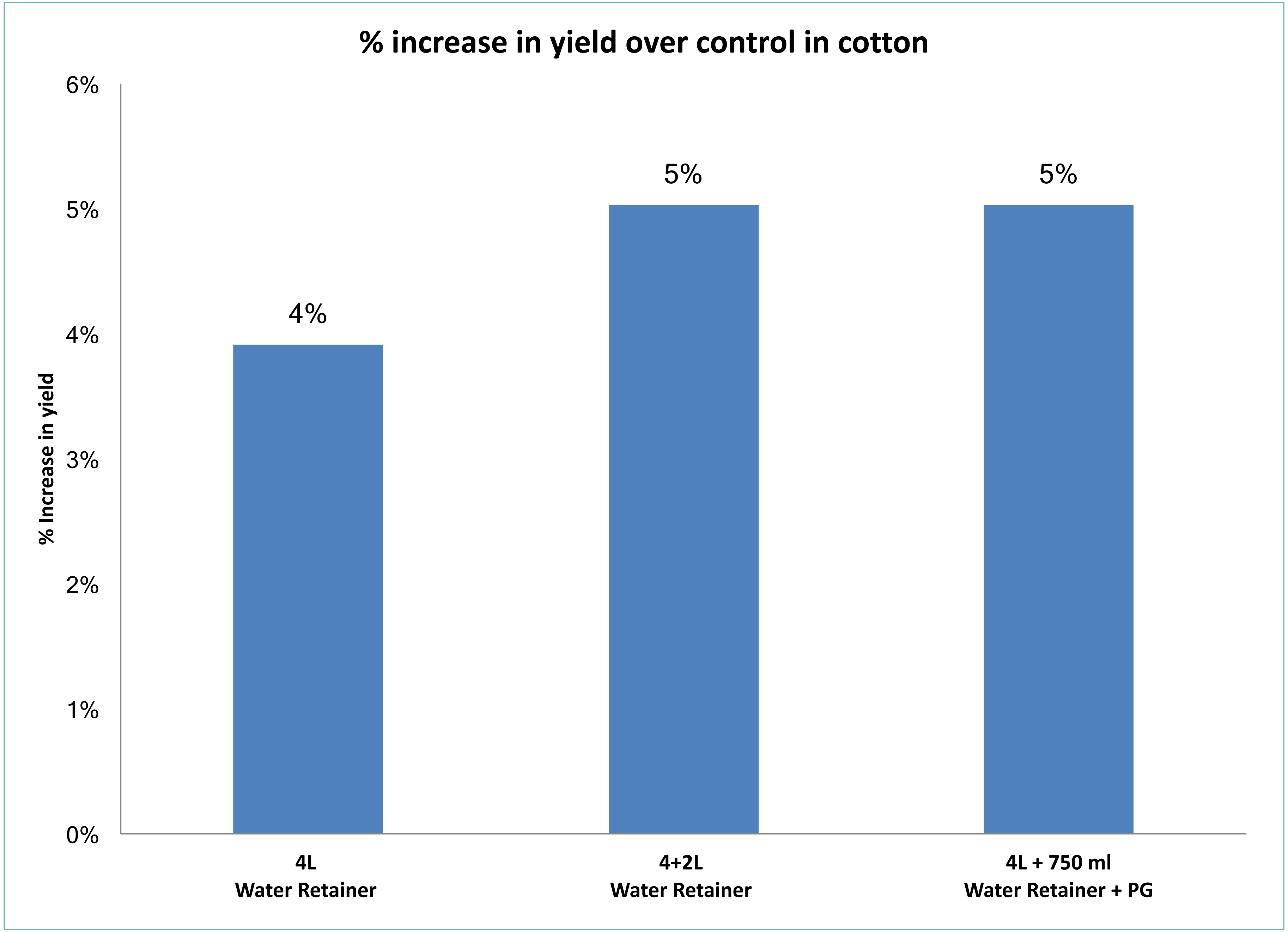
Trial –II
06 Tarpai, Multan
DOA:01-06-2017



Trial –II
06 Tarpai, Multan
DOA:01-06-2017



Trial –II
06 Tarpai, Multan
DOA:01-06-2017



Soil Moisture Contents Trial 1 (Gravimetric method)

Trial-I Date of sampling : 09.06.17	
Before 1st Skipped irrigation	
Treatments	Soil Moisture
T1 (Control)	13.09
T2 (WR @ 4 L)	13.28
T3 (WR @ 4+2L)	13.82

Trial-I Date of Sampling : 15.07.17	
Before 2nd Skipped irrigation	
Treatments	Soil Moisture
T1 (Control)	07.60
T2 (WR @ 4 L)	09.10
T3 (WR @ 4+2L)	09.70

Trial-I Date of Sampling : 10.08.17	
Before 3rd Skipped irrigation	
Treatments	Soil Moisture
T1 (Control)	08.40
T2 (WR @ 4 L)	10.50
T3 (WR @ 4+2L)	11.80

* WR : Water Retainer

Soil Moisture Contents Trial 2 (Gravimetric method)

Trial-II Date of Sampling 15.06.17	
Before 1st Skipped irrigation	
Treatments	Soil Moisture
T1 (Control)	17.54
T2 (WR @ 4 L)	18.01
T3 (WR @ 4+2L)	18.11

Trial-II Date of sampling : 05.07.17	
Before 2nd Skipped irrigation	
Treatments	Soil Moisture
T1 (Control)	12.60
T2 (WR @ 4 L)	14.00
T3 (WR @ 4+2L)	15.50

Trial-II Date of Sampling : 28.07.17	
Before 3rd Skipped irrigation	
Treatments	Soil Moisture
T1 (Control)	17.40
T2 (WR @ 4 L)	17.60
T3 (WR @ 4+2L)	18.30

* WR : Water Retainer

Pictures of activities……

Water Retainer Application

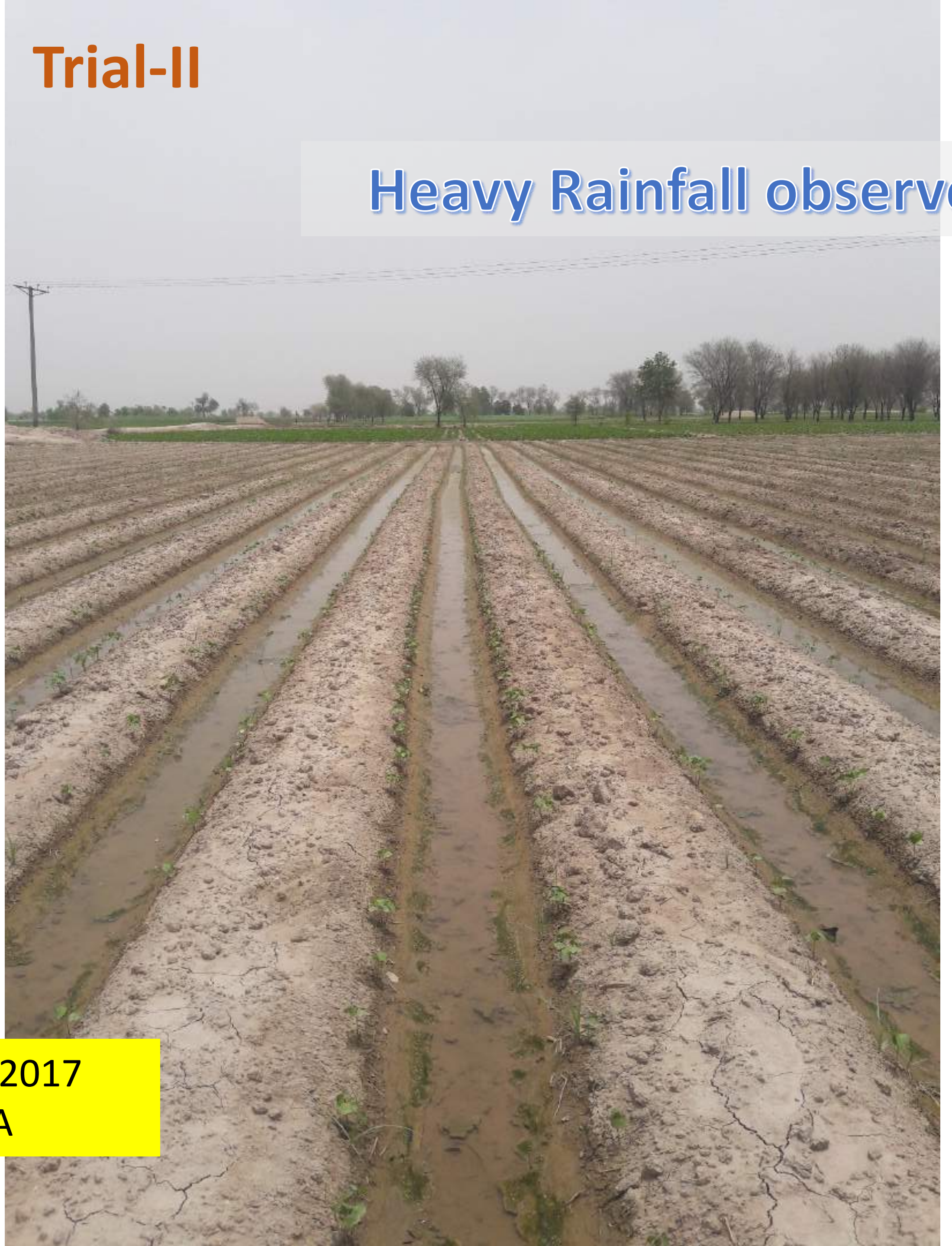
26-05-2017
0 DAA

08-06-2017
13 DAA

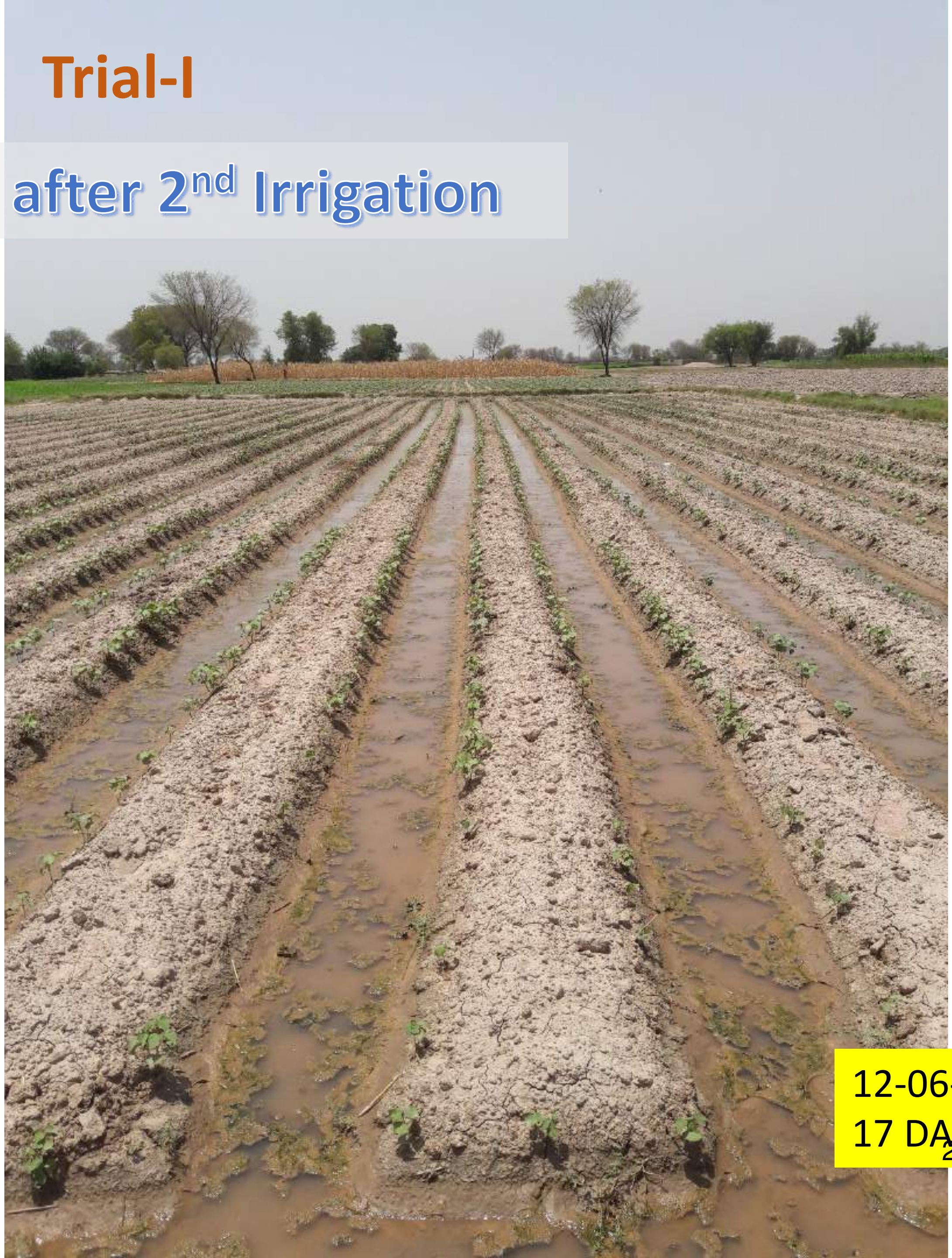
Trial-II


Water Retainer + Panida Grande
Water Retainer
Control
12-06-2017
12 DAA

Heavy Rainfall observed after 2nd Irrigation



17-06-2017
17 DAA



12-06-2017
17 DAA

T3 T2 T1 Trial-I

Trial-II

T4 T3 T2 T1

17-06-2017
3 WAA

Trial-I

T3

T2

T1

05-07-2017
5 WAA

Trial-II

T4	T3	T2	T1
			

05-07-2017
5 WAA

Trial-II

T4

T3

T2

T1

13-07-2017
6 WAA

Trial visit by JASPL Management Team(Mr. PLD, NJ2, AH, AM)

JAFFER

Observations completed

(Trial finished and reported)

Thanks

In order to investigate the effects of Water Retainer on Corn and Sugar Beet in drought stress condition, two separate Randomized Complete Block Design (RCBD) with 4 replications was carried out in Experimental Fields of Razi University, Kermanshah, Iran, under the supervision of Razi University by Dr. Mohsen Saidi, Associate Professor, Engineering of Product & Plant Genetics, Faculty of Agriculture and Natural Resources. Soil characteristics of field is in table 1 and meteorological data during cultivation season is mentioned in table 2.

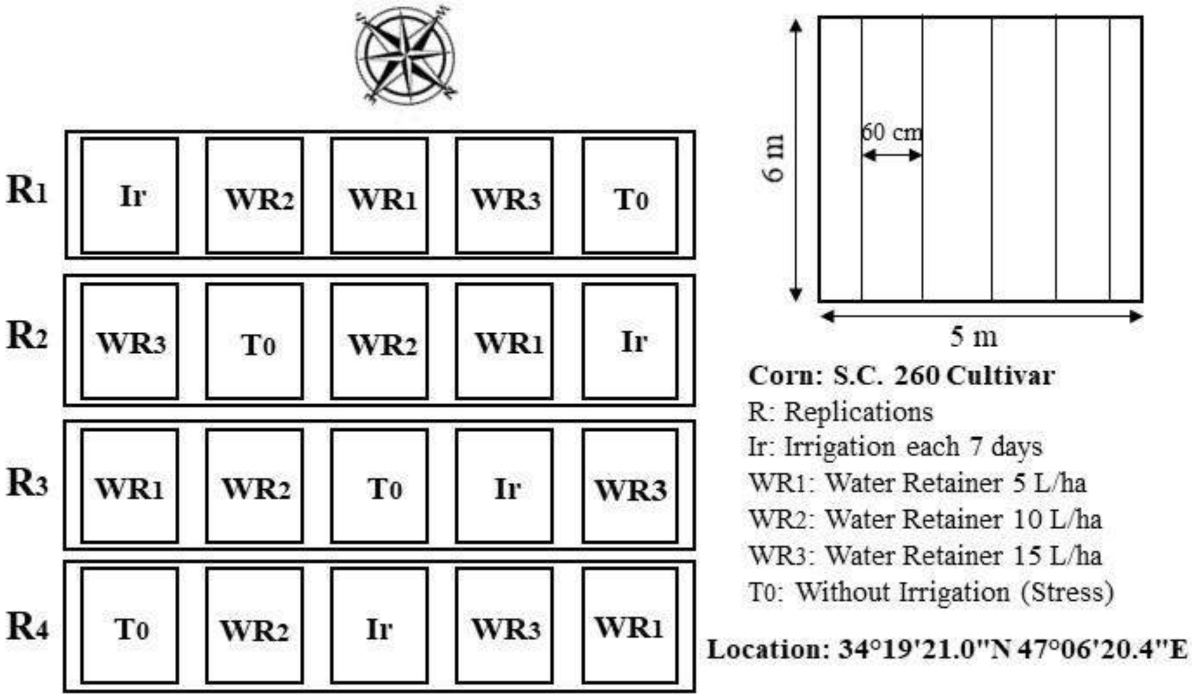
Table 1. Soil characteristics of this experiment

Sand (%)	Silt (%)	Clay (%)	Ca^{+2} (ppm)	Mg^{+2} (ppm)	Na^{+1} (ppm)	K^{+1} (ppm)	N (%)	Organic Matter (%)	Lime (%)	pH of Saturated Extract	ECe ($ds.m^{-1}$)
83	9	8	3.2	1.4	2.1	230	0.059	0.56	9	8	0.98

