COMPLETION REPORT

on

Performance of Structured Water on Growth, Yield and Quality of Cotton and Vegetables

Sponsored by
VWF Industries Pvt. Ltd, Mysore

TAMIL NADU AGRICULTURAL UNIVERSITY
WATER TECHNOLOGY CENTRE
COIMBATORE-641 003

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Phone: 0422 6611278, 6611378, 6611375 (O) / Tel.Fax: 0422 6611478
Mob: 94432 86711 Email: directorwtc@tnau.ac.in , bjp1402@yahoo.co.in

Dr. B.J.Pandian.,Ph.D.,
Director(WTC)i/c & Nodal Officer, TN-IAMWARM Project.

Lr. No. DR/WTC/Private Agency Scheme/Completion Report/2015 Dt: 18.05.2015

To
The President,
VWF Industries Pvt. Ltd,
90, KRS Road, Metagally,
Mysore – 570 016.

Through:
The Director of Research
Tamil Nadu Agricultural University
Coimbatore – 641 003.

Sir,

Sub: TNAU - WTC - Completion Report - Private Agency Scheme – sponsored by M/s. VWF Industries Pvt. Ltd, – sending - regarding.

I am enclosing herewith the completion report for the private agency scheme entitled "Performance of Structured Water on Growth, Yield and Quality of Cotton and Vegetables" sponsored by M/s. VWF Industries Pvt. Ltd, Mysore for kind perusal.

Director (WTC)

18/5/15

No DR/P2/Structured water/WTC/Final Report/2015 dt 19-5-2015

To
The President,
VWF Industries Pvt Ltd.,
Mysore-16.

DIRECTOR OF RESEARCH
Tamil Nadu Agricultural University
COIMBATORE - 641 003.

19/5/15

COMPLETION REPORT

1.	Title	:	Performance of Structured Water on Growth, Yield and Quality of Cotton and Vegetables
2.	Name of the Dept./ Research Station	:	Water Technology Centre, TNAU, Coimbatore - 3.
3.	Project Supervisor	:	Dr. B.J. Pandian Director, Water Technology Centre Tamil Nadu Agricultural University Coimbatore 641 003. Tamil Nadu.
4.	Name and designation of the Project Leaders	:	**Principal Investigator** Dr. D. Jayanthi Assistant Professor (SS&AC) Water Technology Centre, TNAU, Coimbatore 641003 **Co-Principal Investigators** Dr. P. Jothimani Assistant Professor(ENS) Dr. A. Valliammai Assistant Professor(SWCE) Water Technology Centre, TNAU, Coimbatore 641003
5.	Period	:	Two years(April 2013– March 2015)
6.	Objectives	:	i. To assess the influence of structured water unit on chemical composition and various water quality parameters. ii. To evaluate the impact of structured water unit on seedling vigour, growth, soil properties and uptake of nutrients by cotton and vegetables. iii. To compare yield and quality of the produce with existing practices.
7.	Progress made	:	Enclosed in Annexure

Director

DIRECTOR,
Water Technology Centre,
Tamil Nadu Agricultural University
Coimbatore - 641 003.

ANNEXURE

I. Introduction

Structured water units create a tuned environment where water is caused to flow in specific geometrical patterns. The flows and counter flows create an environment of dynamic shear and pressure differentials that turn water into a machine. This technology employs an innovative application and advanced understanding of the vortex phenomenon utilizing the dynamic characteristic of water itself to create a “Natural Action Unit” that works at the molecular level. This “Natural Action unit” alters the molecular structure of the water, activating and retaining the minerals.

Specially tuned geometry creates an energy environment for water to structure itself. This gives water a lower surface tension and better hydrating properties. This geometric technology breaks up large low energy water molecule clusters into smaller high energy clusters. This innovative technology eliminates negative energy patterns and redefines the water’s natural healthy energy pattern.

It is reported that, by irrigating with structured water, plants grow well, fruit and nut trees mature sooner, healthy with dense foliage and well-developed trunks, significant increase in shelf life, significant increase in nutrient density, 30-50% reduction in water use, more drought resistant, heat and freeze resistant, as well as pest and disease resistant etc. Crops watered with structured water have higher nutritional and sugar levels (brix levels). It is a technology used for water treatment which is able to play upon the methods used by nature to produce smoother, softer and cleaner water. This means without the use of chemicals, salts, filters or any completely unnatural solution for purifying water.

II. Materials and methods (First year 2013 – 2014)

To assess the effectiveness of structured water unit on plant growth, yield, soil properties and nutrient uptake the field experiments were conducted during 2013 – 14 employing cotton, bhendi and tomato as test crops. To ascertain its role in improving the irrigation water quality, two separate field trials, one at Agricultural College and Research Institute (TNAU), Coimbatore employing test crop as cotton and two more field trials at farmer's field in Thondamuthur block employing test crop as tomato and bhendi were carried out for confirmation of results. The details of the experimental materials used and the methods adopted are presented below.

1. Crop: Cotton

Sowing of cotton was taken up with the Hybrid Bunny Bt (NCS 145) on 21.08.2013 by adopting paired row system in drip irrigation method. The recommended fertilizer dose of 150:75:75 kg NPK ha^{-1} was given through fertigation and cotton picking was completed on 25.03.2014.

Treatments

T_1 - Drip irrigation with ordinary water

T_2 – Drip irrigation with 100% structured water

T_3 - Drip irrigation with 75% structured water

Design and layout

The layout plan of the experimental field is depicted in Fig.1.

Gross plot size: 12 m x 21 m = 252 m^2

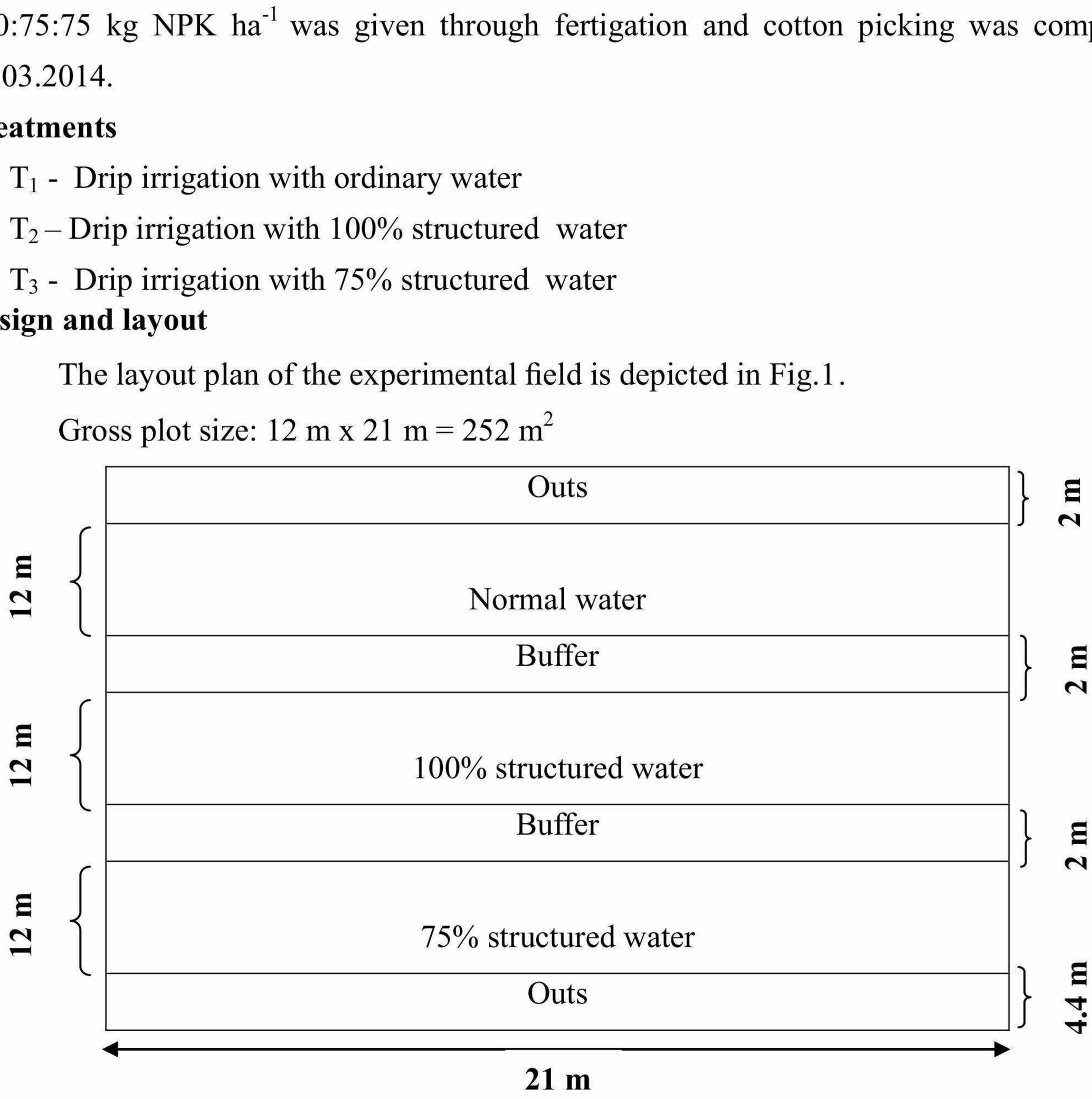
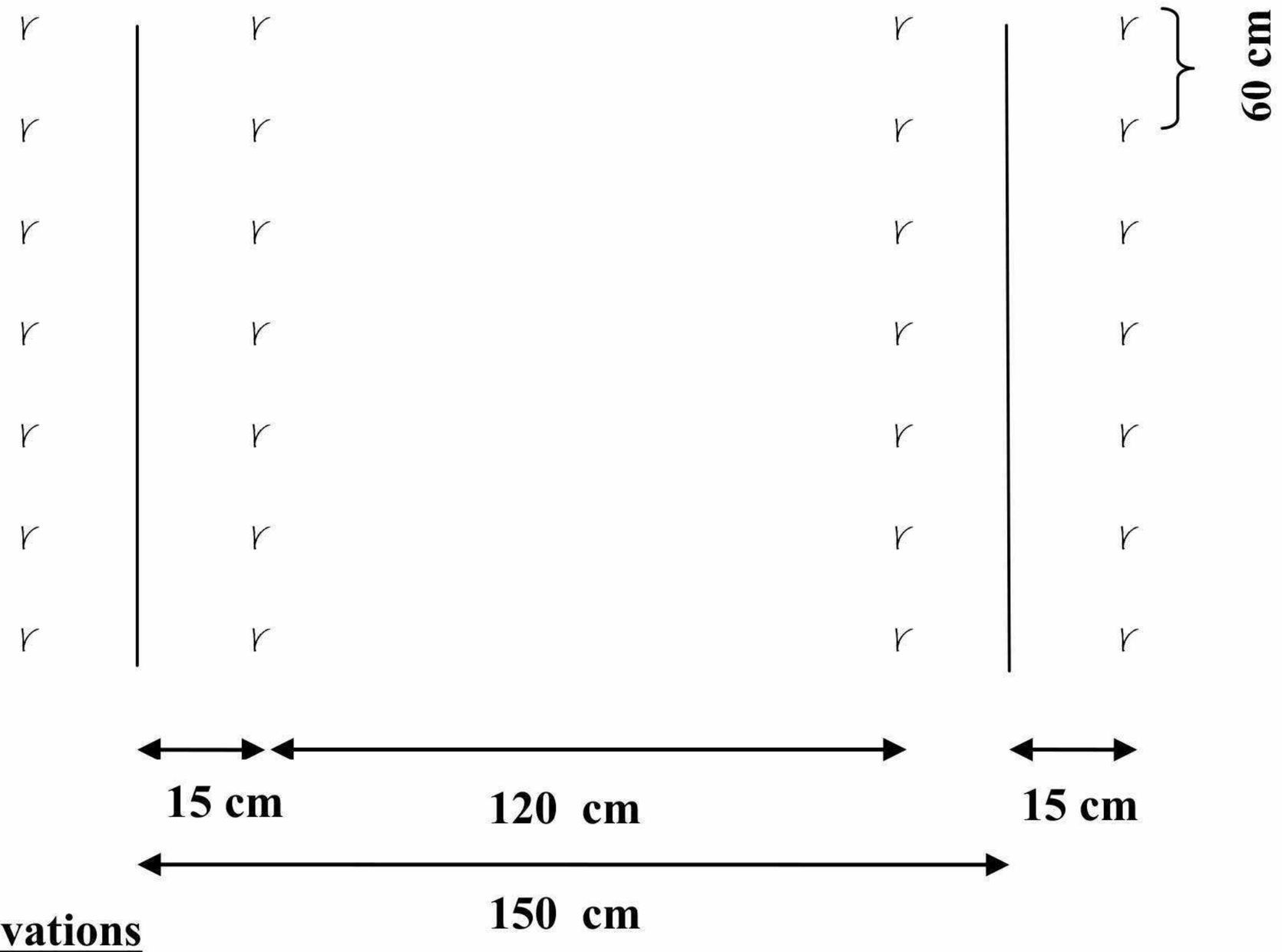


Fig.1. Layout plan of the experimental field of cotton

Paired row method



Biometric Observations

Five plants were selected randomly in each plot and tagged for recording biometric observations. The following observations were recorded.

Germination percentage

Seed germination was counted after seven days and expressed as percentage.

Plant height

The length of the main stem from the cotyledon node to the tip was measured and the average length was expressed in cm. The height measurement was recorded on 40, 80,120 days of sowing (DAS) and at harvest.

Leaf length, breadth and number of leaves plant $^{-1}$

From five randomly selected plants in each plot, leaf length and maximum width of the third leaf from the top was measured. Total number of leaves in each plant was counted. The observations were made on 40, 80,120 DAS.

Number of monopodia plant $^{-1}$

Monopodial branches arising from the auxillary buds were counted on 80 and 120 DAS from five plants in each plot and the mean value was expressed as number per plant.

Number of sympodia plant $^{-1}$

The number of reproductive branches arising from extra auxillary buds was counted on 80 and 120 DAS from five plants in each plot and the mean value was expressed as number per plant.

Root length

The depth of the root was measured and the average length was expressed in cm on 40 DAS.

Number of bolls plant $^{-1}$

From five randomly selected plants in each plot, the number of bolls picked per plant was totaled up for all the pickings and the average worked out to arrive at number of bolls plant $^{-1}$.

Seed cotton yield

The seed cotton was gathered in each plot at fortnightly intervals and weighed. The seed cotton yield was totaled up for all the pickings and expressed in kg ha^{-1}.

Drip - uniformity co – efficient

The uniformity describes how evenly an drip irrigation system distributes water over a field. It is regarded as one of the important features for selection, design and management of the drip irrigation system.