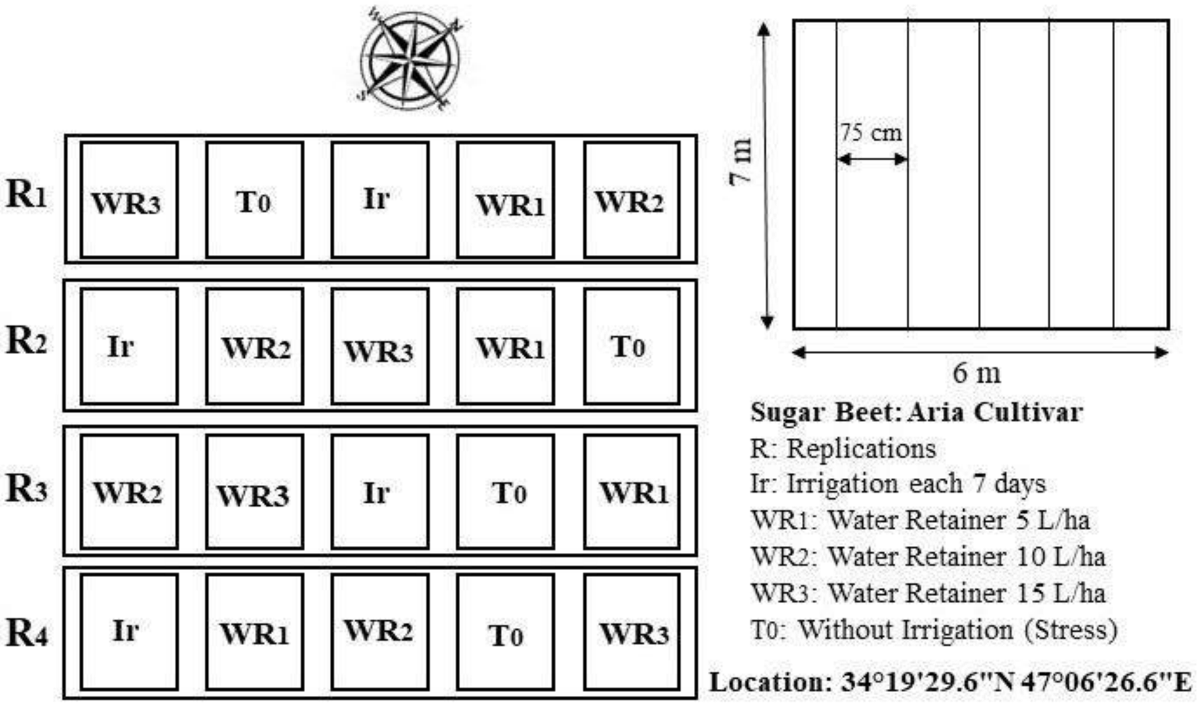
Table 2. Meteorological data during cultivation season

Month	Mean Precipitations (mm)	Mean Relative Humidity (%)	Mean Temperature (°C)
July	0.0	23.8	30.5
August	2.2	20.8	26.6
September	68.4	44.5	19.2

Corn was planted 3 July 2018 and Sugar Beat planted in 8 July 2018, also they harvested at 6 and 10 October 2018, respectively. Treatments was Control (irrigation each 7 days), Using Water Retainer in 5, 10 and 15 Lit/ha after emergence and drought stress as irrigation each 15 days after emergence. Plant design with details are in pic 1 for Corn and pic 2 for Sugar Beet.



Pic 1. Corn planting design



pic 2. Sugar Beet planting design

In order to investigate the effects of drought stress on plants, physiological traits including Relative Water Content (RWC), Proline and Chlorophyll index as major characteristics was recorded in 20 September 2018 as Second sampling date. Besides, Grain Yield of Corn and Root Yield as well as Sugar Yield of Sugar Beet was calculated after harvesting. Results of corn sampling and grain yield calculation are in Table 3.

Table 3. Mean comparison of RWC, Proline, Chlorophyll Index and Grain Yield in different Water Retainer treatments down to drought stress

Treatments	RWC (%)	Prolin ($\mu mol.g^{-1}$)	Chl Index	Grain Yield (t/ha)
Control	70.91 A	4.47 E	12.40 A	8.368 A
WR_1(5 lit/ha)	48.45 D	13.36 B	10.26 D	5.881 C
WR_2(10 lit/ha)	55.49 C	8.27 C	11.03 C	7.118 B
WR_3(15 lit/ha)	61.31 B	5.20 D	11.81 B	7.872 A
Water Stress	45.04 E	15.99 A	9.68 E	5.124 D
MSe	1.588	0.147	0.102	0.139
F Value	269.15	693.82	48.37	52.75
LSD Value	1.94	0.59	0.49	0.57

Figures in each columns with same letter have no significant difference

Effects of Water Retainer in second sampling again was exceptional in comparison with drought stress by considering to control. In order to show it better, the results are summed up in below diagrams.

Diagran 1. Effects of Water stress and Water Retainer treatments on Corn Physiological Characteristics

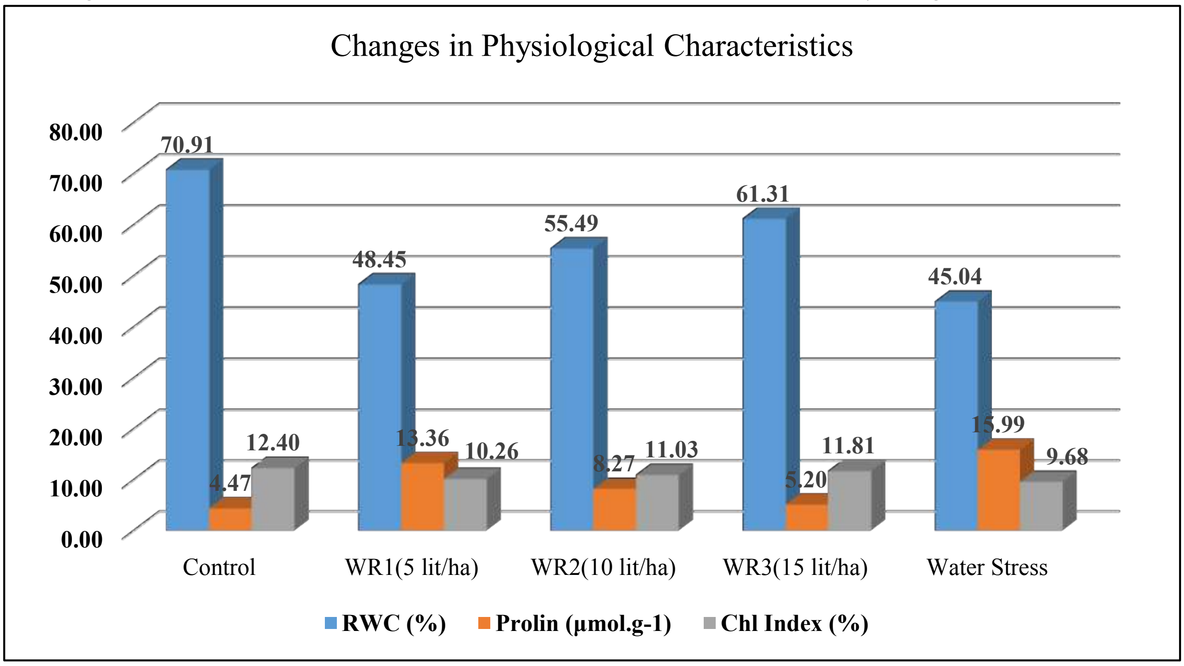
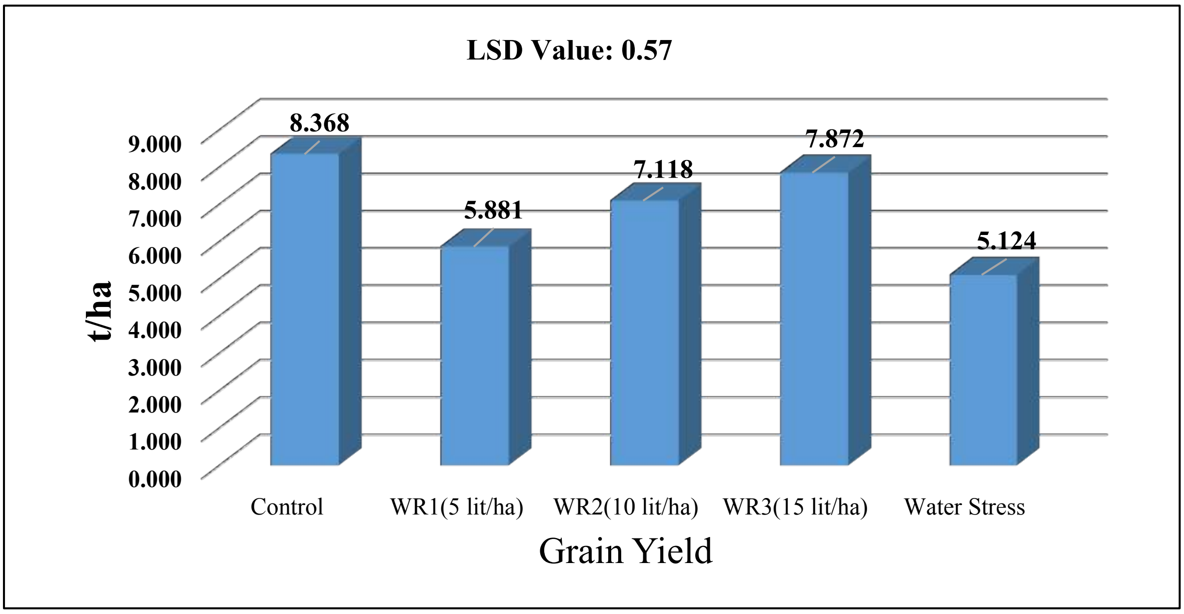


Diagram 2. Effects of Water stress and Water Retainer treatments on Corn grain Yield



Results of sugar beet sampling and Calculation root yield as well as sugar yield are mentioned in Table 3.

Table3. Mean comparison of RWC, Proline, Chlorophyll Index, Root Yield and Sugar Yield in different Water Retainer treatments down to drought stress

Treatments	RWC (%)	Proline (µmol.g^{-1})	Chl Index	Root Yield (t/ha)	Sugar Yield (t/ha)
Control	75.18 A	3.25 D	12.76 A	62.80 A	6.91 A
WR$_1$(5 lit/ha)	58.57 D	12.12 B	10.14 C	45.45 C	5.12 C
WR$_2$(10 lit/ha)	63.63 C	5.60 C	11.32 B	58.25 B	6.39 B
WR$_3$(15 lit/ha)	70.36 B	3.77 D	12.22 A	61.58 A	6.74 A
Water Stress	51.97 E	14.66 A	9.61 C	37.35 D	4.16 D
MSe	4.088	0.089	0.134	2.343	0.014
F Value	83.11	1212.01	53.00	213.02	395.01
LSD Value	3.11	0.45	0.56	2.35	0.18

Figures in each columns with same letter have no significant difference

As it was expected, Water Retainer had superb effects in controlling water reservoirs and provided it for sugar beet using. These results are showed in below diagrams.

Diagran 3. Effects of Water stress and Water Retainer treatments on Sugar Beet Physiological Characteristics

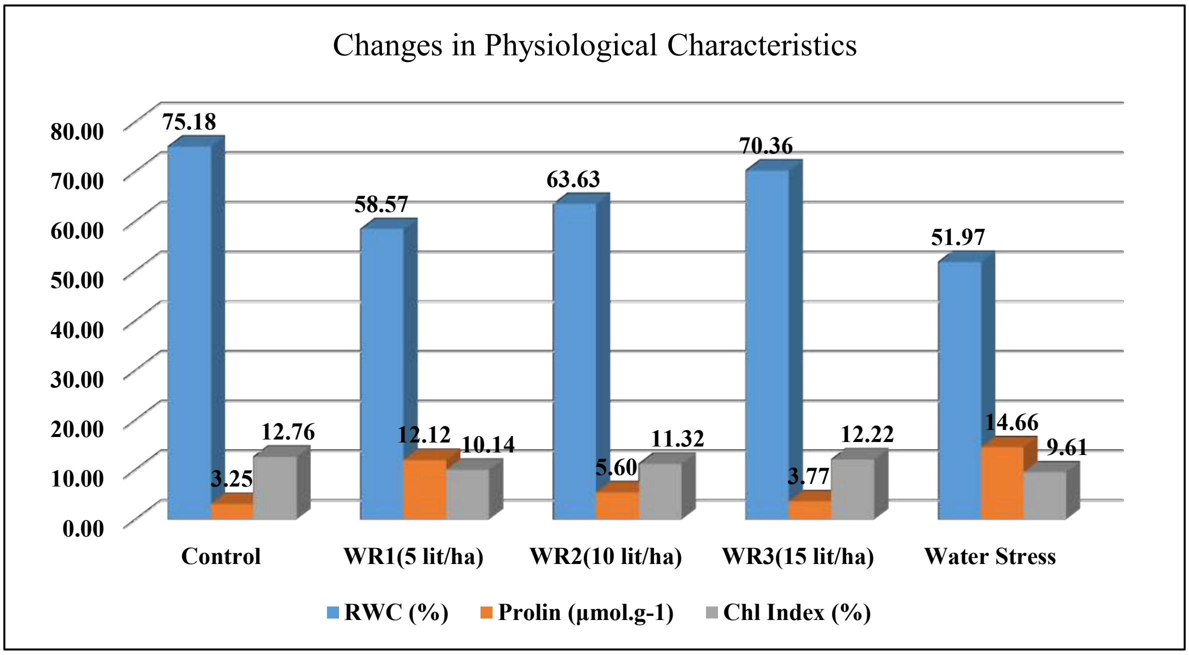
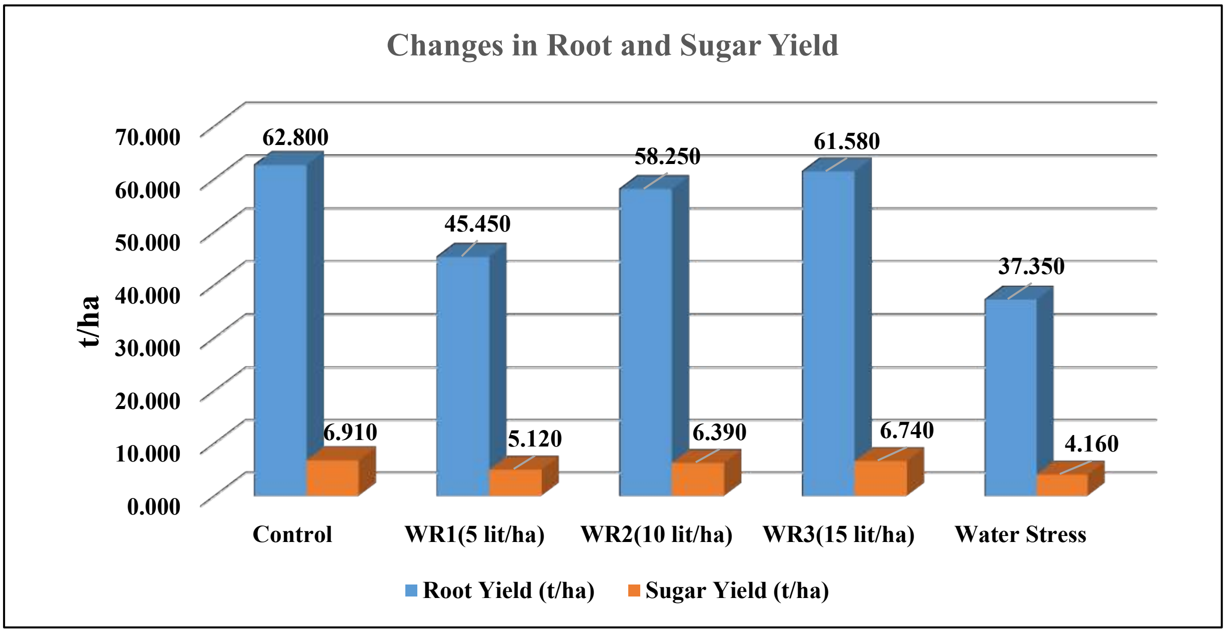


Diagram 4. Effects of Water stress and Water Retainer treatments on Sugar Beet Root Yield and Sugar Yield



Conclusion

Water scarcity and water stress as its subsequent is a vital issue in worldwide especially in Iran. Iran with about 80 m population is placed in semi-arid region and protecting water reservoirs is really crucial because it has a direct role in agriculture and feeding people. By results which observed in this experiment, our research team is strongly advise farmers and anyone who engaged with agriculture to use Water Retainer in cropping systems. As it revealed, using Water Retainer can protect crops (Corn and Sugar Beet in this experiment) against water stress negative effects. The final yield of corn and sugar beet in 15 lit/ha of Water Retainer treatment showed no significant difference with control condition. On the other hand, water stress without Water Retainer treatments sharply decreased corn and sugar beet yield.

It's highly recommended to use 15 lit/ha Water Retainer with cropping system in West of Iran.

Pezhman Allahmoradi
Manager of Pak Rost Neshan® Company

پاک رست نشان
(سهامی خاص) - ۱۹۲۹۸

Mohsen Saidi
Associate Professor, Engineering of Product & Plant Genetics
Faculty of Agriculture and Natural Resources
Razi University, Kermanshah, Iran

To whom it may concern:

Consumption of irrigation water in Corn and Sugar Beet during Water Retainer Test:

Corn	
Treatments	**Water Volume (m^3)**
Control	**10,200**
WR_1, WR_2 and WR_3	**5,950**
Sugar Beet	
Control	**11,400**
WR_1, WR_2 and WR_3	**6,650**

Pezhman Allahmoradi
Manager of Pak Rost Neshan® Company

پاک رست نشان
(سهامی خاص) ۱۹۲۹۸

NATIONAL AGRICULTURAL
RESEARCH AND INNOVATION CENTRE
2100 Gödöllő, Szent-Györgyi Albert u.4.