In uniformity studies the water was collected from emitters in a container for 15 minutes. Ten samples were collected per treatment. The volume of collected sample was measured by using measuring cylinder (ml/15 min) and converted to litre per hour. The uniformity co-efficient was calculated by using the formula,

$$UC = \{ 1 - [1/nq_a * \sum|q_i - q_a| \} * 100$$

Where,

UC – Uniformity co-efficient

n = Number of observed emitters or cans

q_i = Emitter flow rate L/hr

q_a = Average Emitter flow rate L/hr

<u>Quality Parameters in cotton</u>

Ginning percentage

100 g of kapas was weighed and the lint and seed were separated, then the ratio of weight of lint to weight of seed was expressed as percentage.

Lint index

From the weight of lint from 100g of seed cotton obtained as described above, the weight of lint on 100 seed cotton was computed.

Seed index

The seeds obtained after assessing the ginning percentage were counted and weighed. The average weight of 100 seeds was expressed as seed index.

2. <u>Crop: Tomato</u>

Transplanting of tomato was taken up with the variety of Bhagiyavan on 05.09.2013 by adopting drip irrigation method with the spacing of 120 x 60 cm. Recommended fertilizer dose of 200:150:150 kg NPK ha^{-1} was given through fertigation. Totally 7 irrigation was given to the crop.

Treatments

T_1 - Ordinary water

T_2 - Structured water

Design and layout

The layout plan of the experimental field is depicted in Fig.2.

Gross plot size: 40 m x 29 m = 1160 m^2

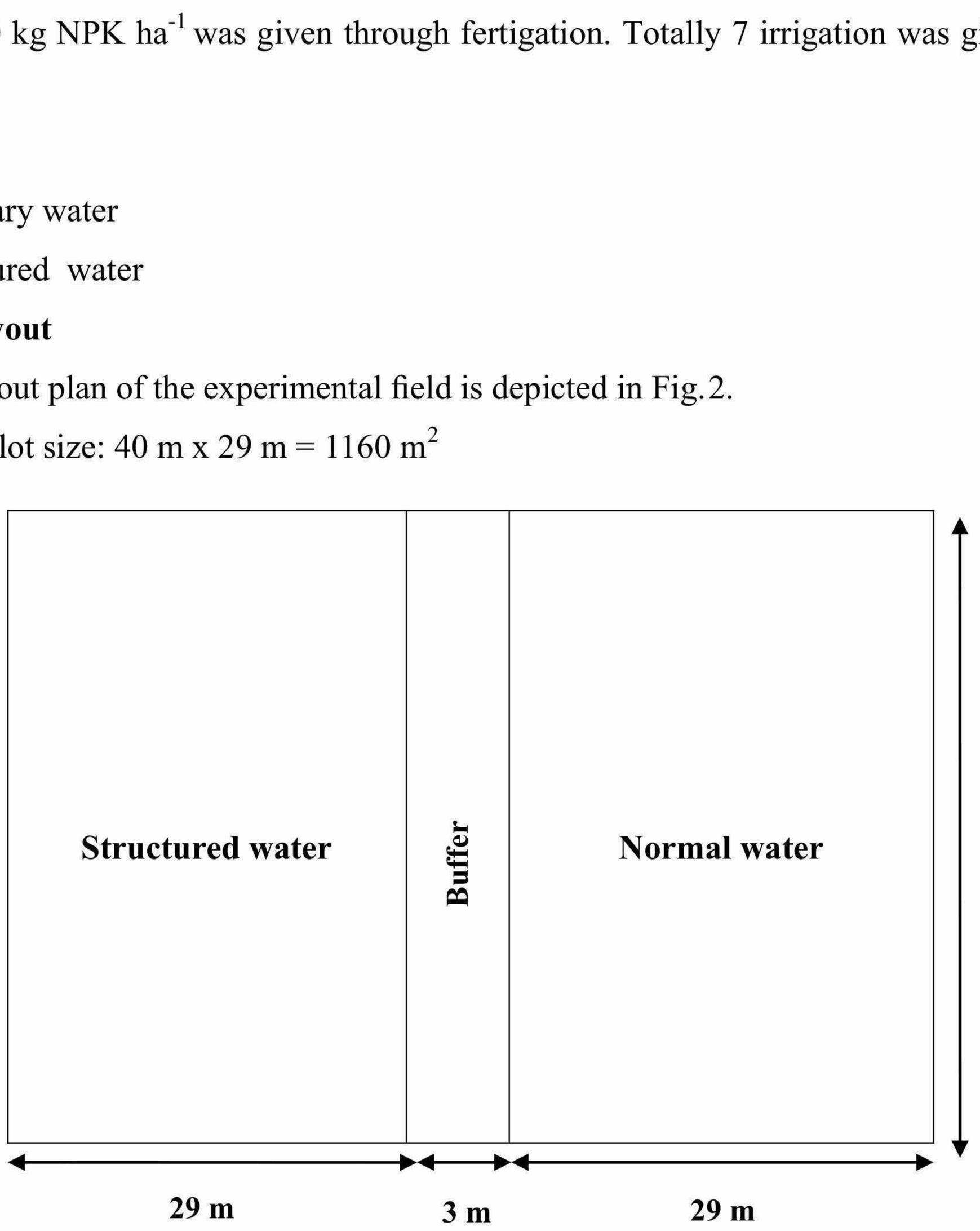


Fig.2. Layout plan of the experimental field of tomato

Biometric observation

Five plants were selected randomly in each plot and tagged for recording biometric observations. The following observations were recorded.

Plant height

The distance between the cotyledonary node to the tip of the main stem was measured using a meter scale at 30, 60 and 90 DAP and the mean value was expressed in centimeter (cm).

Number of Primary branches

The branches that arise from the main stem were reckoned as primary branches which were counted at 30, 60 and 90 DAP and expressed in number per plant.

Number of Secondary branches

The branches that arise from the primary branches were reckoned as secondary branches which were counted at 30, 60 and 90 DAP and expressed in number per plant.

Number of flowers plant^{-1}

Numbers of flowers were counted at 60 and 90 DAP from lower, middle and upper parts of the plant, the mean number of flowers per plant was computed.

Number of fruits plant^{-1}

The fruits collected in each harvest were totaled and the mean was expressed as number plant^{-1}.

Yield plot^{-1} / Yield ha^{-1}

The fruits at each harvest were weighed using an electronic balance and the cumulative weights over all the harvests were recorded and the mean value was expressed as kg plot^{-1} and then converted to kg ha^{-1}.

Quality parameters in tomato

Acidity

Acidity as citric acid was estimated following the method of AOAC and expressed in percentage.

Ascorbic acid

Ascorbic acid in tomato pulp was estimated following the procedure given in AOAC and the same was expressed in mg/100g of fresh sample.

Total soluble solids

The total soluble solids of tomato pulp was found out through a hand refractrometer and expressed as percentage.

Total sugars

The total sugars were estimated as per the procedure given by Somoigyi (1952) and expressed in percentage.

3. Crop: Bhendi

Sowing of bhendi (var.102) was taken up on 07.10.2013 by adopting drip irrigation method with the spacing of 45 x 30 cm. Recommended fertilizer dose of 200:100:100 kg NPK ha^{-1} was given through fertigation. Totally five irrigation was given to the crop during the growth period.

Treatments

T_1 - Ordinary water

T_2 - Structured water

Design and layout

The layout plan of the experimental field is depicted in Fig.3.