Mail address: 2100 Gödöllő, p. code 411
Phone: +36 28 526-100
Fax: +36 28 526-101
Web: http://www.naik.hu

NAIK ZÖKO Research Station of Szeged

In 2017 NAIK ZÖKO Research Station of Szeged and Water&Soil set up an experiment in spicy pepper production in the field of the Research Station of Szeged (land register reference: 01357/1), on an area of half a hectare (5000 m2), where there were 2500 m2 treated and 2500 m2 untreated (control) parcels, in extensive circumstances.
On the treated area we used the product of Water&Soil, the water retainer in the required dose. The aim of the experiment is to examine the difference between the treated and untreated areas concerning the height of the plants, the number of fruit sets and the total amount of crop.
Description of the experiment**:**

- Variety of spicy pepper: Szeged – 80
- Producing seedlings: we used the seed of NAIK ZÖKO Research Station of Szeged and we grew traditional rotten root seedlings under unheated plastic tunnel.
- Time of sowing: 30 March
- Time of planting in the field: 24-25 May
- First treatment: 30 June; dose: 1ml/m2
  Application was made with knapsack sprayers passing between the rows making sure that the substance does not reach the surface of the plants.
- First data collection: 20 July
  We measured the height of and counted the fruit sets on the plants in the treated and untreated parcels.
- Second treatment: 27 July, 0.5 ml/m2
- Application was made with knapsack sprayers passing between the rows making sure that the substance does not reach the surface of the plants.
- Second data collection: 3 August
  We measured the height of and counted the fruit sets on the plants in the treated and untreated parcels.
- Third data collection: 30 August.
  We measured the height of and counted the fruit sets on the plants in the treated and untreated parcels.
  (The measured data are shown in the table below.)

The spicy pepper crop was harvested on 28 and 29 of September in the traditional way, selecting the peppers by hand into raschell bags, separating the crop from the treated and untreated area. After picking the peppers were taken to be prepared for sale, where they were measured by the quintal. On the treated parcel 13.7 q (quintal) raw spicy peppers were harvested, whereas on the untreated area it was 11.3 q.
We can definitely confirm that the difference between the parcels can be attributed to the application of the substance 'Water Retainer' produced by Water&Soil. An additional repeated experiment could be useful to get more profound knowledge about the product.

Róbert Bráj
research station manager
NAIK ZÖKO Szeged

(the seal of the institute)

Source: htp:/www.ksh.hu/docs/Hun/xstadat/xstadat_evkozi/e_met008.html

5.8. Meteorological data of the Szeged monitoring station

Month	Average	Maximum	Minimum	Precipitation, mm	Number of sunshine hours
	temperature, ^{o}C				
2017 Jan	-5.2	4.7	-18.3	15	123
Feb	2.9	20.1	-6.7	18	99
March	9.5	24.3	-2.2	15	217
Apr	10.9	24.7	-0.2	39	208
May	17.2	32.0	2.6	35	313
June	22.2	34.5	9.5	94	329
July	23.3	36.9	11.0	34	384
Aug	24.1	39.3	8.4	17	347
Sep	17.0	34.4	5.1	51	202
Oct	12.0	25.6	1.7	34	213
Nov	6.5	15.7	-3.7	39	112
Dec	2.9	13.9	-7.0	47	107
Jan-Dec	11.9	39.3	-18.3	438	2645

Data Collection 1

Place of data collection: NAIK ZÖKO 6728 Szeged, Külterület 7.
Date of data collection: 20 July 2017
Plant variety: Szeged 80 spicy pepper
Date of treatment: 30 June 2017
Dose: 1 ml/m2
Area:
Treated: 2500 m2
Untreated: 2500 m2

Description of data	Treated	Untreated	
Height of the plant	38	33	1
	37	31	2
	38	36	3
	43	39	4
	42	39	5
	48	39	6
	46	38	7
	46	40	8
	43	38	9
	44	43	10
	44	41	11
	38	35	12
	45	40	13
	47	38	14
	44	40	15
	39	39	16
	42	39	17
	42	40	18
	41	40	19
	41	39	20
	40	40	21
	42	35	22
	48	36	23
	43	40	24
	44	42	25
Average	42.6	38.4	
treated/untreated %	110.94%		

Data Collection 1

Place of data collection: NAIK ZÖKO 6728 Szeged, Külterület 7.
Date of data collection: 20 July 2017
Plant variety: Szeged 80 spicy pepper
Date of treatment: 30 June 2017
Dose: 1 ml/m2
Area:
Treated: 2500 m2
Untreated: 2500 m2

Description of data	Treated	Untreated	
Number of fruit sets	10	11	1
	10	11	2
	15	13	3
	8	13	4
	12	12	5
	14	13	6
	16	12	7
	16	17	8
	12	13	9
	17	19	10
	18	10	11
	14	10	12
	16	12	13
	15	8	14
	16	12	15
	12	14	16
	18	11	17
	16	13	18
	19	15	19
	16	12	20
	20	14	21
	17	12	22
	18	13	23
	15	15	24
	16	12	25
Average	15.04	12.68	
treated/untreated %	118.61%		

General Data Collection Sheet

Place of data collection:	Szeged, Külterület 7.
Date of data collection:	20 July 2017
Plant variety:	Szeged 80 spicy pepper
Date of treatment:	30 June 2017
Dose:	1 ml/m2

(table filled in by hand)

Description of data	**Treated**	**Untreated**	
Height of the plant	**38**	**33**	**1**
	37	**31**	2
	38	**36**	3
	43	**39**	4
	42	**39**	5
	48	**39**	6
	46	**38**	7
	46	**40**	8
	43	**38**	9
	44	**43**	10
	44	**41**	11
	38	**35**	12
	45	**40**	13
	47	**38**	14
	44	**40**	15
	39	**39**	16
	42	**39**	17
	42	**40**	18
	41	**40**	19
	41	**39**	20
	40	**40**	21
	42	**35**	22
	48	**36**	23
	43	**40**	24
	44	**42**	25
Average			
treated/untreated %			

(hand-written:)
People recording data: Róbert Braj
Richárd Vattay

Sample selection method:

10-15 21-25

6-10

1-5 16-20

General Data Collection Sheet

Place of data collection: Szeged, Külterület 7.
Date of data collection: 20 July 2017
Plant variety: Szeged 80 spicy pepper
Date of treatment: 30 June 2017
Dose: 1 ml/m2
(table filled in by hand)

Description of data	Treated	Untreated	
Number of fruit sets	**10**	**11**	**1**
	10	**11**	2
	15	**13**	3
	8	**13**	4
	12	**12**	5
	14	**13**	6
	16	**12**	7
	16	**17**	8
	12	**13**	9
	17	**19**	10
	18	**10**	11
	14	**10**	12
	16	**12**	13
	15	**8**	14
	16	**12**	15
	12	**14**	16
	18	**11**	17
	16	**13**	18
	19	**15**	19
	16	**12**	20
	20	**14**	21
	17	**12**	22
	18	**13**	23
	15	**15**	24
	16	**12**	25
Average	**15.04**	**12.68**	
treated/untreated %	**118.61%**		

Sample selection method:

10-15		21-25
	6-10	
1-5		16-20

Data Collection 2

Place of data collection:	NAIK ZÖKO 6728 Szeged, Külterület 7.
Date of data collection:	3 August 2017
Plant variety:	Szeged 80 spicy pepper
Date of treatment:	27 July 2017
Dose:	0.5 ml/m2
Area:	
Treated:	2500 m2
Untreated:	2500 m2

Description of data	**Treated**	**Untreated**	
Height of the plant	**38**	**35**	**1**
	36	**33**	2
	37	**37**	3
	38	**36**	4
	43	**38**	5
	40	**40**	6
	45	**39**	7
	46	**42**	8
	47	**39**	9
	39	**40**	10
	39	**40**	11
	46	**38**	12
	45	**43**	13
	44	**39**	14
	44	**41**	15
	38	**37**	16
	46	**44**	17
	40	**40**	18
	42	**39**	19
	40	**38**	20
	41	**35**	21
	44	**39**	22
	47	**41**	23
	43	**40**	24
	43	**41**	25
Average	**42.04**	**38.96**	
treated/untreated %	**107.91%**		

Data Collection 2

Place of data collection: NAIK ZÖKO 6728 Szeged, Külterület 7.
Date of data collection: 3 August 2017
Plant variety: Szeged 80 spicy pepper
Date of treatment: 27 July 2017
Dose: 0.5 ml/m2
Area:
Treated: 2500 m2
Untreated: 2500 m2

Description of data	Treated	Untreated	
Number of fruit sets	12	12	1
	14	13	2
	14	12	3
	10	11	4
	15	13	5
	14	13	6
	17	14	7
	15	16	8
	13	12	9
	19	16	10
	20	15	11
	15	14	12
	15	13	13
	17	14	14
	14	12	15
	15	13	16
	18	15	17
	15	16	18
	18	14	19
	18	16	20
	20	15	21
	17	14	22
	16	14	23
	19	16	24
	16	14	25
Average	15.84	13.88	
treated/untreated %	114.12%		

Data Collection 3

Place of data collection:	NAIK ZÖKO 6728 Szeged, Külterület 7.
Date of data collection:	30 August 2017
Plant variety:	Szeged 80 spicy pepper
Date of treatment:	27 July 2017
Dose:	0.5 ml/m2
Area:	
Treated:	2500 m2
Untreated:	2500 m2

Description of data	Treated	Untreated	
Height of the plant	**40**	**39**	**1**
	39	**38**	2
	37	**40**	3
	42	**39**	4
	44	**41**	5
	42	**38**	6
	45	**41**	7
	48	**40**	8
	44	**42**	9
	45	**42**	10
	49	**44**	11
	44	**41**	12
	48	**43**	13
	46	**40**	14
	45	**42**	15
	40	**40**	16
	47	**43**	17
	43	**42**	18
	44	**39**	19
	46	**38**	20
	49	**37**	21
	43	**39**	22
	45	**40**	23
	43	**38**	24
	39	**41**	25
Average	**43.88**	**40.28**	
treated/untreated %	**108.94%**		

Data Collection 3

Place of data collection:	NAIK ZÖKO 6728 Szeged, Külterület 7.
Date of data collection:	30 August 2017
Plant variety:	Szeged 80 spicy pepper
Date of treatment:	27 July 2017
Dose:	0.5 ml/m2
Area:	
Treated:	2500 m2
Untreated:	2500 m2

Description of data	**Treated**	**Untreated**	
Number of fruit sets	**14**	**11**	**1**
	15	**14**	2
	15	**16**	3
	13	**13**	4
	15	**14**	5
	16	**16**	6
	17	**15**	7
	17	**14**	8
	15	**13**	9
	20	**18**	10
	20	**17**	11
	16	**15**	12
	14	**14**	13
	16	**13**	14
	17	**16**	15
	16	**15**	16
	18	**15**	17
	16	**17**	18
	17	**15**	19
	19	**18**	20
	20	**19**	21
	18	**15**	22
	17	**16**	23
	20	**16**	24
	15	**15**	25
Average	**16.64**	**15.2**	
treated/untreated %	**109.47%**		

Vegetable Crop Research Department
Kalocsa Research Station

RESEARCH REPORT

2017

'WATER RETAINER' TREATMENTS IN INTENSIVE FIELD AND FOIL TENT GROWING OF PAPRIKA

Compiled by:

Miklós Pér
researcher

Kalocsa

10th October 2017

‘WATER RETAINER’ TREATMENTS
IN INTENSIVE FIELD AND FOIL TENT GROWING OF PAPRIKA

Experiment Objectives

Testing the Water Retainer product called ‘the Water Retainer’ (hereinafter: the Water Retainer), as commissioned by Water&Soil Kft.:

1. Testing in intensive field growing of ‘Kaldóm’ paprika.

2. Testing in intensive under plastic growing ‘Szegedi-178’ paprika.

For the purposes of this experiment, the ‘treatment’ is defined as application of the Water Retainer in a dosage of 1 ml/m^2 while reducing the irrigation water by 50%. In under plastic growing, the treatment of the Water Retainer was done again by 50% (a dosage of 0.5 ml/m^2) in the second half of the vegetation period at the end of July.

Materials and Methods

Experiment Site:

Kalocsa, the field and polytunnel of Kalocsa Research Station of National Agricultural Research and Innovation Centre

Growing Seedlings

The seedlings of ‘Kaldóm’ and ‘Szegedi-178’ paprika varieties were produced in Kalocsa Research Station’s own polytunnels in 2017. During the growing of seedlings, we paid special attention to even plant growth and the ‘training’ of seeds to fit the date of bedding.

Cultivation and Harvesting

<u>Preparation of the field</u>

In 2016, the green crop was autumn wheat. During the autumn period, the field was not fertilized by manure; it was only deep tillaged.

For the intensive field growing, beds with ridges and drip laterals were developed. These were covered with black plastic foil. The Water Retainer was applied directly before preparing the ridges in mid May 2017, as recommended, in a concentration of 1 ml/m^2.

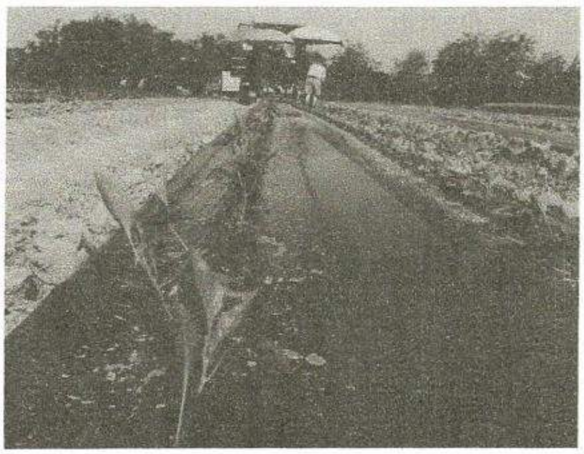
Preparation of under plastic field

The under plastic field was prepared before the bedding of seedlings. Before placing the drip laterals, we used backpack sprayers to apply the Water Retainer on the ground surface; also as recommended, in a concentration of 1 ml/m^2. The treatment was repeated in the second half of the vegetation period at the end of July, in a concentration of 0.5 ml/m^2, applied using the same technology.

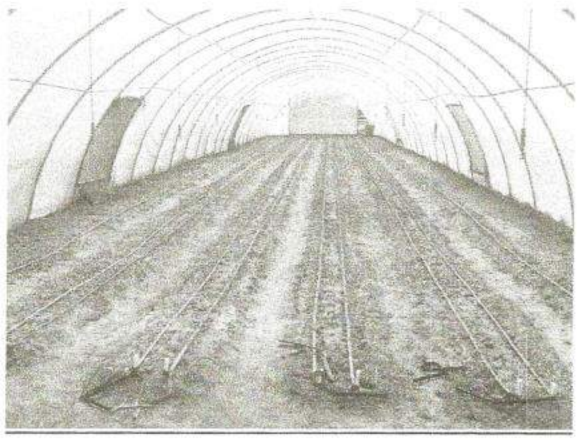
The seedlings forced in unheated polytunnel were bedded out in a twin row configuration by hand. This equalled 35 thousand plants per hectare.

Planting in the field

The seedlings on trays were bedded out by a suspended planting machine operated by the Research Station staff. The seedlings were bedded out in the about 50 cm-wide ridges, in twin row configuration. This equalled approx. 45 thousand seedlings per hectare.
At the time of bedding the seedlings were in ideal condition.



Picture 1 - bedding 'Kaldóm' seedlings



Picture 2 - 'Szegedi-178' out-bedded physiognomy

Weed Control

Weeding has been executed 4 times by a row crop cultivator, and 4 times by manual hoeing. Under plastic, weeding has been done every two weeks by manual hoeing.

Treatments

'Szegedi-178' hot paprika variety (growing under plastic)

1. The Water Retainer applied: first on 6th June in a 1 ml/m^2 dosage, next on 27th July in a 0.5 ml/m^2 dosage. Compared to the control crops, 50% less irrigation water used during the vegetation period.

2. Control Crops

In case of the foil tent crops, the plants were irrigated by both clear water and liquid fertilizer in the first half of the vegetation period, but the treated area was irrigated by only 50% of the water and liquid fertilizer. In the second half of the vegetation period, in order to balance the nutrient supply, the control crops received 50% less liquid fertilizer, while the rate of irrigation water between the treated and the control crops remained the same: 50-100%.

'Kaldóm' sweet paprika variety

1. The Water Retainer applied in a 10 l/ha (1 ml/m^2) dosage. Compared to the control crops, 50% less irrigation water used during the vegetation period

2. Control Crops

In case of the field crops, irrigation water and liquid fertilizer were used only once in equal amount. After having applied the liquid fertilizer, we irrigated both areas again, where the treated crops received 50% less irrigation water than the control crops.

Note:
For both irrigation and nutrient replenishment purposes, the filtered water from Vajas canal was used.

Plant Protection

Field crops needed three different treatments against viral vector insects and pesticides. Pesticides of cypermethrin and indoxacarb active ingredients were used. Under plastic crops have not required any pesticide treatment because the crops were covered with a fine mesh screen.

Phenology Measurements

Plant growth was measured by plant height, number of flowers and number of set fruits. Data tables are shown in Appendix 1 to 4.

Harvest dates:

Szegedi-178: 19-20th September 2017

Kaldóm: 10-11th September 2017

Results

During the 2017 vegetation period of paprika, extreme weather conditions occurred again, such as drought, prolonged heatwaves, and sudden heavy rainfalls followed by cold periods. Regardless of the adverse weather, pests and pathogens, due to the intensive field growing technology of paprika, the plants reached an even condition, which balanced out the loss of yield usually occurring due to traditional growing technology.

Based on the discussion with the representative of Water&Soil Ltd., harvest results refer to the first harvest of the treated sections.