Gross plot size: 40 m x 17.4 m = 696 m^2

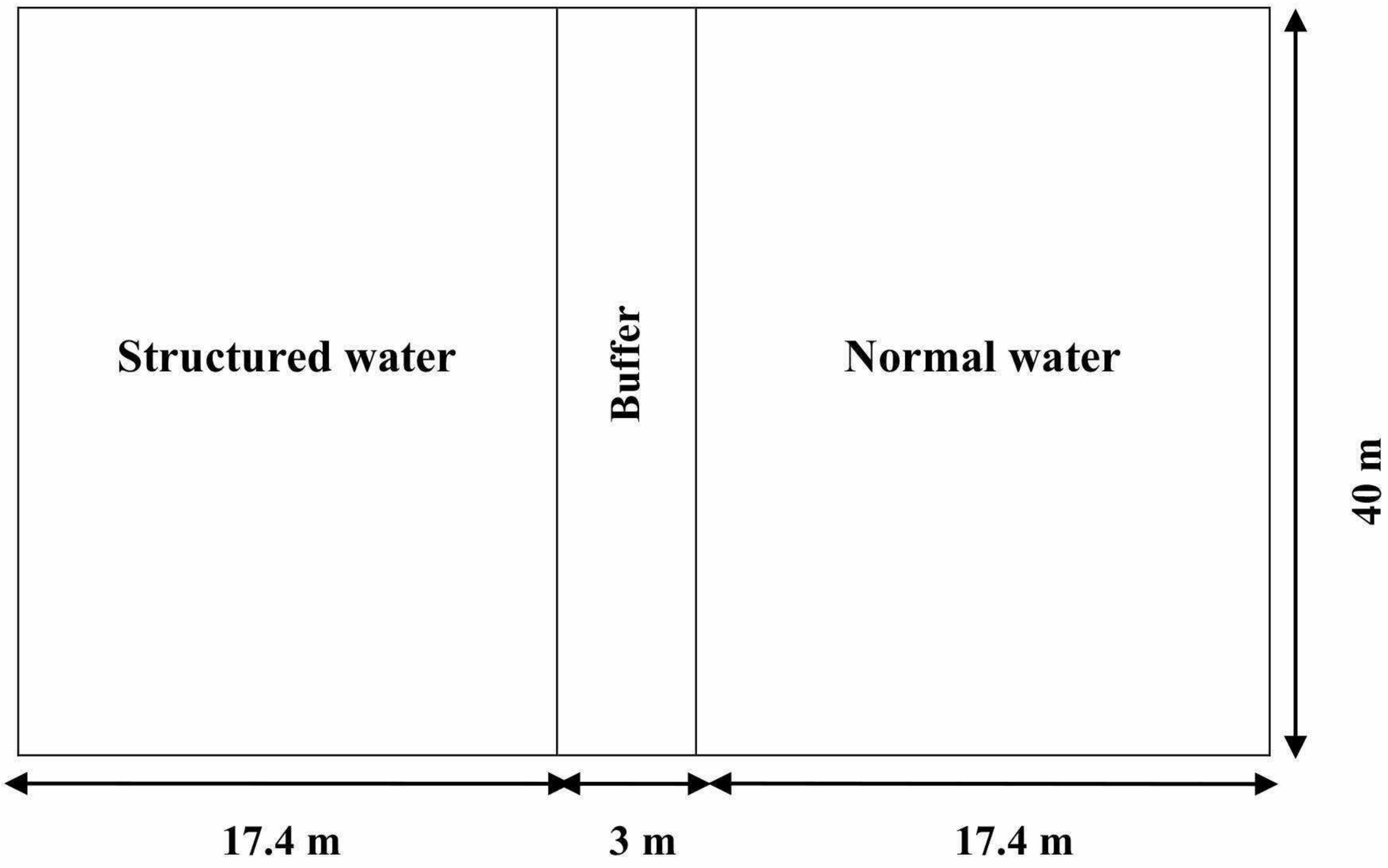


Fig.3. Layout plan of the experimental field of bhendi

Biometric observation

Five plants were selected randomly in each plot and tagged for recording biometric observations. The following observations were recorded.

Germination percentage

Seed germination was counted after seven days and expressed as percentage.

Plant height

The height was measured from a fixed point (i.e.) just above soil surface level to the growing tip of the main shoot at 30, 60 and 90 DAS and expressed in cm.

Number of leaves

Total number of leaves was counted at 30, 60 and 90 DAS and expressed in numbers.

Leaf length and breadth

The 3rd leaf length and breadth from the top was measured 30, 60 and 90 DAS and expressed in cm.

Number of fruits

Total number of fruits harvested from the selected plants till the final harvest was recorded and expressed as number of fruits per plant.

Fruit length and girth

The length and girth of the fruit was measured using a meter scale and expressed in cm.

Yield plot^{-1} / Yield ha^{-1}

The fruits at each harvest were weighed using an electronic balance and the cumulative weights over all the harvests were recorded and the mean expressed as kg plot^{-1} and then converted to kg ha^{-1}.

III. Materials and methods (Second year 2014 – 2015)

The confirmation field experiments were conducted during 2014 – 15 employing sorghum and onion as test crops at farmer's field in Sulur, Coimbatore (Dt) and at farmer's field in Vellode, Erode (Dt). The details of the experimental materials used and the methods adopted are presented below.

4. Crop: Sorghum

Sowing of sorghum was taken up with the local variety on 06.09.2014 by adopting surface irrigation method. The recommended fertilizer dose of 90:45:45 kg NPK ha^{-1} was applied and totally four irrigation was given to the crop.

Treatments

T_1 - Ordinary water

T_2 - Structured water

Design and layout

The layout plan of the experimental field is depicted in Fig.4.