Table 1: Harvest results (yield)

Treatment	Kaldóm (field) kg/section (150 m^2)	Szegedi -178 (under plastic) kg/section (150 m^2)
Treatment (50% irrigation water)	183	189
Control Crops	175	200

Having compared the Water Retainer treated section, which received 50% of the irrigation water, and the control section of the same varieties and growing technologies, no significant differences were found. Any differences between the varieties were probably caused by the characteristics of the varieties (Kaldóm - early, semi-determinate plant growth, Szegedi-178 - mid-early, indeterminate plant growth) and the different growing methods.

Parameter measurements were taken directly after harvest in the Research Station's laboratory. Dry content has been measured by using a drying oven and digital scales. Total pigment content has been measured by a Unicam spectrophotometer, and the data has been converted into the internationally accepted ASIA values. Germination potency data has been obtained after a two-week germinating period.

Table 2: Quality parameter results

Treatment	variety/examined part	pcs	moist weight (g)	dry weight (g)	dry content %	ASTA color value	raw seed sprout %
Water Retainer - 50% less irrigation water	Kaldóm exocarp	14	317.7	56.5	17.8	198	99
	Kaldóm powder	15	342.9	56.2	16.4	152	
Control Crops	Kaldóm exocarp	15	325.5	57.5	17.7	200	95
	Kaldóm powder	15	347.1	61.2	17.6	166	
Water Retainer - 50% less irrigation water	Sz-178 exocarp	15	278.2	44.3	15.9	187	96
	Sz-178 powder	15	278.2	44.9	16.1	161	
Control Crops	Sz-178 exocarp	16	302.1	49.9	16.5	190	97
	Sz-178 powder	16	331.2	53.0	16.0	141	

Due to early ripening, the filed-grown Kaldóm variety had higher dry content and higher pigment content compared to Szegedi-178 variety. The filed-grown Kaldóm in the treated sections received half the irrigation water than the control crops. This turned into an advantage when heavy rainfall hit in the end of July, and caused stress in the lower fields.

But within the same varieties, there were no significant differences found in dry content or total pigment content between the crops treated with the Water Retainer and 50% less water, and the control crops.

Germination potency values were equally high and stable in both the control and treated crops. High germination potency has a significance from a sowing-seed production point of view, since farmers prefer quickly sprouting sowing-seeds with a potentially high percent of germination.

Summary

Based on phenological measurements and the resulting data shown in the tables, it can be ascertained that within the same varieties there are no significant differences between the main quality parameters and yields of the treated and the control, field or under plastic crops.

The results of our 2017 experiment also show exceptionally high germinating capacities of the seed samples.

The treatment is deemed effective both applied before the preparation of ridges and under plastic, and applied on the surface by means of other cultivator machinery.

Thus, by applying the Water Retainer, even half of the irrigation water used during the vegetation period and the other costs of irrigation application can be saved.

Kalocsa, 10th October 2017

NAIK stamp

signature

Tibor Gáll
head of department

NAIK (National Agricultural Research and Innovation Centre),
ZÖKO (Vegetable Crop Research Department)

Table 1 - Treated Kaldóm (Water Retainer and 50% less irrigation water) phenological data

	Height cm	Number of flowers pcs (11-07-2017)	Number of fruits pcs (11-07-2017)	Number of fruits pcs (22-08-2017)
1	60	2	4	18
2	50	3	5	22
3	58	2	5	10
4	45	set	3	15
5	58	set	6	13
6	57	set	5	9
7	58	4	6	7
8	55	2	5	17
9	56	1	4	13
10	47	set	3	17
11	60	b	5	21
12	58	b	2	18
13	55	b	5	13
14	45	1	4	7
15	53		3	17
16	42	2	3	12
17	52	3	5	8
18	53	2	6	17
19	43	set	5	28
20	48	1	5	9
21	58	2	5	10
22	45	1	4	16
23	60	2	5	34
24	50	3	5	21
25	49	2	4	8
26	48	2	4	15
27	45	2	4	16
28	43	2	3	15
29	40	1	5	16
30	60	3	7	13
31	48	2	5	16
32	60	3	6	17
33	59	2	5	7
34	60	3	7	25
35	58	2	5	28
36	62	2	7	24
37	59	1	5	12
38	55	2	5	8
39	60	3	6	14
40	60	3	7	23
41	55	2	6	7
42	50	1	5	17
43	50	2	6	14
44	48	2	5	17
45	45	1	4	8
46	48	2	4	16
47	45	1	4	10
48	47	1	5	17
49	45	2	5	13
50	45	1	5	15

Table 2 - Control Kaldóm phenological data

	Height cm	Number of flowers pcs (11-07-2017)	Number of fruits pcs (11-07-2017)	Number of fruits pcs (22-08-2017)
1	53	1	4	13
2	55	1	5	18
3	53	8	6	13
4	60	3	5	8
5	55	3	5	11
6	62	4	6	27
7	65	2	6	19
8	65	3	5	25
9	60	3	5	16
10	55	2	5	17
11	60	3	5	10
12	56	4	3	16
13	63	2	6	28
14	60	3	6	12
15	46	2	6	1
16	59	1	7	26
17	69	4	5	25
18	65	2	7	12
19	56	2	3	9
20	60	2	5	14
21	52	2	3	22
22	50	1	5	27
23	60	3	4	30
24	59	1	6	26
25	60	3	4	7
26	58	2	5	15
27	53	4	4	12
28	65	2	5	19
29	50	1	4	20
30	62	2	4	14
31	54	2	4	16
32	60	3	5	20
33	60	1	5	18
34	53	3	5	17
35	50	1	3	21
36	45	2	4	12
37	50	3	5	19
38	45	2	4	17
39	53	4	5	11
40	60	2	5	13
41	65	1	5	28
42	53	2	5	15
43	48	1	4	21
44	50	1	5	12
45	63	1	6	31
46	45	1	5	10
47	60	1	5	31
48	50	1	4	10
49	53	1	3	13
50	62	5	5	13

Table 3 - Treated Szegedi-178 (Water Retainer and 50% less irrigation water) phenological data

	Height cm	Number of flowers pcs (11-07-2017)	Number of fruits pcs (11-07-2017)	Number of fruits pcs (22-08-2017)
1	57	5	16	18
2	46	set	12	22
3	56	6	15	17
4	54	5	5	21
5	65	7	15	13
6	32	set	2	9
7	60	3	15	16
8	63	6	9	20
9	62	6	14	20
10	53	2	10	18
11	54	4	13	15
12	57	4	12	13
13	59	8	12	19
14	48	4	8	8
15	53	5	8	16
16	66	9	13	19
17	44	set	7	14
18	61	10	7	17
19	67	5	14	18
20	68	8	11	18
21	60	5	13	19
22	49	2	9	16
23	52	5	11	18
24	67	3	12	15
25	64	11	13	11
26	60	2	15	17
27	44	3	2	9
28	60	8	10	15
29	59	6	16	10
30	60	6	15	20
31	52	2	15	24
32	56	2	3	10
33	52	3	12	10
34	57	5	15	18
35	61	5	13	20
36	57	5	9	14
37	53	5	8	17
38	65	11	17	18
39	66	3	13	14
40	51	8	13	18
41	67	4	12	18
42	60	3	12	17
43	57	2	14	10
44	54	5	11	22
45	53	2	13	13
46	51	8	9	20
47	60	4	14	16
48	58	2	11	24
49	57	1	18	15
50	57	7	9	16

Table 4 - Control Szegedi-178 phenological data

	Height cm	Number of flowers pcs (11-07-2017)	Number of fruits pcs (11-07-2017)	Number of fruits pcs (22-08-2017)
1	53	3	10	15
2	50	2	9	10
3	40	0	6	10
4	40	0	5	12
5	42	1	66	16
6	45	4	13	20
7	50	set	10	14
8	50	set	10	20
9	48	6	12	20
10	49	set	12	22
11	47	3	10	13
12	60	2	10	22
13	56	4	8	16
14	58	3	12	18
15	58	4	12	10
16	59	4	17	33
17	75	5	14	24
18	50	2	6	12
19	63	8	13	20
20	52	2	10	19
21	49	6	17	22
22	49	1	9	17
23	64	5	13	30
24	55	2	11	20
25	48	0	4	13
26	50	6	11	22
27	49	3	8	14
28	55	7	15	17
29	63	3	7	15
30	57	4	11	9
31	47	3	5	7
32	55	2	13	20
33	60	5	6	14
34	59	6	3	10
35	57	6	7	16
36	56	4	11	20
37	60	8	7	16
38	55	3	11	20
39	56	10	15	22
40	56	5	15	20
41	50	4	6	14
42	58	5	7	16
43	56	6	10	16
44	46	3	8	16
45	62	3	10	18
46	52	3	8	15
47	65	7	17	25
48	63	8	13	20
49	62	4	15	21
50	60	3	12	20

Haut Commissariat aux Eaux et Forêts
et à la Lutte Contre la Désertification

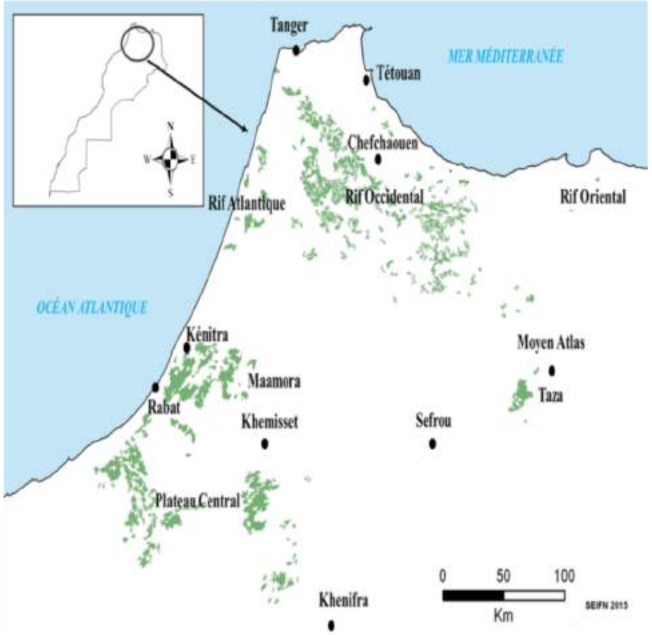
Effet de Water Retainer sur la réhabilitation de l'écosystème chêne-liège

Rabat, le 13-12- 2018

Plan

- Introduction
- Problématique et Objectifs
- Présentation du produit WR
- Méthodologie
- Résultats obtenus (6mois)
- Conclusion

Introduction



Subéraies marocaines représentent 14 % de la superficie mondiale soit 377 500 ha.

Forêts de montagne 49 %

Forêts de plaine 51 %

Rôle multifonctionnel

- Approvisionnement du marché en liège (4% de la production mondiale)
- Source de revenu pour les collectivités locales (i.e Mamora > 100 M dh/an)
- Protection des agglomérations et des infrastructures
- Conservation des eaux et des sols
- Réservoir génétique de faune et de flore
- Rôle récréatif pour la population citadine
- Source de revenus importante (bois, liège, cellulose, glands, feuilles, écorce à tanin, miel, PAM, champignons)

Ecosystème Fragile

à

Restaurer

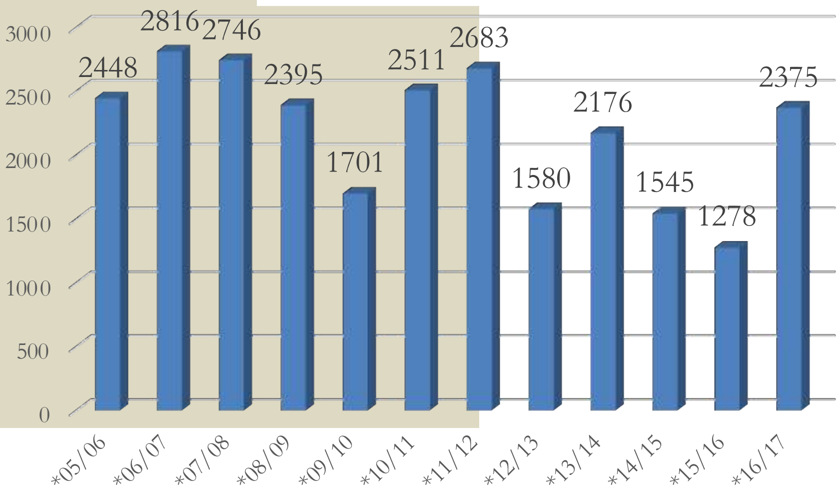
Les écosystèmes à chêne-liège sont soumis à de nombreuses contraintes : Surpâturage, Non respect des mises en défens, Droits d'usage, Ramassage systématique des glands, difficultés de régénération, Attaques parasitaires et Effets du Changement climatique (Sécheresse récurrente , hausse de T°C)

Dépérissement

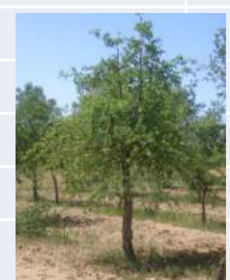
Déclin de la biodiversité

Dédensification des forêts de chêne-Liège

Un effort de Régénération de chêne-liège Important



BILAN DES REALISATIONS DE REGENERATION DE CHENE-LIEGE (Période 2005/2006-2016/2017)	
DREFLCD	Superficie (ha)
Nord Ouest	8 643
Rabat Salé Zemmour Zaer	8 720
Rif	3 747
Nord Est	4 295
Centre	456
Moyen Atlas	27693
Total (ha)	**26 254**



Water Retainer

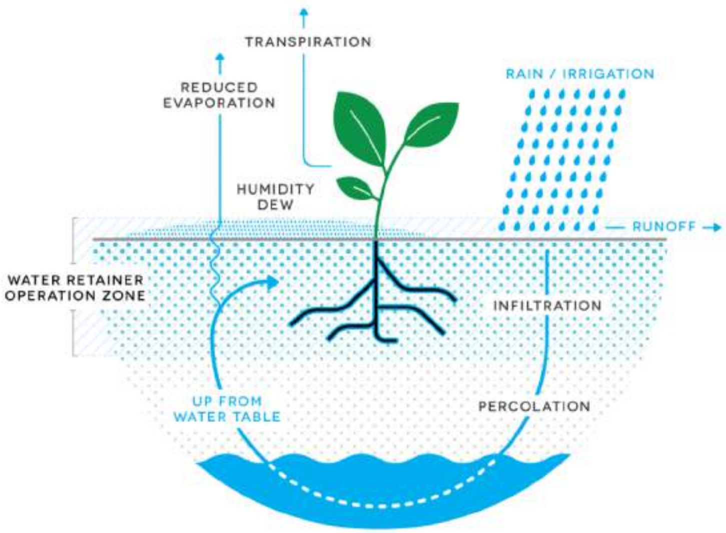
Cependant

Le Taux de survie dans certaines parcelles de régénération est inférieur à 70% après le cap de l'été

Convention de Partenariat HCEFLCD-Société Soil & Water (Hongrie)

Objectif : Tester l'effet d'un rétenteur d'eau « Water Retainer », en solution liquide, sur le taux de survie, le développement et la croissance de plants de chêne -liège

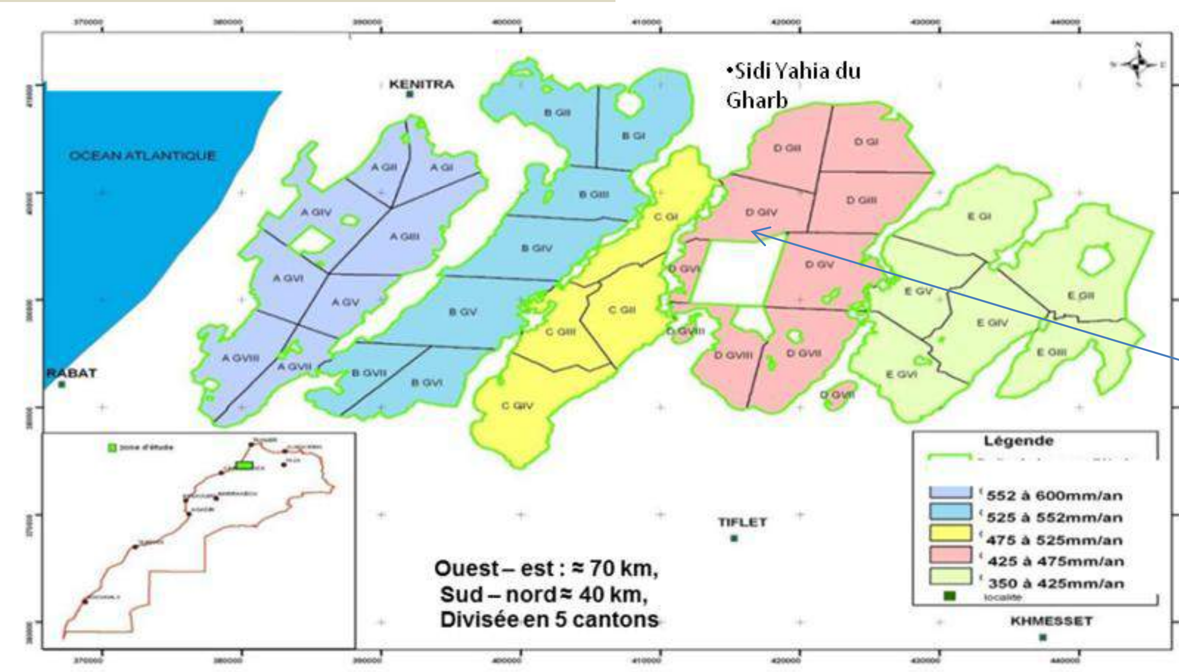
Le Produit et son Principe d'utilisation



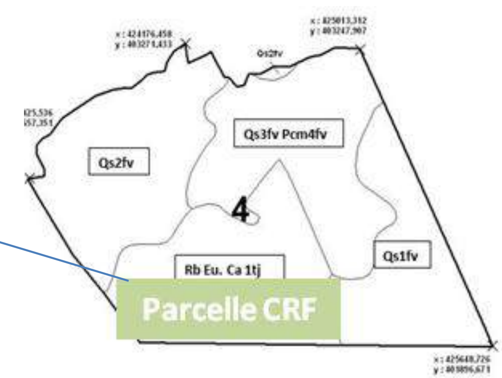
Water Retainer est appliqué par pulvérisation, dilué dans l'eau ;
WR piège l'eau d'évaporation et la transforme en minuscules gouttelettes d'eau dont la plante peut bénéficier au niveau des racines.
Pulvérisé à la surface, **WR** emprisonne l'humidité de l'air.
Sa durée de vie est de 3 mois, période pendant laquelle la capacité de rétention d'eau du sol est sensiblement augmentée.

Choix du site

Tester le produit dans des parcelles de régénération de chêne-liège de la Maamora



Carte des précipitations dans la Maâmora



Rb Eu. Ca 1tj : Reboisement *Eucalyptus*
QsFv : *Quercus suber*, vieille futaie.

DREFLCD NORD OUEST
DPEFLCD : SIDI SLIMANE
CCDRF : SIDI YAHIA EST
Secteur : DOUAGHER
Commune Rurale :KCEIBIA
Parcelle : Canton D GI4

Localisation : parcelle DI4 située à proximité d'une parcelle de chêne-liège adulte mise en défens pour la régénération sous couvert, proche de Sidi Yahia du Gharb

Antécédent cultural : *Eucalyptus camaldulensis*

Altitude : Maximale : 85m Minimale : 70m

Bioclimat : Semi-Aride Limite inférieure de l'Aire de répartition du Chêne-Liège

Précipitations : Moy . Ann = 4**25 à 475 mm/an**

Température : Max = 39°c

Sol : argilo-sableux

Actions entreprises

Pépinière

Production des plants à la pépinière du CRF

- Date de mise en portoirs des glands : Décembre 2017

Caractérisation du sol de la parcelle DI4

Réalisation d'un profil pédologique de 120x170x165cm

- Humidité mesurée à divers niveaux :
  De 0 à 5cm =12% / De 5 à 10cm =15% / De 10 à 90 cm =18% / De 90 à100 cm =20%
  De 100 à 160 cm = 40% et apparition du plancher argileux à 160 cm

Analyse physico-chimique

Parcelle DI4

- Tracé et piquetage et Ouverture des trous de plantation

- Rebouchage, plantation et confection des impluviums

Installation d'un Dispositif expérimental Water Retainer (WR)

BLOC I Arrosage 5l/plant		
Témoin (1) 1,30m	WR D2 (2) 1,30m	Témoin (3) 1,30m
WR D1 (4) 1,40m	WR D1 (5) 1,30m	Témoin (6) 1,30m
WR D2 (7) 1,50m	WR D2 (8) 1,50m	WR D1 (9) 1,30m
BLOC II Arrosage 10l/plant		
WR D1 (1) 1,50m	WR D1 (2) 1,40m	WR D2 (3) 1,30m
Témoin (4) 1,70m	Témoin (5) 1,60m	WR D2 (6) 1,40m
WR D1 (7) 1,70m	Témoin (8) 1,60m	WR D2 (9) 1,30m

648 plants de Chêne-liège

Deux Types d'arrosage et deux doses (3ml et 5ml)

- **5L pour 324 plants :**

108 dose 3 ml de Water Retainer

108 dose 5 ml de Water Retainer

108 Témoin

- **10L pour 324 plants**

108 dose 3 ml de Water Retainer

108 dose 5 ml de Water Retainer

108 Témoin

La dose du Produit, le nombre et le calendrier des applications nécessaires ont été établis, en fonction du CPS (1 arrosage d'appoint à la plantation + 2 arrosages), en concertation avec M. Vattay.

2 Blocs x 36 plants/UE x Témoin et 2 traitements x 3 répétitions = 648 plants

Principaux paramètres mesurés :

Taux de survie, Croissance en Hauteur et Diamètre au collet

Application du Water Retainer (WR)

Application du WR après arrosage des plants

- 1^{e} Application du WR : 24 et 25 Avril 2018

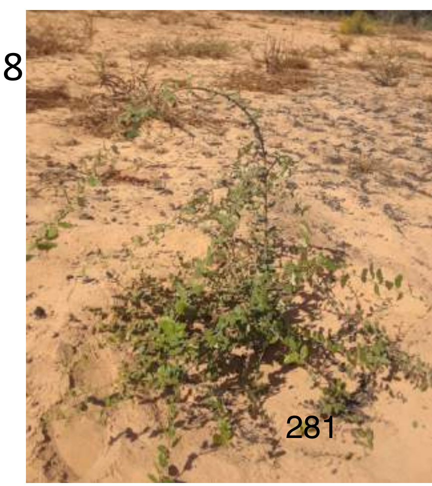
  Moyennes mensuelles :
  T:20°C,
  Précipitations : 92 mm de pluies,
  Hmoy : 80%
  Pas d'arrosage en raison des précipitations

- 2^{e} Application du WR : 20 et 21 juin 2018

  Moyennes mensuelles :
  T:26°C,
  Précipitations : 8 mm de pluies,
  Hmoy :60%
  Arrosage de 5l et 10l/plant

- 3^{e} Application du WR : 24 et 25 juillet 2018

  Moyennes mensuelles :
  T: 30°C,
  Précipitations : 0 mm de pluies,
  Hmoy : 54%
  Arrosage de 5l et 10L/plant



Résultats Préliminaires

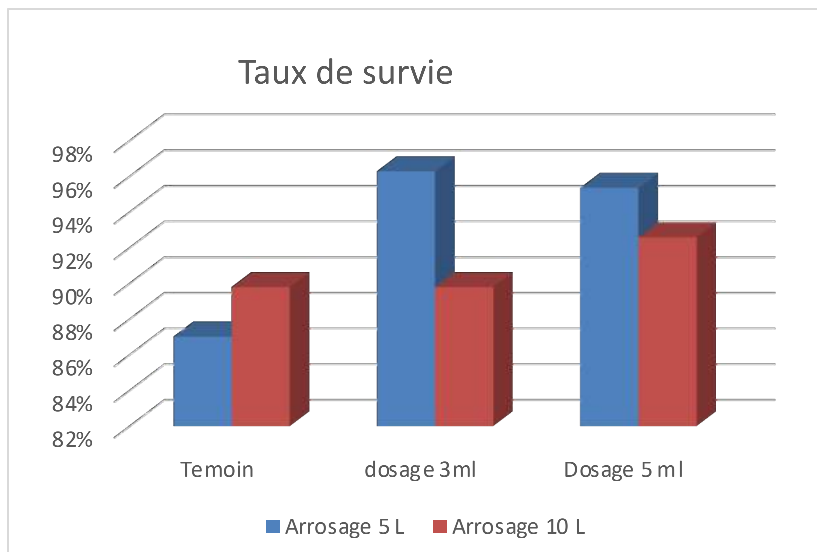
Plantation en mars 2018
Plants de 3 mois

Taux de Survie

Période/5L	Témoin	3 ml	5ml
avant Mai	0	2	0
avant juin	2	0	0
avant juillet	1	1	0
avant oct	11	1	5
Total	14	4	5

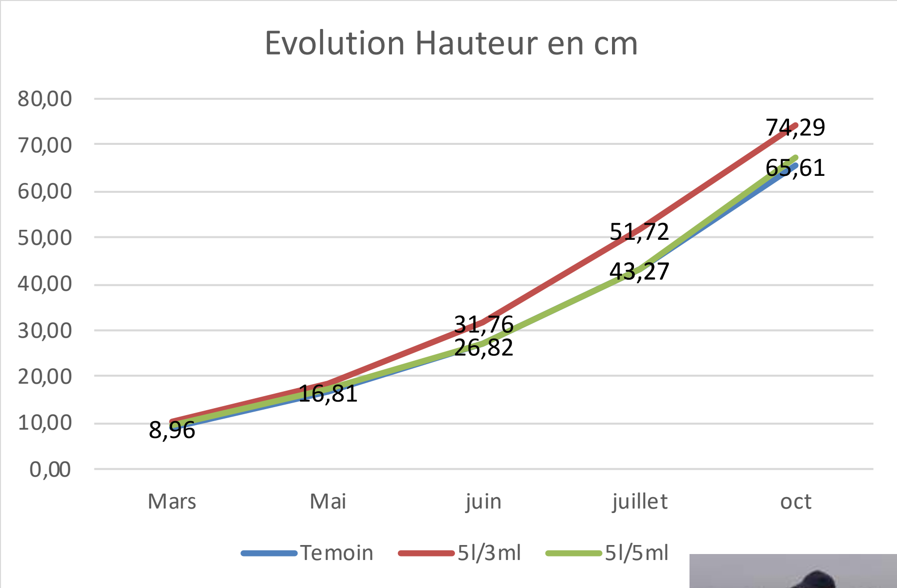
Période/10L	Temoin	3ml	5ml
Mars-Mai		1	1
Mai-juin	1	4	1
juin-juillet	2	2	0
Juillet-oct	8	4	6
Total plts morts	11	11	8

Taux de survie/dosage	Témoin	3ml	5 ml
Arrosage 5 L	87%	96%	95%
Arrosage 10 L	90%	90%	93%



Avril 2018

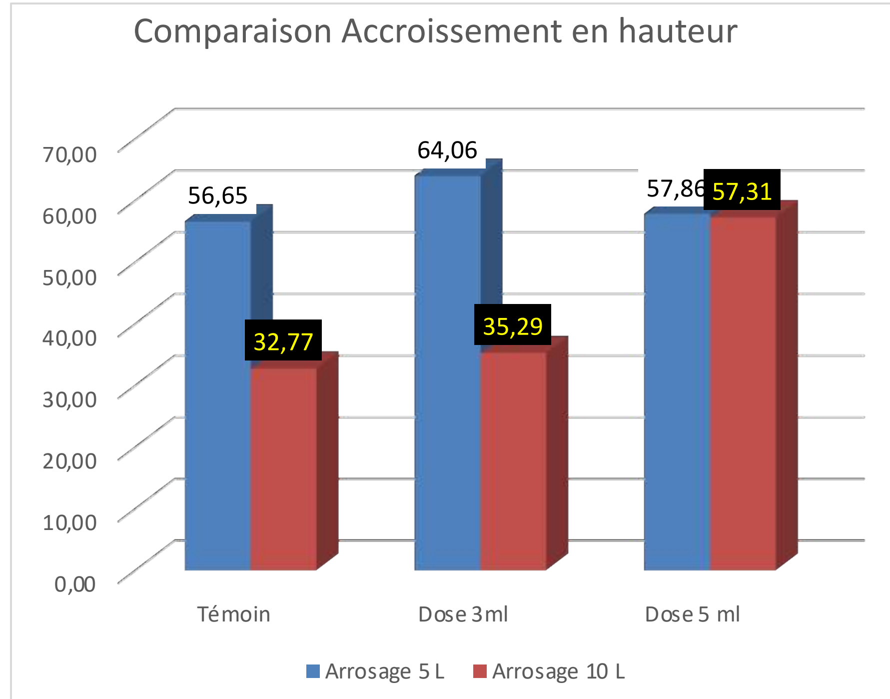
Water Retainer améliore le taux de survie notamment pendant l'été

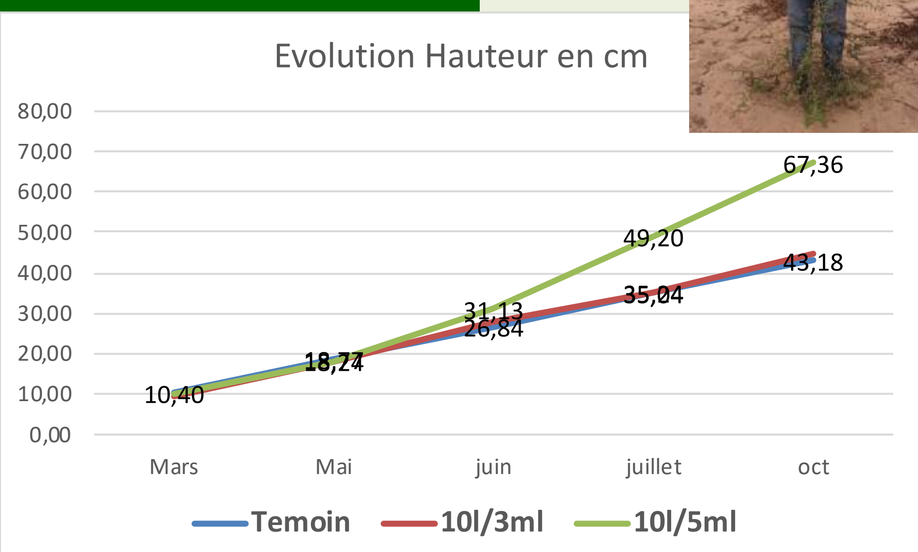


Comparaison Accroissement (cm) Hauteur

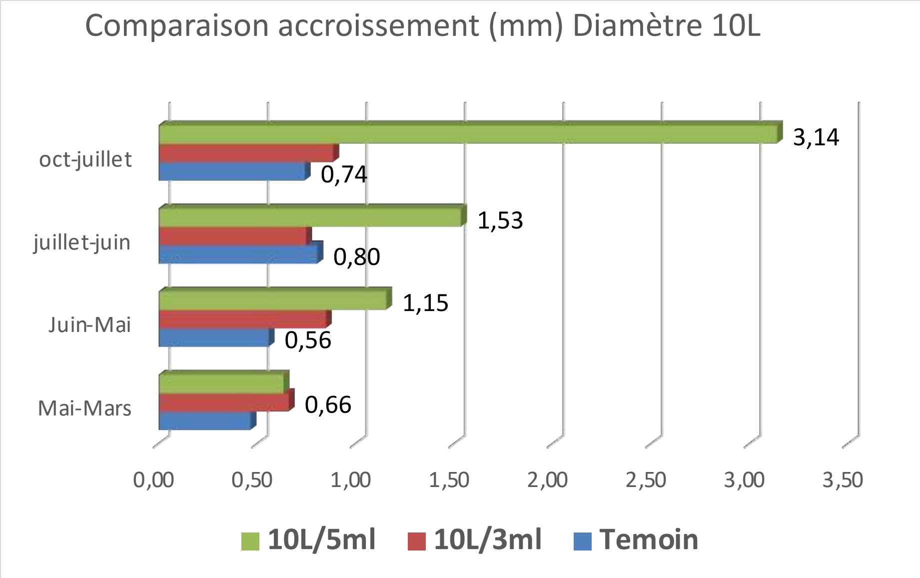
	Témoin	Dose 3ml	Dose 5 ml
Arrosage 5 L	56,65	**64,06**	57,86
Arrosage 10 L	32,77	35,29	57,31

Résultats Préliminaires





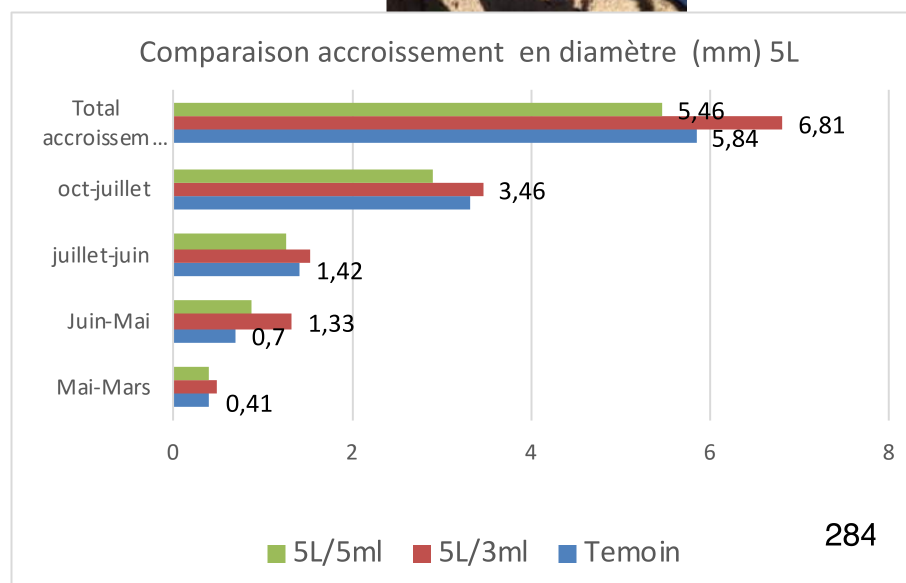
Water Retainer a montré un effet positif sur la croissance en hauteur