Gross plot size: 9 m x 7.5 m = 67.5 m^2

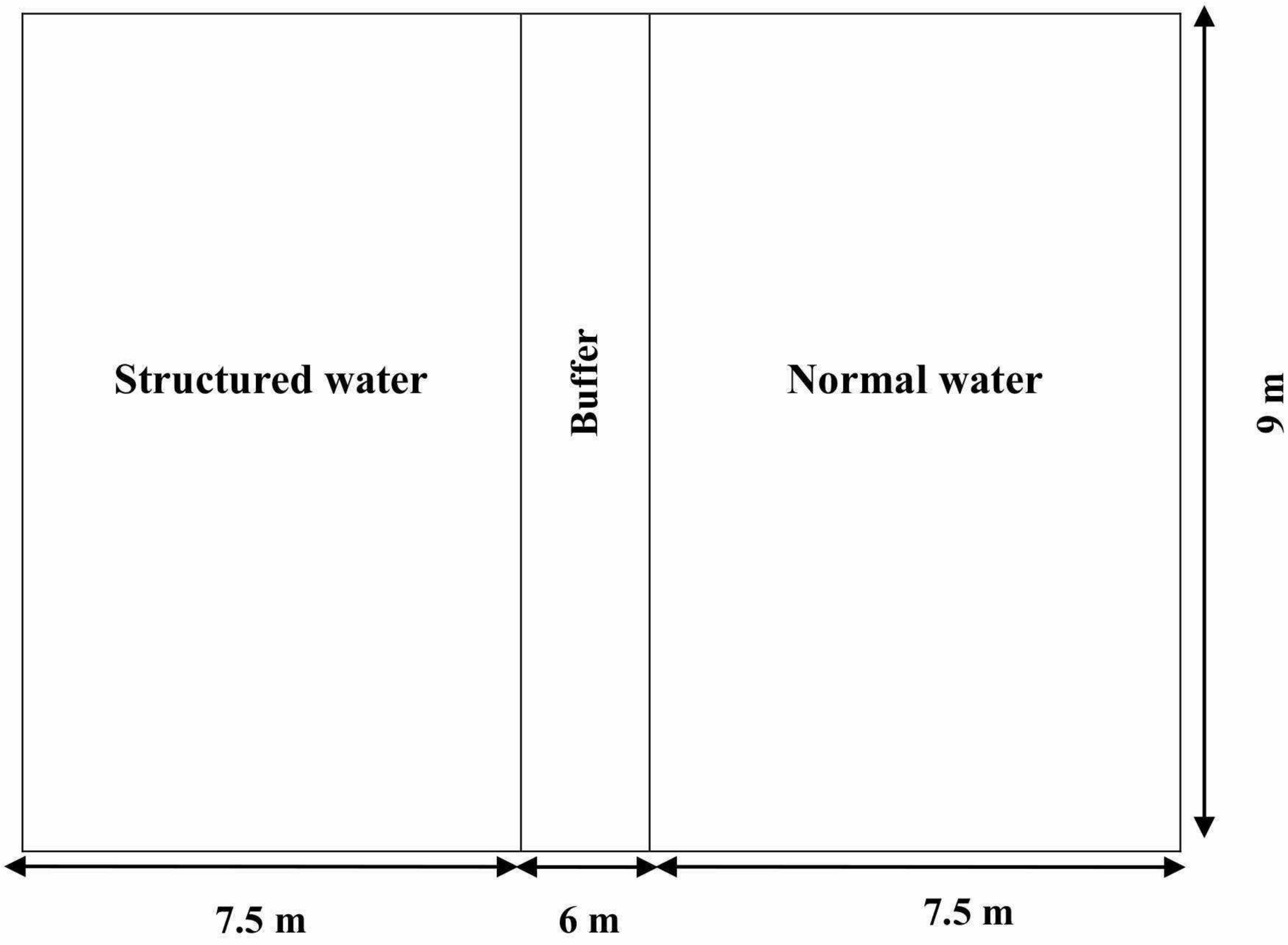


Fig.4. Layout plan of the experimental field of sorghum

Biometric observation

Ten plants were selected randomly in each plot and tagged for recording biometric observations. The following observations were recorded.

Plant height

Plant height is measured from ground level to the tip of the top most leaf at 30, 60 and 90 DAS.

Leaf length, Leaf breadth and Number of leaves plant^{-1}

Length and width (at the broadest part of lamina) of the fourth leaf from top and number of leaves per plant were recorded at 30, 60 and 90 DAS.

Root length

Plants were uprooted with extra care to extract the maximum amount of roots. The distance from the base to the tip of the longest root was measured in cm at 30, 60 and 90 DAS.

Root spread

Root spread was measured on 30, 60, 90 DAS and at harvest by brushing the roots uniformly on a table and the maximum distance between two extreme ends was measured.

Dry matter production

Five plants were selected from the sample rows in each plot at 30, 60 and 90 DAS and oven dry weight of samples were taken and dry matter production was expressed in kg ha $^{-1}$.

Grain yield

Earheads from each net plot were dried, threshed and the weight of cleaned grain at 14% moisture was recorded and grain yield was expressed in kg ha $^{-1}$.

5. Crop: Onion

Planting of onion was taken up with the local variety as an intercrop in coconut on 12.10.2014 by adopting surface irrigation method. The recommended fertilizer dose of 60:60:30 kg NPK ha^{-1} was applied and totally four irrigation was given to the crop.

Treatments

T_1 - Ordinary water

T_2 - Structured water

Design and layout

The layout plan of the experimental field is depicted in Fig.5.

Gross plot size: 14 m x 4 m = 56 m^2

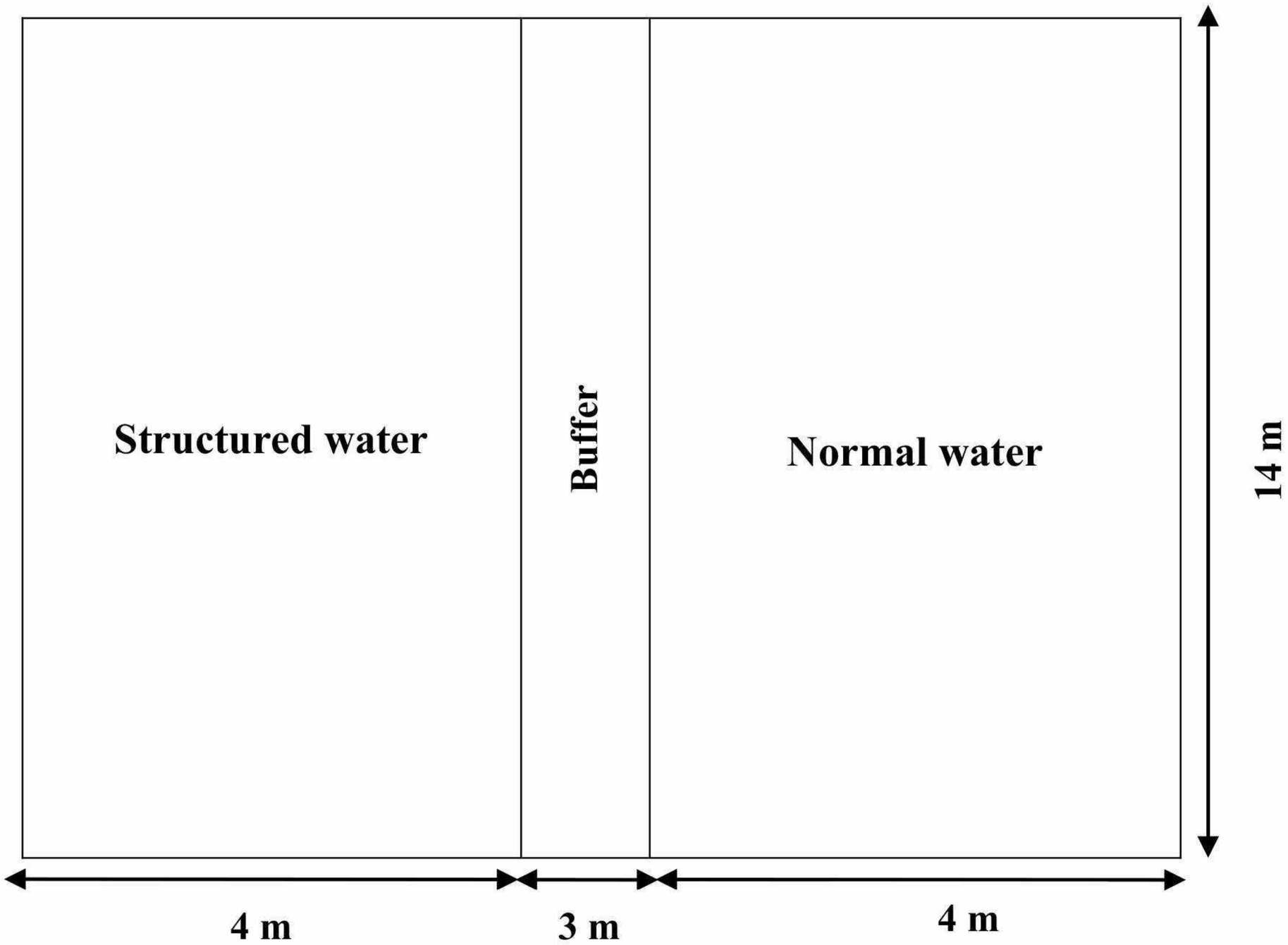


Fig.5. Layout plan of the experimental field of onion

Plant height

The height of the plant from ground level to the tip of leaf was measured and recorded in centimeter at the stage of 30, 60 and 90days after planting and at the time of harvest.

Number of leaves plant $^{-1}$

Total number of leaves plant^{-1} was recorded at the stage of 30, 60 and 90 days after planting and at the time of harvest.

Leaf length and breadth

The 3rd leaf length and breadth from the base of the leaf *(viz.)* neck of the bulb to the tip of the leaf was measured and recorded in centimeter during vegetative stage.

Onion yield

Onion picked at harvest was weighed by using an electronic balance and expressed as kg plot^{-1} and converted to kg ha^{-1}.

6. Crop: Tapioca

Planting of tapioca was taken up with Vijaya variety on 02.03.2014. Crop was harvested on 12.02.2015 and recorded tuber yield starch content.

Treatments

T_1 - Ordinary water

T_2 - Structured water

Plot size

Gross plot size: 47 m x 21.5 m = 1010.5 m^2 = 25 cents = 0.25 acre.

Chemical analysis of plant and soil

Name of the analysis	Methodology	Reference
A. Plant analysis (nutrient uptake)		
Nitrogen	Micro Kjeldahl method	Humphries, 1956
Phosphorus	Triple acid digestion method	Jackson, 1973
Potassium	Triple acid digestion method	Jackson, 1973
B. Soil analysis (available soil nutrient)		
Soil reaction (pH)	pH meter with glass electrode (soil water ratio 1:2.5)	Jackson (1973)
Electrical Conductivity (EC)	Conductometry	Jackson (1973)
Organic Carbon	Chromic acid wet digestion	Walkley and black (1934)
Nitrogen	Alkaline permanganate method	Subbiah and Asija, 1956
Phosphorus	Olsens method	Olsen *et al.,* 1954
Potassium	Neutral normal ammonium acetate method	Stanford and English, 1949

Water analysis method

Analysis	Method adopted	Reference
pH	Potentiometry using combined electrode pH Meter	United states salinity laboratory staff (1968)
Electrical Conductivity	Conductometry using a Conductivity Bridge	United states salinity laboratory staff (1968)
Sodium	Flame Photometric Method	Stanford and English (1949)
Potassium	Flame Photometry	Stanford and English (1949)
Calcium	Versanate titration Method	Diehl et al. (1950)
Magnesium	Versanate titration Method	Diehl et al. (1950)
Chloride	Mohr's Method	Association of Official Agricultural Chemist (1950)
Sulphate	Turbidoi]ometric Method	Tandon (1995)
Carbonates and bicarbonates	Titrimetric Method	Association of Official Agricultural Chemist (1950)

Economic analysis

i. Gross return

Gross return was computed by multiplying the crop yield in respective treatments with the unit market price of the produce and expressed as kg ha^{-1}.

ii. Net return

The net return was worked out for all the treatment by subtracting the cost of cultivation from the gross return and expressed as kg ha^{-1}.

iii. Benefit cost ratio

Benefit cost ratio was computed using the formula given below.

$$\text{: C ratio} = \frac{\text{Gross return (Rs./ ha)}}{\text{Cost of cultivation (Rs./ ha)}}$$

IV. Results (2013 – 2014)

(i) Impact of structured water unit on water quality:

Irrigation Water samples for the proposed study was collected before and after treatment with structured water unit. These samples were analysed for pH, Electrical Conductivity and Total Dissolved Solids (TDS), Cations (Ca, mg, Na, K) and Anions (CO_3, HCO_3, Cl, SO_4), Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). The results are furnished in Table.1 and Table.2.

Table 1. Characteristics of Structured and Ordinary Water (WTC - irrigation cafeteria)

Parameters	Ordinary Water	Structured Water
pH	7.15	7.52
EC (dS m^{-1})	1.03	1.05
TDS (mg l^{-1})	659	672
Calcium (cmol p+ kg^{-1})	3.96	4.54
Magnesium (cmol p+ kg^{-1})	1.24	1.76
Sodium (cmol p+ kg^{-1})	4.54	5.11
Potassium (cmol p+ kg^{-1})	0.39	0.52
Carbonates (cmol p+ kg^{-1})	--	--
Bicarbonates (cmol p+ kg^{-1})	5.90	5.92
Chloride (cmol p+ kg^{-1})	1.84	1.60
Sulphate (cmol p+ kg^{-1})	1.95	2.01
BOD (mg l^{-1})	29.0	27.0
COD (mg l^{-1})	82.0	80.0

Table 2. Characteristics of Structured and Ordinary Water (Farmer's field)

Parameters	Ordinary Water	Structured Water
pH	7.71	7.78
EC (dS m^{-1})	0.90	0.97
TDS (mg l^{-1})	576	621
Calcium (cmol p+ kg^{-1})	2.52	2.90
Magnesium (cmol p+ kg^{-1})	1.56	1.36
Sodium (cmol p+ kg^{-1})	4.35	3.73
Potassium (cmol p+ kg^{-1})	0.41	0.44
Carbonates (cmol p+ kg^{-1})	0.12	0.14
Bicarbonates(cmol p+ kg^{-1})	6.59	6.87
Chloride (cmol p+ kg^{-1})	1.46	1.28
Sulphate (cmol p+ kg^{-1})	0.23	0.57

Table 3. Initial soil characteristics of the experimental field

Parameters	WTC - Irrigation Cafeteria	Farmers field
pH	8.2	7.9
EC (dS m^{-1})	0.31	0.48
Organic Carbon (%)	0.65	0.52
Available N (kg ha^{-1})	225	233
Available P (kg ha^{-1})	16.1	14.6
Available K (kg ha^{-1})	525	496

The initial soil characteristics of the experimental field (Irrigation Cafeteria at Agricultural College and Research Institute (TNAU), Coimbatore and farmer's field in Thondamuthur block is given in Table.3.

(ii) Studies on the field efficacy of structured water unit on growth, yield and quality of cotton:

The results of the experiments on growth, yield parameters and economic returns of cotton are presented below.

Table 4. Effect of structured water on germination and growth parameters of cotto n at 40 DAS

Treatments / Parameters	Ordinary Water	75% Structured Water	100% Structured Water	% increase over ordinary water (For 100% SW)
Germination (%)	64.5	82.5	90.4	40.2
Plant height (cm)	23.7	35.5	39.4	66.2
No. of leaves plant^{-1}	24.5	44.0	50.1	104.5
Leaf length (cm)	4.5	9.0	10.3	129.0
Leaf breath (cm)	4.4	8.7	9.9	125.5
No. of monopodial branches plant^{-1}	1.8	1.4	1.3	- 27.8
No. of sympodial branches plant^{-1}	4.1	6.2	6.4	56.1
Root length (cm)	19.4	23.5	26.0	34.0

The effects of treatments on germination and growth parameters of cotton were presented in Table 4. The results showed that, 100% structured water irrigation practice recorded higher germination percentage (90.4%) and plant height (39.4 cm) at 40 DAS. Irrigation with ordinary water recorded the lowest germination percentage (64.5%) and plant height (23.7 cm). Number of leaves plant^{-1}, leaf length, leaf breadth, number of sympodial branches plant^{-1} and root length were also highly influenced by 100% structured water irrigation compared with 75% structured water irrigation and ordinary water application except number of monopodial branches plant^{-1}.