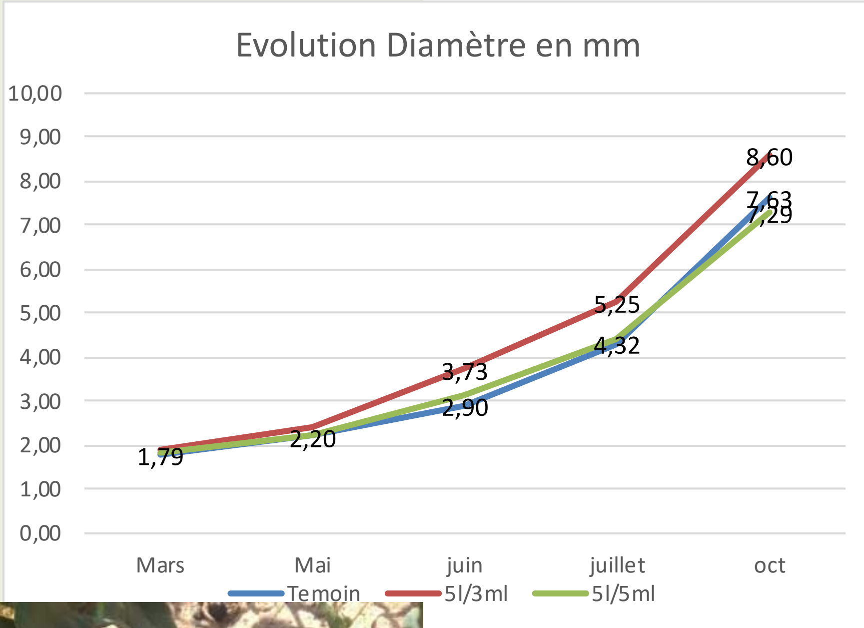
Résultats Préliminaires

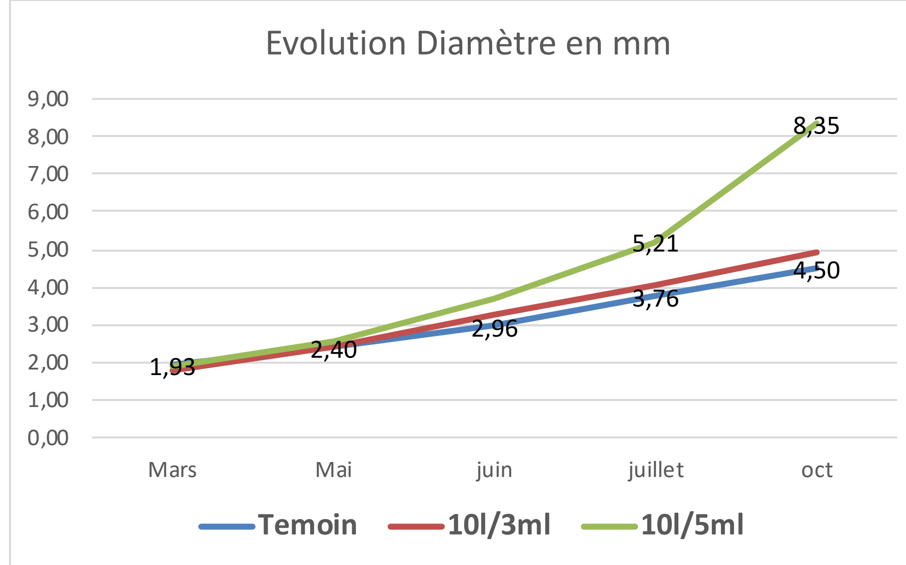
Comparaison Accroissement (mm) Diamètre au collet

	Témoin	3ml	5 ml
Arrosage 5 L	5,84	**6,81**	5,46
Arrosage 10 L	2,57	3,14	**6,46**



Résultats Préliminaires





Les Analyses statistiques ont montré un effet significatif du produit sur l'accroissement en hauteur et en diamètre au collet même dans le cas d'un arrosage de 5L

D'autres paramètres sont également mesurés: Humidité du sol à différentes profondeur, nombre de branches…

Conclusion

Au terme de cette première année d'expérimentation

Effet du Water Retainer

- Les doses 3 et 5 ml ont montré un effet significatif sur les trois paramètres suivis : taux de survie, croissance en hauteur et Diamètre au Collet pour les 2 régies d'arrosage 5 litres et 10 litres par potêt.

- Pour les 2 arrosages , la dose 3ml avec un arrosage de 5L et la dose 5ml avec un arrosage de 10 L sont les meilleurs et statistiquement similaires.

Le taux de survie et les mesures dendrométriques des plants seront réalisés 2 fois par an, avant et après la saison d'été, pendant 4 années.

Merci pour votre attention

Centre de Recherche Forestière

Etude de l'effet de Water Retainer sur le développement des plants d'arganier et du Caroubier en zones arides :

Site Sidi Jaber et Jbilet (Kalâa des sraghna)

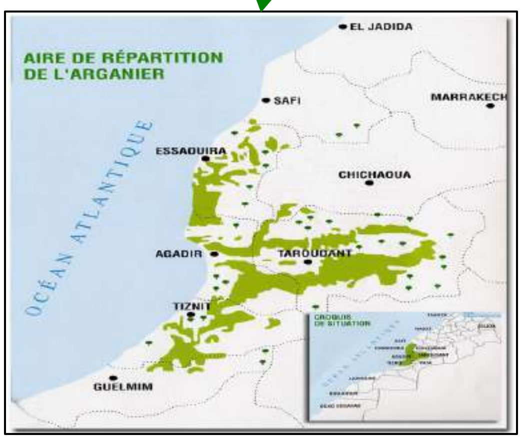
Rabat, 13 Dec 2018

Plan

- Introduction
- Problématique et Objectifs
- Présentation du produit WR
- Méthodologie
- Résultats obtenus (6mois)
- Conclusion

Introduction

Ecosystème à base d’arganier



Espèce endémique du Maroc

Forte adaptation au **stress hydrique** et aux variations de températures

Région du **Sud-Ouest** (Haha + Souss) (860 000 ha)

Patrimoine universel de l’UNESCO = Réserve de Biosphère de l’Arganeraie (1998)

Importance socio-économique = « Arbre qui donne tout » (bois, feuillage, huile d’argan, tourteau, …)

écologique = protection des sols, régulation des eaux et lutte contre la désertification

Un patrimoine Fragile

à réhabiliter

l'arganeraie subit depuis longtemps de profonds changements en raison des effets combinés de la croissance démographique, la surexploitation des ressources et des changements climatiques

1,6 millions ha
300 arbres/ha

Un siècle

860.000 ha
60 arbres/ha

Reduction de 50% (600 ha/an)

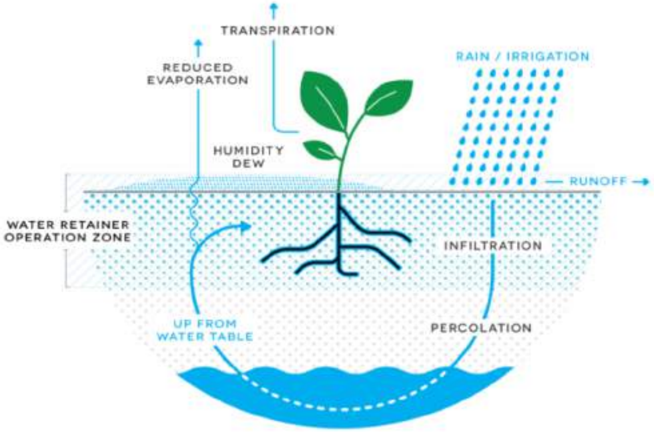
Absence totale de la régénération naturelle

Notre devoir de restaurer l'écosystème arganier par la régénération assistée

Le défi majeur est de permettre aux jeunes plantations de surmonter les caps estivaux pendant les deux premières années (périodes très critique pour la survie du plants

D'où l'intérêt de tester le rétenteur d'eau (Water Retainer WR)

Water Retainer



Les bienfaits déclarés du WR

Test WR en Fév 2016, Marrakech sur une jeune plantation **agricole** où l'irrigation a été **réduite de 50%** après l'application du produit.

WR : solution appliqué par pulvérisation à la surface du sol (autour du plant) formant une couche écran réduisant l'évaporation de l'eau.

Pour les espèces forestières (Arganier et caroubier), Le WR pourrait –il engendrer les mêmes effets??

Produit Ami de la nature

Passer à l'action

Convention de collaboration HCEFLCD Maroc – SOIL&WATER Hongrie

Tester le produit sur les plantations d'Arganier et de caroubier

Choix du site : Arboretum de Sidi Jaber

Parcelle expérimentale pour les espèces sahariennes et arides.

Localisation : A 46 Km au NE d'El Kalâa des Sraghnas)

Altitude : 400 - 450 m

Bioclimat aride à été hiver froid

Précipitation : Moy . Ann = 252mm

Température : Max = 38.38°c et Min = 4,4°c

Sol : sols schisteux et calcaire

Végétation : *est constituée d'Acacia gummifera, Ziziphus lotus, Retama monosperma, Stippa retorta et diverses espèces annuelles* qui apparaissent au printemps lorsque l'année est pluvieuse.

Passer à l’action

Choix du site : Réserve de Jbilet

Parcelle expérimentale pour les espèces sylvopastorales des zones et réserve à gazelle dorcas

Localisation : A 46 Km au NO de Marrakech

Altitude : 550 -600m

Bioclimat aride à été hiver froid

Précipitation : Moy . Ann = 278mm

Température : Max = 39°c   et Min = 4,7°c

Sol : argilo-calcaire avec accumulation en profondeur des sels de sodium et de magnésium

La végétation caractéristique est une brousse *très dégradée* à *base surtout de Zizyphus lotus, Withania frutescens, Pistacia atlantica, Ephedra altissima, Asparagus stipularis,* ……………..

Le Protocole expérimental

Arganier :600 plants

3 types d'arrosage :

- 10L (8 fois par ans),
- 15L (8 fois par ans)
- 15L (4 fois par ans)

3 dosages Water R.

- 5ml, 8ml et 10ml

Caroubier: 180 plants

1 seul type d'arrosage :

- 15L (8 fois/an)

2 dosages Water R.

- 5ml et 8ml.

Le Protocole expérimental

Arganier :160 plants

types d'arrosage :

- 15L (8 fois par ans)

1 dose Water R. : 10ml

Autres espèces : 400 plants

.

1 seul type d'arrosage :

- 15L (8 fois/an)

1 dose Water R. : 10 ml

Ceratonia siliqua,
Tetraclinis articulata,
Prosopis juliflora,
Acacia raddiana,
Acacia gummifera,
Chamecytisus albidus
Acacia aneura

Démarches entreprises

Activités menées pour l'essai WR

Nature des activités	Dates
1-Conception et validation du protocole expérimentale	Nov/Déc 2017
2-Production des plants en pépinière	•Arganier en Pép. du CRRF 2018 •Caroubier en Pép. De la DPEFMA 2018
3-Acquisition produit WR	Fin Février 2018
4-Ouverture des tous	20 février 2018
5-Préparation du sol	27 février au 1 mars 2018
6-Rebouchage/plantation et Arrosage de plantation (d'appoint) + Prise des mesures 1 (état initial)	27 février au 1 mars 2018

Activités menées : Application WR

Nature des activités	Dates
7-Premier arrosage et 1ère application de RW	17 au 19 avril 2018
8-Deuxième arrosage et 2ème application de RW + Prise de mesure 2 (Avant été)	26 au 28 juin 2018
9-Troisième arrosage et 3ème application de RW	16 au 18 juillet 2018
10-Quatrième arrosage	7 au 8 Aout 2018
11-Cinquième arrosage et 4ème application de RW + Prise mesure 3 (Après cap estival)	16 au 18 septembre 2018
12-Sixième arrosage	Compensé par précipitation/saison
13-Septième arrosage	Compensé par précipitation/saison
14-Huitième arrosage + Prise des mesure 4 (Période froide)	Compensé par précipitation/saison

Démarches entreprises

Suivi des passages d'arrosage et d'application WR

Tableau 1 : Calendrier prévisionnel des opérations d'arrosage et d'application de Water Retainer à Sidi Jaber.

A : Arganier ; C : Caroubier ; F1 : fréquence 1(8 passages), F2 : fréquence 2(4 passages)

Arrosage	Arrosage d'appoint			1ème arrosage			2ème arrosage			3ème arrosage		
Date	27 février au 1 Mars			17 au 19 avril			Du 26 au 28 juin			Du 16 au 18 Juillet		
Intervale	A la plantation			48 J			48 J			20 J		
Espèces	A	A et C	A	A	A et C	A	A	A et C	A	A	A et C	A
Quantité	10L	15L F1	15L F2	10L	15L F1	15L F2	10L	15L F1	15L F2	10L	15L F1	15L F2
RW												

Arrosage	4ème arrosage			5ème arrosage			6ème arrosage			7ème arrosage			8ème arrosage		
Dates	Du 7 au 8 Aout			Du 16 au 18 septembre			Du 16 au 18 octobre			Du 16 au 18 Nov			16 au 18 Déc		
Intervale	20 J			38 J			30 J			30J			30J		
Espèces	A	A et C		A	A et C		A	A et C		A	A et C		A	A et C	
Quantité	10L	15F1		10L	15L F1	15L F2	10L	15L F1		10L	15L F1		10L	15L F1	
RW															

Tableau 2 : Précipitation enregistrée au niveau de la zone de la parcelle de Sidi Jaber (Station d'El Kalaa) depuis le 1er janvier 2018

	1	2	3	4	5	6	7	8	9	10	11	12	Cumul
Date	3Jours	3J	2J	5J	1J	0	0	1J	3J	3J	5J		26 Jours
Quantité	28.3	24.7	16.8	34.6	2.8	0	0	14.8	38.5	20.9	28.6		210.0 mm

Tableau 3 : Calendrier rectifié, en tenant compte des précipitations, des opérations d'arrosage à Sidi Jaber

	Arrosage d'appoint	1ème arrosage	2ème arrosage	3ème arrosage	4ème arrosage	5ème arrosage	6ème arrosage	7ème arrosage	8ème arrosage
Date	27 Fév au 1 Mar	17 au 19 avril	26 au 28 Juin	16 au 18 juillet	7 au 8 Aout	16 au 18 Septembre	Mi-Oct	Mi- Nov	Mi-Dec
Quantité	15L /10L	15L/10L	15L/10L	15L /10L	15L/ 10L	15L/ 10L	Annulé	Annulé	Annulé

Paramètres mesurés

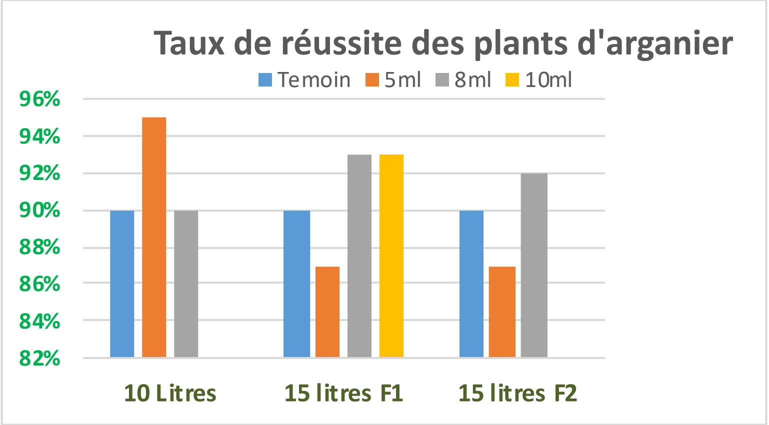
Les principaux critères retenus pour évaluer l'impact du produit WR sur le développement des plants d'Arganier et du Caroubier sont:

- **Le taux de réussite**
- **La hauteur de la tige plants**
- **Le diamètre au collet**

Résultats

Taux de réussite des plants

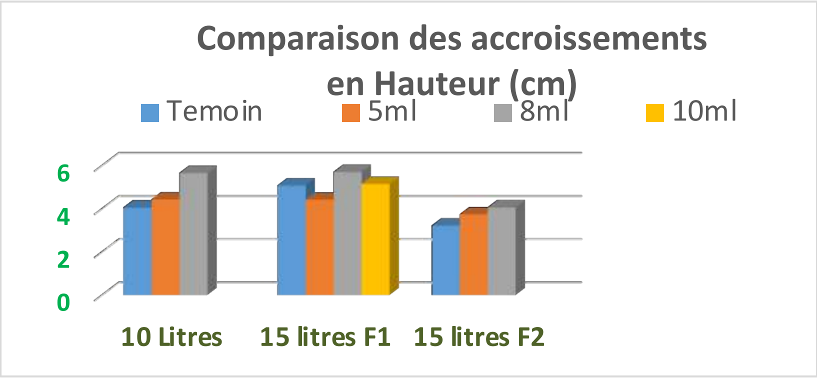
La dose de 5 ml associée à un arrosage 10 Litres est la plus performante (supérieur à 94%)



Arganier

Croissance en hauteur

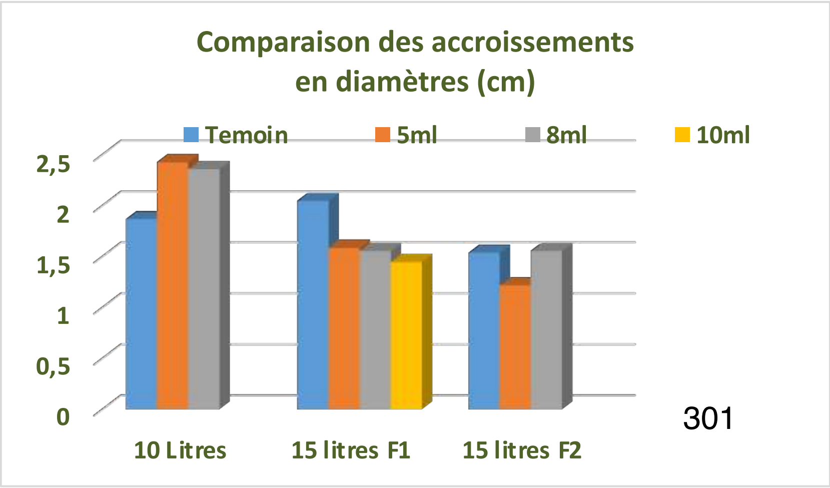
La dose de 8 ml a enregistré la meilleure performance pour tous les types d'arrosage



Convention de collaboration HCEFLCD Maroc – SOIL&WATER Hongrie

Croissance en diamètre

La dose de 5 ml associé avec l'arrosage de 10 L a dépassé légèrement la dose 8 ml pour le même type d'arrosage.