Table 5. Effect of structured water on growth of cotton at 80 DAS

Treatments / Parameters	Ordinary Water	75% Structured Water	100% Structured Water	% increase over ordinary water (For 100% SW)
Plant height (cm)	43.3	90.7	91.4	111.1
No. of leaves plant^{-1}	63.0	142.3	153.6	143.8
Leaf length (cm)	8.9	12.7	12.9	44.9
Leaf breath (cm)	7.9	11.3	12.1	53.2
No. of monopodial branches plant^{-1}	1.3	1.3	1.8	38.5
No. of sympodial branches plant^{-1}	8.3	14.3	15.0	80.7
No. of bolls plant^{-1}	14.4	24.2	30.3	52.1

Among the different irrigation treatments, 100% structured water irrigation recorded higher growth parameters *viz.,* plant height, number of leaves plant^{-1}, leaf length and leaf breadth at 80 DAS (Table 5). The lowest growth parameters were observed under ordinary water irrigation. The yield attributes *viz.,* number of sympodial branches plant^{-1} (15) and number of bolls plant^{-1} (30.3) were higher in 100% structured water irrigation practice except number of monopodial branches plant^{-1}. This was followed by 75% structured water irrigation.

Table . Effect of structured water on growth of cotton at 120 DAS

Treatments / Parameters	Ordinary Water	75% Structured Water	100% Structured Water	% increase over ordinary water (For 100% SW)
Plant height (cm)	47.5	99.3	99.9	110.3
No. of leaves plant^{-1}	133.4	132.2	137.3	2.9
Leaf length (cm)	8.9	12.6	12.9	44.9
Leaf breath (cm)	7.9	11.3	12.1	53.2
No.of monopodial branches plant^{-1}	1.8	1.3	1.3	38.5
No. of sympodial branches plant^{-1}	9.8	16.9	16.4	67.4
No. of bolls plant^{-1}	11.7	20.4	21.9	87.2

Regarding different treatments, 100% structured water irrigation practice recorded maximum plant height (99.9 cm), number of leaves plant^{-1} (137.3), leaf length (12.9 cm) and leaf breadth (12.1 cm) at 120 DAS (Table 6). Irrigation with ordinary water recorded the lowest plant height, number of leaves plant^{-1}, leaf length and leaf breadth compared to other treatments. Number of sympodial branches plant^{-1} and bolls plant^{-1} was also higher under 100% structured water irrigation compared with 75% structured water and ordinary water irrigation except in number of monopodial branches plant^{-1}.

Table 7. Effect of structured water on seed cotton yield (kg ha^{-1})

Treatments / Parameters	Ordinary Water		75% Structured Water		100% Structured Water		% increase over ordinary water (For 100% SW)
	plot^{-1}	ha^{-1}	plot^{-1}	ha^{-1}	plot^{-1}	ha^{-1}	
I st picking	6.5	258	7.5	298	10.5	417	**36.6**
II nd picking	16.5	655	16.0	635	12.0	476	
III rd picking	10.0	397	16.5	655	18.0	714	
IV th picking	58.5	389	23.0	913	29.0	1151	
Total	**42.8**	**1699**	**54.0**	**2144**	**58.5**	**2321**	

Seed cotton yield was highly influenced by different treatments (Table 7). Irrigation with 100% structured water recorded the highest seed cotton yield of 2321 kg ha^{-1} with an yield increase of 36.6% over ordinary water and it was followed by 75% structured water irrigation. The lowest seed cotton yield (1699 kg ha^{-1}) was obtained under odinary water irrigation.

Table 8. Effect of structured water on drip - uniformity co - efficient

Parameters	Ordinary Water	75% Structured Water	100% Structured Water	% increase over ordinary water (For 100% SW)
Uniformity co-efficient	86.92 %	91.69 %	92.78 %	6.74

The results of the drip uniformity co-efficient indicated that 100% structured water irrigation treatment recorded higher drip uniformity co-efficient (92.78%) than the other irrigation management practices (Table 8).

Table 9. Effect of structured water on post harvest soil properties

Treatments / Parameters	Ordinary Water	75% Structured Water	100% Structured Water
pH	8.20	8.22	8.22
EC (dS m^{-1})	0.31	0.31	0.30
Organic Carbon (%)	0.67	0.68	0.69
Available N (kg ha^{-1})	236	230	228
Available P (kg ha^{-1})	17.3	17.1	17.0
Available K (kg ha^{-1})	529	527	524

With regard to soil fertility, higher NPK content was observed under ordinary water irrigation and this was followed by 75% structured water irrigation. The lowest NPK content was recorded in 100% structured water application. Regarding pH, EC and organic carbon, higher pH and organic carbon were registered with application of 100% structured water irrigation compared to other treatments. Among the treatments, the difference was not exsist in EC (Table 9).

Table 10. Effect of structured water on quality parameters in cotton

Treatments / Parameters	Ordinary Water	100% Structured Water
Ginning percentage	32.30	32.65
Lint index	38.94	40.09
Seed index	84.58	85.39

The results on quality of cotton (Table 10) showed that structured water irrigation practice recorded higher ginning percent (32.65), lint index (40.09) and seed index (86.39). Structured water irrigation showed increased quality in cotton while compared to ordinary water irrigation.

Table 11. Effect of structured water on nutrient uptake (kg ha^{-1}) of cotton at harvest

Treatments / Parameters	Ordinary Water		75 % Structured Water		100% Structured Water	
	80 DAS	120 DAS	80 DAS	120 DAS	80 DAS	120 DAS
N	55.58	74.24	59.83	86.75	63.71	90.46
P	11.46	17.16	12.19	18.98	12.92	21.18
K	54.86	94.48	59.14	96.31	68.67	104.79

The effect of treatments on nutrient uptake of cotton at 80 DAS and harvest is presented in Table 11. The results showed that 100 % structured water irrigation practice recorded higher nutrient uptake in both the stages of observation when compared to all other treatments.

(iii) <u>Studies on the field efficacy of structured water unit on growth, yield and quality of tomato:</u>

The results of the experiments on growth, yield parameters and economic returns of cotton are presented below.

Table 12. Effect of structured water on growth of tomato at 30 DAP

Treatments / Parameters	Ordinary Water	Structured Water	% increase over ordinary water
Plant height (cm)	20.1	28.4	41.85
No. of primary branches plant^{-1}	2.7	3.3	22.22
No. of secondary branches plant^{-1}	4.9	7.5	53.06

The effect of treatments on growth of tomato at 30 DAP is presented in Table 12. Among the treatments, structured water irrigation recorded the highest plant height (28.4 cm), number of primary branches plant^{-1} (3.3) and number of secondary branches plant^{-1} (7.5) compared to ordinary water irrigation practice.

Table 13. Effect of structured water on growth and yield parameters of tomato at 60

DAP

Treatments / Parameter	Ordinary Water	Structured Water	% increase over ordinary water
Plant height (cm)s	33.3	59.9	79.78
No. of primary branches plant^{-1}	11.0	12.5	13.64
No. of secondary branches plant^{-1}	11.3	14.2	25.66
No. of flowers plant^{-1}	22.1	27.0	22.17
No. of fruits plant^{-1}	8.7	14.4	65.52

The treatments favorably influenced the growth and yield parameters of tomato at 60 DAP (Table 13). Structured water irrigation recorded the highest plant height (59.9 cm), number of primary branches plant^{-1} (12.5) and number of secondary branches plant^{-1} (14.2). Number of flowers plant^{-1} (27.0) and number of fruits plant^{-1} (14.4) were also higher in 100% structured water irrigation compared to ordinary water application.