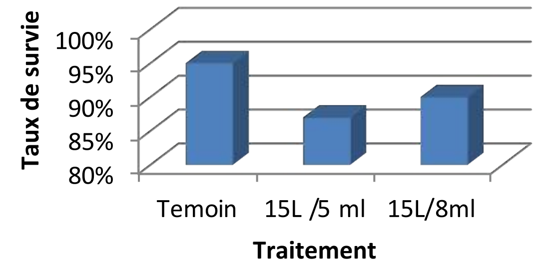
Résultats

Caroubier

Convention de collaboration HCEFLCD Maroc – SOIL&WATER Hongrie

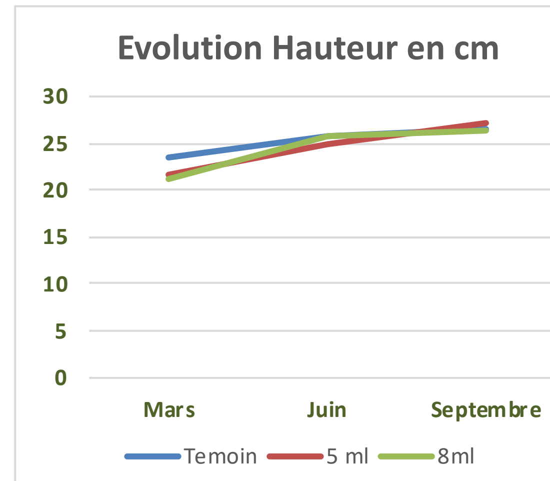
Taux de réussite des plants

Le témoin présente un taux de réussite plus élevé que l'utilisation du WR (+93%)



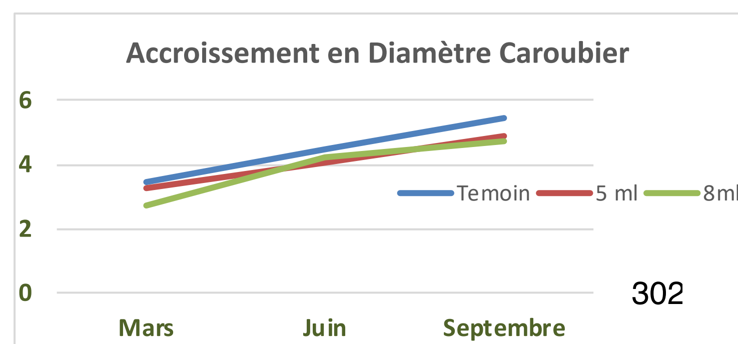
Croissance en hauteur

La dose 5ml donne un léger avantage à la croissance en hauteur



Croissance en diamètre

le témoin semble un peu mieux que l'utilisation du WR

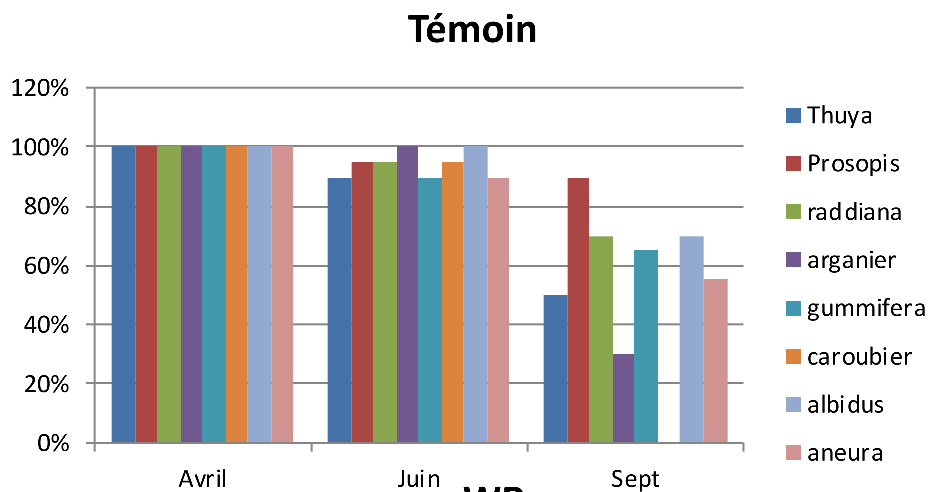


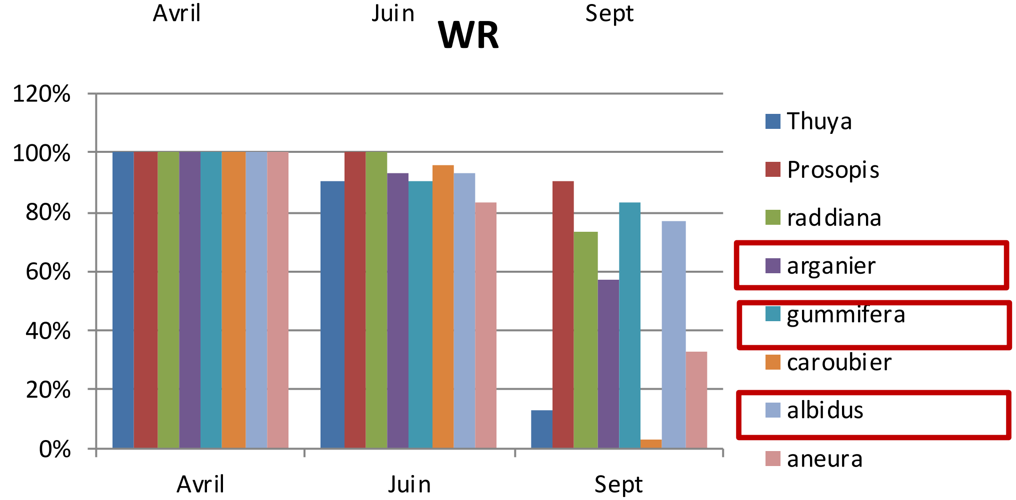
Résultats

Taux de réussite des plants

Autres espèces

Convention de collaboration HCEFLCD Maroc – SOIL&WATER Hongrie





WR n'a d'effet bénéfique que pour 3 espèces.

Conclusions

Après le premier cap estival de la plantation

Arganier

- WR améliore le taux de réussite et la croissance des plants
- La dose de 5ml associée à un arrosage de 10l semble la meilleure (5passages)

Caroubier

- Il semble que le WR n'a Aucun effet bénéfique sur la croissance et la survie des plants (après 6 mois de suivi).

Autres espèces

- WR améliore le taux de réussite des plants d'Acacia gummifere et Chamaecytisus albidus

Perspectives

- Selon les nouveaux CPS de 28 mois , il est nécessaire de continuer l'essai et les mesures durant l'année prochaine (2019)
- Continuer le suivi annuel jusqu'à l'âge de défensabilité des plants (au moins 3 ans)

Fin de présentation
Merci

3. Testimonials from farmers, growers, etc.:

- Arable crops
- Horticulture, viticulture
- Gardening, grass growing, golf course maintenance

Tapasztalataim a Water Retainer -ről, azaz a „Vízőr” -ről

Izsó Lajos agrármérnök vagyok, 2003 óta irányítom a csárdaszállási Biocsárda Kft –t, mint ügyvezető és termelési vezető egyben. Társaságunk 514 ha-on gazdálkodik, kizárólag ökológiai gazdálkodást folytatunk. Fő növényeink a tönköly és a rizs, ezeken kívül még termesztünk csemegekukoricát, napraforgót, olajtököt, lenmagot, kölest. Vetőmagtermesztéssel is foglalkozunk, mint olajretek, mustár, lucerna, őszi borsó, hibridkukorica.

Az évek során számos készítményt kipróbáltunk a termés növelése érdekében, mint talajjavítókat, lombtrágyákat, termésnövelő anyagokat. Négy éve került a látókörömbe a Vízőr, furcsa anyagnak tűnt, mert nem igazán sorolható az előző készítmények közé, hiszen egy teljesen új lehetőséget kínált Nekünk, termelőknek. 2016 –ban próbáltam ki először, olajretek vetőmag-előállításban. Abban reménykedtem, hogy a Vízőr segítségével sikerül egy jó kelést elérni. A tavasz száraz volt abban az évben – a kelési időszakban összesen 8-10 mm eső esett nálunk, mégis szép állomány alakult ki. Kissé vontatott volt ugyan a kelés, mert fekete földön gazdálkodunk és tavasszal nehéz jó magágyat készíteni az aprómagnak. Biztos vagyok benne, hogy a Vízőr hozzájárult a szép állomány kialakulásához.

Az első év tapasztalata alapján úgy döntöttem, hogy a következő évben is használni fogom. 2017 –ben csemegekukorica területre jutattuk ki a Vízőrt és ismét nem csalódtam benne. Nagyon szép, egyenletes volt a kelés. A kelesztő öntözést követően az állomány hosszú ideg kitartott és sikerült két öntözéssel megúszni az évet.

Az idei szezonra már 2017 őszén megrendeltem a szükséges Vízőrt. Még nagyobb területen használtam, mint az előző években, ugyanis kezd beépülni a technológiai sorba a készítmény. Idén csemegekukorica és hibridkukorica kultúrákat kezeltünk Vízőrrel. A kelési időszakban (május közepe) nagyon kevés volt a csapadék, mégis hibátlan lett a kelés mindkét növény esetében. Társaságunk történetében rekordtermést értünk el mindkét kultúra esetében. A Vízőr hatása különösen a csemege esetében mutatkozott meg, ugyanis pengeélen táncolt az öntözés megkezdése de az állomány kitartott és szerencsére megérkeztek az esők. A csemege táblán többször volt kisebb eső, amit talán a Vízőr hatására jól tudott beosztani az állomány. Öntözés nélkül tudtuk végigvinni a szezont mindkét kultúrában, igaz idén sok csapadék hullott a virágzás és termékenyülés idején.

Egyetlen hátrányát tapasztaltam a készítménynek a 3 év alatt, ez pedig a kijuttathatóság területén jelentkezett. Ha a szer lejárati ideje közelében vagyunk előfordult, hogy nem mindegyik permetezőnk tudta kipermetezni az anyagot, mert dugultak a szűrők. A gyártó tájékoztatása alapján elkerülhető a dugulás, ha az anyagot beöntés előtt nagyon alaposan felkeverjük.

Csárdaszállás, 2018 október 03.

Izsó Lajos

BIOCSÁRDA KFT.
5621 Csárdaszállás, Külterület 060/21
Adószám: 11990589-2-04

Izsó Lajos
30/837-0409
carina_e@freemail.hu

My experience of the Water Retainer
I am Lajos Izsó, an agricultural engineer. In my capacity of managing director and production manager, I have been running the Biocsárda Kft. since 2003. Our company cultivates a land area of 514 hectars and we exclusively pursue organic farming. Our main agricultural crops are spelt and rice but we also produce sweet corn, sunflowers, oil pumpkins, linseeds and millet. We are also engaged in sowing-seed production, such as fodder radish, field mustard, alfalfa, autumn peas and hybrid-maize.
Over the years we have tested several formulations to increase production, such as soil improvers, foliar fertilisers and crop enhancing substances. The Water Retainer came to my attention four years ago and at the time it seemed rather strange to me since it could not really be listed among the aforementioned products as it provided us, the producers, with an absolutely new possibility. I first tested it in 2016 in the production of oil radish sowing-seed. By means of the Water Retainer I was hoping to achieve good results in germination. Spring brought dry weather that year. In the germination period we had a total amount of 8-10 mm of rains, still we had a sufficiently good crop yield. Although germination was a little slow as we farm on black soil and in spring it is difficult to prepare seedbeds for tiny seeds. I am sure the Water Retainer contributed a lot to the development of good production result.
On the basis of the first year's experience, I decided to use it also the next year. In 2017 we applied the Water Retainer on sweet corn field and this time I was also pleased. Germination was fine and steady. After germination irrigation, the crop stock lasted long and we managed to get away with irrigating only on two occasions.
For this season I ordered the necessary Water Retainer for the autumn season already in 2017. I used it on an area even larger than it was in the previous years, since the product is beginning to become an integral part of the list of technologies used so far. This year we have treated hybrid maize cultures by means of the Water Retainer. In the germination period (the middle of may) we had scarce rains. Nevertheless, germination was proper for both plants. In the history of our company we first reached a record yield in both cultures. The effectiveness of the Water Retainer was particular spectacular in the production of sweet corn, since the commencement of irrigation rested in the balance but the crop stock endured and fortunately the arrival of rains was of help, too. The corn field had some rains several times, the sparing use of which by the stock was made possible by the Water Retainer. We managed to finish off the season without irrigation in either culture, though it is true to say that this year was rich in rains both in the period of flowering and in that of fertilization.
I have found one disadvantage of the product during the past 3 years, which is constituted by its applicability. Near the time of its expiry it happened that due to clogs in the filters not every sprayer was capable of spraying out the material. According to the manufacturer's information, clogging can be avoided by thorough mixing of the material before filling in.
October 03, 2018, Csárdaszállás
Lajos Izsó
30/837-0409
carina_e@freemail.hu

Szarvas Zoltán
kertész-szakmérnök, növényorvos
egyéni vállalkozó

cím: 4060 Balmazújváros Széchenyi u 95. Magyarország
telefon: + 36 30 343 74 94
e-mail: szarvaszo@gmail.com

Mr. Richard Vattay
development director

Water&Soil Ltd.

Budapest
Lipthay u. 9.
1027

Szeged, 11th November, 2014

Water&Soil Water Retainer test result

Dear Mr. Vattay,

We have tested Water&Soil Water Retainer and we inform you about the results.

Corn

Test area: 1 hectares embedded in a large field, which was the control.
Treatment: 16 liters/hectare of Water&Soil Water Retainer mixed with herbicide. The spraying was done right after the seeding. No irrigation.
Yield: control 10,8 tons/hectare
treated 12,1 tons/hectare.

Yours sincerely,

Zoltán Szarvas
horticulturist
plant doctor

Jászapáti 2000. Mezőgazdasági Zártkörű Részvénytársaság
Szolnoki Törvényszék által a Cg. 16-10-001716 cégjegyzékszámon bejegyezve
5130 Jászapáti, Dr. Szlovencsák Imre út 4-6.sz., Pf. 14.
Tel.: 57/440-516; 30/250-2822 Fax: 57/540-620
e-mail: info@jaszapatimgzrt.hu; honlap: www.jaszapatimgzrt.hu

Mr. Richard Vattay
development director

Water&Soil Ltd.

Budapest
Lipthay u. 9.
1027

Jászapáti, 25th September, 2015

Water&Soil Water Retainer test results

Dear Mr. Vattay,

We have tested Water&Soil Water Retainer and we inform you about the results.

Sunflower

Test area: 2 hectares embedded in a large field, which was the control.
Treatment: 16 liters/hectare of Water&Soil Water Retainer mixed with herbicide.
The spraying was done right after the seeding. No irrigation.
Yield: control 2.80 tons/hectare
treated 3.10 tons/hectare.

Yours sincerely,

Jászapáti 2000 Mg. ZRt.
5130 Jászapáti
Dr. Szlovencsák I. út 4-6.

Miklós Lóczi
general manager

Jászapáti 2000. Mezőgazdasági Zártkörű Részvénytársaság
Szolnoki Törvényszék által a Cg. 16-10-001716 cégjegyzékszámon bejegyezve
5130 Jászapáti, Dr. Szlovencsák Imre út 4-6.sz., Pf. 14.
Tel.: 57/440-516; 30/250-2822 Fax: 57/540-620
e-mail: info@jaszapatimgzrt.hu; honlap: www.jaszapatimgzrt.hu

Mr. Richard Vattay
development director

Water&Soil Ltd.

Budapest
Lipthay u. 9.
1027

Jászapáti, 25th September, 2015

Water&Soil Water Retainer test results

Dear Mr. Vattay,

We have tested Water&Soil Water Retainer and we inform you about the results.

Field tomato

Test area: 2 hectares embedded in a 27 hectare field, which was the control.
Treatment: 16 liters/hectare of Water&Soil Water Retainer mixed with herbicide. The spraying was done right after the seeding. Drip irrigation.
Yield: control 47.67 tons/hectare
treated 65.3 tons/hectare.

Yours sincerely,

Jászapáti 2000 Mg. ZRt.
5130 Jászapáti
Dr. Szlovencsák I. út 4-6.

Miklós Lóczi
general manager

Intermaspolska Sp. Z o.o.
95-200 Pabianice
Ul.Lutomierska 46

Mr. Richard Vattay
development director

Water&Soil Ltd.

Budapest
Lipthay u. 9.
1027

Lodz, 5th November, 2015

Water&Soil Water Retainer test results

Dear Mr. Vattay,

We have tested Water&Soil Water Retainer and we inform you about the results.

Potato

Test area: We split the field into 2 even parts. Half was treated and the other half was the control.
Treatment: 16 liters/hectare of Water&Soil Water Retainer. No irrigation.
Yield: control 12.00 tons/hectare
treated 14.34 tons/hectare.

Yours sincerely,

Hartai Zoltan

Zoltan Hartai
general manager

Jászapáti 2000. Mezőgazdasági Zártkörű Részvénytársaság
Szolnoki Törvényszék által a Cg. 16-10-001716 cégjegyzékszámon bejegyezve
5130 Jászapáti, Dr. Szlovencsák Imre út 4-6.sz., Pf. 14.
Tel.: 57/440-516; 30/250-2822 Fax: 57/540-620
e-mail: info@jaszapatimgzrt.hu; honlap: www.jaszapatimgzrt.hu

Mr. Richard Vattay
development director

Water&Soil Ltd.

Budapest
Lipthay u. 9.
1027

Jászapáti, 27th November, 2014

Water&Soil Water Retainer test results

Dear Mr. Vattay,

We have tested Water&Soil Water Retainer and we inform you about the results.

Sugar beet

Test area: 2 hectares embedded in a large field, which was the control.
Treatment: 16 liters/hectare of Water&Soil Water Retainer mixed with herbicide.
The spraying was done right after the seeding. No irrigation.
Yield: control 66.04 tons/hectare
treated 83.38 tons/hectare.

Yours sincerely,

Jászapáti 2000 Mg. ZRt.
5130 Jászapáti
Dr. Szlovencsák I. út 4-6.

Miklós Lóczi
general manager

Mr. Richard Vattay
development director

Water&Soil Ltd.

Budapest
Lipthay u. 9.
1027

Orosháza, 26th October, 2015

Water&Soil Water Retainer test results

Dear Mr. Vattay,

We have tested Water&Soil Water Retainer and we inform you about the results.

Sunflower

Test area: 1.0 hectares embedded in a 2.5 hectares field, which was the control.
Treatment: 16 liters/hectare of Water&Soil Water Retainer mixed with herbicide.
The spraying was done right after the seeding. No irrigation.
Yield: control 3.05 tons/hectare
treated 3.50 tons/hectare.

Yours sincerely,

Vass Zoltán
Orosháza

VASS SPEED KFT.
5900 Orosháza, Kosztolányi u. 8.
Adószám: 13174839-2-04
CIB Bank
10700316-24141008-51100005

Mr. Richard Vattay
development director

Water&Soil Ltd.

Budapest
Lipthay u. 9.
1027

Szarvas, 26th October, 2015

Water&Soil Water Retainer test results

Dear Mr. Vattay,

We have tested Water&Soil Water Retainer and we inform you about the results.

Sunflower

Test area: 5 hectares embedded in an 8 hectares field, which was the control.
Treatment: 16 liters/hectare of Water&Soil Water Retainer mixed with herbicide.
The spraying was done right after the seeding. No irrigation.
Yield: control 2.70 tons/hectare
treated 3.40 tons/hectare.

Yours sincerely,

Balatoni László
Szarvas

Szarvas Zoltán
kertész-szakmérnök, növényorvos
egyéni vállalkozó

cím: 4060 Balmazújváros Széchenyi u 95. Magyarország
telefon: + 36 30 343 74 94
e-mail: szarvaszo@gmail.com

Mr. Richard Vattay
development director

Water&Soil Ltd.

Budapest
Lipthay u. 9.
1027

Szeged, 07th October, 2014

Water&Soil Water Retainer test result

Dear Mr. Vattay,

We have tested Water&Soil Water Retainer and we inform you about the results.

Sunflower

Test area: 2 hectares embedded in a large field, which was the control.
Treatment: 16 liters/hectare of Water&Soil Water Retainer mixed with herbicide. The spraying was done right after the seeding. No irrigation.
Yield: control 3.6 tons/hectare
treated 4.1 tons/hectare.

Yours sincerely,

Zoltán Szarvas
horticulturist
plant doctor

Mr. Richard Vattay
development director

Water&Soil Ltd.

Budapest
Lipthay u. 9.
1027

Orosháza, 11th January, 2016

Water&Soil Water Retainer test results

Dear Mr. Vattay,

We have tested Water&Soil Water Retainer and we inform you about the results.

Broccoli (field)

Treatment: 16 liters/hectare of Water&Soil Water Retainer. The spraying was done right after the planting.

Results:

Yield:

treated: 12 000 kg/hectare
control: 9 250 kg/hectare.
Yield surplus on the treated: 2 750 kg = + 29.73%.

Income surplus:

2 750 kg/ha x EUR/kg 0.97 = EUR 2 667.50

Yours sincerely,

VASS SPEED KFT.
5900 Orosháza, Kosztolányi u. 8.
Adószám: 13174839-2-04
CIB Bank
10700316-24141008-51100005

Zoltán Vass
Orosháza

Mr. Richard Vattay
development director

Water&Soil Ltd.

Budapest
Lipthay u. 9.
1027

Orosháza, 11th January, 2016

Water&Soil Water Retainer test results

Dear Mr. Vattay,

We have tested Water&Soil Water Retainer and we inform you about the results.

Cauliflower (field)

Treatment: 16 liters/hectare of Water&Soil Water Retainer. The spraying was done right after the planting.

Results:

Yield:

treated: 71 100 kg/hectare
control: 66 749 kg/hectare.
Yield surplus on the treated: 4 351 kg = + 6.52%.

Income surplus:

4 351 kg/ha x EUR/kg 0.51 = EUR 2 219.01

Yours sincerely,

Zoltán Vass
Orosháza

Szarvas Zoltán
kertész-szakmérnök, növényorvos
egyéni vállalkozó

cím: 4060 Balmazújváros Széchenyi u 95. Magyarország
telefon: + 36 30 343 74 94
e-mail: szarvaszo@gmail.com

Mr. Richard Vattay
development director

Water&Soil Ltd.

Budapest
Lipthay u. 9.
1027

Szeged, 21st October, 2014

Water&Soil Water Retainer test result

Dear Mr. Vattay,

We have tested Water&Soil Water Retainer and we inform you about the results.

Kohlrabi

Test area: 800 m² greenhouse without heating
Treatment: 16 liter/hectare after planting washed by 2.5 mm irrigation. The use of irrigation water was 45 % less in the treated.
Yield: average weight: treated: 571.2 gram, control: 567.8 gram
average diameter: treated: 92.2 mm, control: 97 mm
Note: The taste of the treated was much more intensive.

Yours sincerely,

Zoltán Szarvas
horticulturist
plant doctor

Szarvas Zoltán
kertész-szakmérnök, növényorvos
egyéni vállalkozó

cím: 4060 Balmazújváros Széchenyi u 95. Magyarország
telefon: + 36 30 343 74 94
e-mail: szarvaszo@gmail.com

Mr. Richard Vattay
development director

Water&Soil Ltd.

Budapest
Lipthay u. 9.
1027

Szeged, 21st October, 2014

Water&Soil Water Retainer test result

Dear Mr. Vattay,

We have tested Water&Soil Water Retainer and we inform you about the results.

Kohlrabi

Test area: 800 m² greenhouse without heating
Treatment: 16 liter/hectare after planting washed by 2.5 mm irrigation. The use of irrigation water was 45 % less in the treated.
Yield: average weight: treated: 571.2 gram, control: 567.8 gram
average diameter: treated: 92.2 mm, control: 97 mm
Note: The taste of the treated was much more intensive.

Yours sincerely,

Zoltán Szarvas
horticulturist
plant doctor

TreeTec
Bio Solutions

Santiago, September 25th, 2017

Mr.
Richard Vattay
Director
Water&Soil Ltd.
Budapest, Hungary

Ref: Vineyards Test Results from Season 2016-2017 in Chile

Dear Richard,

Please find below result for Water Retainer in a vineyard located in Chile during the past season 2016-2017.

CUSTOMER: VIÑA VENTISQUERO

Executive in Charge: Mr. Miguel Gallet

Principal Results:

"During last season 2016-2017 all of the vineyards in Chile, including ours, did present a lack of production in terms of kilograms harvested, but we did not face that less production on the area where we made the treatment with Water Retainer. In addition, we did irrigate 30% less than the other areas of the vineyard"

This customer and another - VIÑA MONTES - confirmed that they will run their test on bigger plot and with more detail during the coming season 2017-2018.

Best regards,

Felipe Díaz

TREETEC CHILE SpA.
RUT: 76.514.588-0

Manager

Treetec Chile SpA.


Ornamental plant nursery
No irrigation
After more than 30 days without rain
Left: Treated with the Water Retainer; Right:
Untreated control

Relax Garden Kft.
2030 Érd, Szirtes u. 29.

relaxgarden

Richárd Vattay
CEO
Water&Soil Ltd.
1027 Budapest, Lipthay street 9.

Practical experiences in lawn irrigation with the Water&Soil Water Retainer® product

Dear Mr Vattay!

The Water Retainer® product developed by your company is, in my opinion, the most promising agricultural innovation of our time. It was for my great joy that we could be one of the first ones to try it out in practice. I would like to share the experiences from this experiment with you!

In Tihany, in the Cserhegy-hill, there's a garden built and maintained regularly by us. The garden is overlooking a lake, has southern exposure with a drier and warmer weather than average, since it's in a hillside with sub-Mediterranean microclimate. There's 4000 m² lawn in the garden. The grass is kept by regular nutrient refill, fertilization, watering, mowing, aeration. The lawn is watered by an automatic irrigation system, which lacking other options is supplied by the common water system.

While continuing with the usual maintenance we used Water Retainer® in 2015. The 16 liter/ha dose product was applied doubled – 32 liter/ha dose - in 2 occasions. The first treatment was conducted 2nd of May, the second was two months later, on the 3rd of July. The release with motorized dorsal sprayers is quick and easy. The same time as the first treatment the irrigation system was reprogrammed. The quantity of the irrigation water was reduced with 40%.

Based on our experience by using Water Retainer® compared to the previous years the lawn was greener, fresher, more spectacular throughout the whole year. The hot spells of last year's summer and early autumn didn't affect it negatively. The dry patches that appeared in the summer during the previous years didn't come. Besides these positive experiences, there was also a significant water saving. The possible ecological significance of having to use 40% less water speaks for itself. On another note the expenses show significant changes too. By our estimation the owner with every HUF spent on Water Retainer® saved 10 HUF worth of water charge. In case of the garden in Tihany this means hundred thousands HUF.

Summarizing our experiences we think that by using Water Retainer® the garden owner gains a lot by spending little. Consequently from our experiences in Tihany we will use it in all of our gardens in 2016 while applying it in areas like laying down grass, plantation and indoor plants. We highly recommend Water Retainer® to the gardener colleagues as well.

Yours faithfully

József Horváth
managing director
Relax Garden Ltd.

RELAX GARDEN KFT.
2030 Érd, Szirtes u.29.
Adószám: 22748221-2-13
Bsz.: 11722010-20000167

Érd, 23rd January 2016.

E-mail: info@relaxgarden.hu
Web: www.relaxgarden.hu

Mr. Richard Vattay
development director

Water&Soil Ltd.

Budapest
Lipthay u. 9.
1027

Kisoroszi, 21st October, 2014

Water&Soil Water Retainer test result

Dear Mr. Vattay,

We have tested Water&Soil Water Retainer on our golf course and we inform you about the results.

Test area: 15th fairway top of the bumpy area

Treatment: 10 liter/hectare sprayed to the surface of the fairway than washed by 2.5 mm irrigation. During the period of 14th June 2014 – 15th July 2014 we gave 50% less irrigation every second day for the treated part of the fairway. The condition was of the fairway was the very same for both the treated and the control. We could save 25% of irrigation water during this period of time.
We provided a maintaining treatment on the 23rd July 2014 and we increased the dosage for 20 liters/ha. From that time we were able to reduce the use of irrigation by further 25%, which means we were able to save 50% of the irrigation water in comparison to the control.

Yours sincerely,

István Nagy
President

MAGYAR GOLF CLUB 1911 KISOROSZI

Magyar Golf Club
Cím: 1073 Bp., Erzsébet krt. 58.
E-mail: info@magyargolfclub.hu
Telefonszám: 06 26 592 020
Adószám: 19676119-1-42

We used the Water Retainer (in Hungarian: VízŐr) in 2015 on the Hungarian Golf Club's course located in Kisoroszi, in its smaller areas for testing purposes. The soil of our course is heavily sandy in many parts, with the poor water retaining capacity typical for this.

We decided to apply it in 2016 in all parts of the course where, in our experience, the grass "burns out".

We performed the first treatment by using the WR on 1-2 June, in two phases:

In the first 9 sections, the burnout-prone hilltops, the parts with highly sandy soil and on sections 15-18 a total of 20 pcs of greens of the entire surface and the course received a treatment with a dose of 15 l/ha. On 2 June we treated the entire surface of the first 9 sections with a dose of 15 l/ha.
Therefore, in the first nine sections, the burnout-prone areas were treated with a total dose of 30 l/ha. The reason for the different treatment applied in the specific parts was that, knowing the course well, we had an assumption about the treatment by which we can achieve the desired result, with a possible correction, if necessary.
On 10 August, we applied a repeated treatment, all the green surfaces and the burnout-prone areas received a treatment of a dose of 10 l/ha.

As a result of treatments, it can be said that on the entire surface of the course, evenly, the irrigation water - reduced by half - was sufficient. Before the use of the Water Retainer, in order to ensure an adequate water supply of the problematic parts, we had to irrigate also the areas which do not require excess water, with a double water volume. By placing out the Water Retainer (VízŐr) to the proper places, the optimal watering of the total area became possible, and the areas not prone to desiccation were not irrigated with too much water. There was no dessication.
The year of 2016 was relatively wet, but it was not particularly significant because it influenced only the total water consumption for irrigation.

We noticed also an other significant effect: We started to apply a fungus-eating fungus-based preparation in 2015 to protect against fungal diseases on the green. In addition to this, we also had to apply chemicals - in a relatively drier year, just like 2016 - to protect against fungal infections. This year, in addition to the application of the Water Retainer, it was enough to use the fungus-eating fungus, we did not have to use chemicals. The nutrition extent of the area was the same as in the previous years.

On the fairways, we treated Agrostis stolonifere 07 grass. On the green surfaces, we treated 50-50% Agrostis stolonifere 007 and Agrostis stolonifere Pennlinks 1 grass mixtures.

In our opinion and also according to the golfers, our grass surfaces were more beautiful than in the previous years.

Kisoroszi, 11 January, 2017

István Nagy
Chairman

MAGYAR GOLF CLUB
KISOROSZI
1073 Bp.Erzsébet krt 58.3/17
Adószám: 19676119-1-42

MAGYAR GOLF CLUB - KISOROSZI

Mr. Richard Vattay
development director

Water&Soil Ltd.

Budapest
Lipthay u. 9.
1027

Kisoroszi, 21st October, 2014

Water&Soil Water Retainer test result

Dear Mr. Vattay,

We have tested Water&Soil Water Retainer on our golf course and we inform you about the results.

Test area: 15th fairway top of the bumpy area

Treatment: 10 liter/hectare sprayed to the surface of the fairway than washed by 2.5 mm irrigation. During the period of 14th June 2014 – 15th July 2014 we gave 50% less irrigation every second day for the treated part of the fairway. The condition was of the fairway was the very same for both the treated and the control. We could save 25% of irrigation water during this period of time.
We provided a maintaining treatment on the 23rd July 2014 and we increased the dosage for 20 liters/ha. From that time we were able to reduce the use of irrigation by further 25%, which means we were able to save 50% of the irrigation water in comparison to the control.

Yours sincerely,

István Nagy
President

For the attention of Water&Soil Kft.

At your request, my experience related to the use of the Water Retainer is summarized below.

I use the Water Retainer in the production of turfgrass. I cultivate an area of low rainfall (430-540 mm rain/year) and that of very loose, sandy structure, which is located near to Áporka municipality.

Irrigation of crucial importance in the production of turfgrass. I started to use the Water Retainer in 2017, right after grass seed sowing. Sowing is performed by using a professional seeder.

In the previous years, the watering needs of the turfgrass on the given area (1.2 ha) were ensured by irrigation carried out four times a day for a period of 21 days. This typically means a daily water volume of 120 m^3, which is provided through the application of a mobile reel drum irrigation system. At a later stage, after an early summer sowing, the amount of the irrigated water used is $300m^3/7$ days. In case this amount is supplemented by rain, or when gloomy and windless weather results in less water loss from the soil, the aforementioned amount of irrigation water may become decreased.

By using the Water Retainer - which meant a single 10 l/ha treatment - during the germination and sprouting periods, the number of irrigations and consequently the water usage could be reduced to 1/day and to the quarter of the above amount. In the subsequent period irrigation water use decreased by about its half. Naturally, the related energy and labour force expenses also decreased accordingly.

Additionally, a significant benefit derived from using Water Retainer is that plant density at least doubled in the treated area as compared to that obtained earlier, consequently, this resulted in a more evenly distributed grass seed germination, which constitues further advantages in the production of turfgrass.

May 2nd, 2018, Áporka

Tóth Gábor

+36309509982

gaboragrar@gmail.com

BERETVÁS
KERTÉSZET

Beretvás Kertészet Kft.

Cím: 2319 Szigetújfalu, 060/91. hrsz.

Email: beretvaskert@gmail.com

Weboldal: www.beretvas.hu

Mr. Richard Vattay
development director
Water&Soil Ltd.
1027 Budapest, Lipthay u. 9.

Water&Soil Water Retainer test results

Dear Mr. Vattay,

Our perennial nursery, the Beretvás és Társai Kft. has been dealing with perennial cultivation for more than 8 years, through all seasons of the year. We grow our plants in pots of different sizes. The most common potsize we use is 9x9x10 cm. We often develop 20-30 cm high plants in these pots, therefore the evaporation surface is much larger than the water absorption surface. Since many years we suffer from significant "summer losses" because of the extreme warm summers, and in some cases these losses can even exceed our winter losses. This is due mainly to the dry and hot periods, whereby the 9x9 cm pot plants evaporate large amounts of water and we can hardly keep up with the irrigation. A further case for such losses is the great number of diverse pathogens turning up during the hot summer period. These pathogens, parasites and other pests often appear as a consequence of uneven water supply (a sudden huge amount of rainfall and then a dry period with a temperature over 35°C).

We started to use Water Retainer in 2014. First we used it on different stocks of perennials in such a way that we treated the half of our plants and didn't treat the other half, which became the control material. We irrigated the control half daily and the treated half every second day. The plants were placed in a polytunnel (a closed area from upwards), so the water application was fully under control. As a result of the test we can state that regarding the development of our perennials we couldn't recognize any differences between the treated and the control material, despite the fact that the treated plants got only a half amount of water.

As a result of this test we decided to use Water Retainer treatment on our whole container plantation area in June 2015, a year in which we had an exceptional drought and heat. After the treatment we recognized losses only in negligible percentage! We didn't need to employ one more person for watering or to work extra hours with the existing staff on our 2.5 hectares area.

Normally two summers are always a bit different, but we can state by all means that this year – hotter than an average summer – we used roughly the same amount of hours for watering and practically there were no losses because of the drought. Our plants were in a very good condition during the whole year and most of them have been already sold during the summer.

Best regards,

BERETVÁS ÉS TÁRSAI KFT.
2319 Szigetújfalu, 060/91. hrsz.
Adószám: 14327834-2-13

István Patkós
owner
Beretvás és Társai Kft.
2319 Szigetújfalu, 060/91. hrsz.

Szigetújfalu, 6th November, 2015.