Table 14. Effect of structured water on growth and yield parameters of tomato at 90 DAP

Treatments / Parameter	Ordinary Water	Structured Water	% increase over ordinary water
Plant height (cm)s	69.3	80.7	16.45
No. of primary branches plant^{-1}	12.9	15.0	16.28
No. of secondary branches plant^{-1}	15.3	18.1	18.30
No. of flowers plant^{-1}	24.8	30.9	24.60
No. of fruits plant^{-1}	11.7	16.8	43.59

Among the treatments, structured water irrigation recorded the highest plant height (80.7 cm), number of primary branches plant^{-1} (15.0) and number of secondary branches plant^{-1} (18.1) at 90 DAP. Ordinary water irrigation recorded lower plant height, number of primary branches plant^{-1} and number of secondary branches plant^{-1}. Yield parameters *viz.,* number of flowers plant^{-1} (30.9) and number of fruits plant^{-1} (16.8) were higher in structured water irrigation compared to ordinary water irrigation (Table 14).

Table 15. Effect of structured water on yield and economics of tomato (kg ha^{-1})

Parameters / Treatments	Ordinary Water		Structured Water		% yield increase over ordinary water
	plot $^{-1}$	ha^{-1}	plot $^{-1}$	ha^{-1}	
Total yield (kg)	1097	9457	1531	13198	**39.55**
Cost of cultivation (Rs)	-	61000	-	100000	
Gross return (Rs)	-	141855	-	197970	
Net return (Rs)	-	80855	-	97970	
BCR	-	1:2.32	-	1:1.98	

Tomato fruit yield was favourably influenced by the irrigation practices and among the practices tested, structured water irrigation recorded the highest fruit yield of 13198 kg ha^{-1} with a yield increase of 39.55% over ordinary water irrigation. Ordinary water irrigation registered fruit yield of 9457 ha^{-1} (Table 15).

The effect of treatments on economic returns of tomato is presented in Table 15. The economic returns showed that structured water irrigation recorded the highest net return of Rs. 97970 per ha and ordinary water recorded Rs. 80855 per ha. The ordinary water irrigation recorded higher BCR (2.32) than structured water irrigation owing to the lesser cost of cultivation. The highest cost of cultivation in structured water irrigation treatment is due to initial investment on structured water unit.

Table 16. Effect of structured water on post harvest soil properties

Treatments / Parameters	Ordinary Water	Structured Water
pH	7.90	7.93
EC (dS m^{-1})	0.48	0.50
Organic Carbon (%)	0.54	0.55
Available N (kg ha^{-1})	248	246
Available P (kg ha^{-1})	16.2	15.9
Available K (kg ha^{-1})	489	484

Regarding post harvest soil properties, structured water irrigation practice recorded

higher pH (7.93), EC (0.50 dS m^{-1}) and organic carbon (0.55 %) than ordinary water application (Table 16). But higher NPK content of soil was observed under ordinary water application compared to structured water irrigation.

Table 17. Effect of structured water on quality parameters in Tomato

Treatments / Parameters	Ordinary Water	Structured Water
Acidity (%)	0.54	0.55
Ascorbic acid (mg 100mg $^{-1}$)	29.20	30.38
Total soluble solids	3.32	3.44
Total sugars	2.80	3.02

The effect of treatments on quality of tomato is presented in Table 17. The results showed that structured water irrigation practice recorded higher acidity percentage (0.55%), ascorbic acid (30.38mg 100g^{-1}), total soluble solids (3.44) and total sugars (3.02). Thus the structured water irrigation showed increased quality in tomato while compared to ordinary water irrigation.

Table 18. Effect of structured water on nutrient uptake (kg ha^{-1}) of tomato at harvest

Treatments / Parameters	Ordinary Water		Structured Water	
	Vegetative	Fruit	Vegetative	Fruit
N	62.11	101.26	70.09	120.76
P	8.08	11.00	10.92	13.14
K	69.43	121.65	79.28	152.97

The effect of treatments on nutrient uptake of tomato at harvest is presented in Table 18. The results showed that structured water irrigation practice recorded higher nutrient uptake at the time of harvest in both vegetative part and tomato fruit when compared to ordinary water application.

(iv) <u>Studies on the field efficacy of structured water unit on growth and yield of bhendi</u>:

Table 19. Effect of structured water on germination and growth of bhendi at 30 DAS

Parameters / Treatments	Ordinary Water	Structured Water	% increase over ordinary water
Germination (%)	70.4	84.8	20.5
Plant height (cm)	10.3	15.1	46.6
No. of leaves plant^{-1}	4.0	5.8	45.0
Leaf length (cm)	8.5	9.8	15.3
Leaf breadth (cm)	3.8	4.9	29.0

Application of structured water irrigation recorded higher germination percentage of 84.8% (Table 19). Plant height (15.1 cm), number of leaves plant^{-1} (5.8), leaf length (9.8 cm) and leaf breadth (4.9 cm) at 30 DAS were also higher under structured water irrigation compared to ordinary water application.

Table 20. Effect of structured water on growth and yield attributes of bhendi at 60 DAS

Parameters / Treatments	Ordinary Water	Structured Water	% increase over ordinary water
Plant height (cm)	47.7	50.9	6.7
No. of leaves plant^{-1}	13.0	14.6	12.3
Leaf length (cm)	10.7	11.3	6.0
Leaf breadth (cm)	5.2	5.3	1.1
No. of fruits plant^{-1}	7.8	8.2	5.1
Fruit length (cm)	13.3	13.6	2.0
Fruit girth (cm)	4.1	4.5	7.7

The results revealed that structured water application recorded higher growth and yield parameters *viz.,* plant height (50.9 cm), number of leaves plant^{-1} (14.6), leaf length (11.3 cm), leaf breadth (5.3 cm), number of fruits plant^{-1} (8.2), fruit length (13.6 cm) and fruit girth (4.5 cm) at 60 DAS. The lower growth and yield parameters of bhendi were observed under ordinary water irrigation (Table 20).

Table 21. Effect of structured water on growth and yield attributes of bhendi at 90 DAS

Parameters / Treatments	Ordinary Water	Structured Water	% increase over ordinary water
Plant height (cm)	48.7	51.8	6.4
No. of leaves plant^{-1}	11.8	14.0	18.6
Leaf length (cm)	10.4	11.2	7.7
Leaf breadth (cm)	4.8	5.0	4.2
No. of fruits plant^{-1}	4.2	5.0	19.0
Fruit length (cm)	12.6	13.4	6.3
Fruit girth (cm)	3.4	3.8	11.8

Among the treatments, structured water irrigation recorded higher plant height (51.8 cm), number of leaves plant^{-1} (14.0), leaf length (11.2 cm), leaf breadth (5.0 cm), number of fruits plant^{-1} (5.0), fruit length (13.4 cm) and fruit girth (3.8 cm) at 90 DAS. Ordinary water irrigation recorded lower growth and yield parameters compared to structured water irrigation (Table 21).

Table 22. Effect of structured water on yield and economics of bhendi (kg ha^{-1})

Parameters / Treatments	Ordinary Water		Structured Water		% yield increase over ordinary water (For 100% SW)
	plot $^{-1}$	ha^{-1}	plot $^{-1}$	ha^{-1}	
Total yield (kg)	438	6293	595	8549	**35.84**
Cost of cultivation (Rs)	-	40600	-	79600	
Gross return (Rs)	-	75516	-	102588	
Net return (Rs)	-	34916	-	22988	
BCR	-	1.86	-	1.29	

The results of bhendi yield revealed that fruit yield was higher under structured water irrigaion (8549 kg ha^{-1}) with 35.84 % yield increased over ordinary water irrigation and ordinary water application recorded the fruit yield of 6293 kg ha^{-1} (Table 22).

The effect of treatments on economic returns of bhendi is presented in Table 22.

Among the treatments, application of structured water irrigaion recorded the highest gross return (Rs.102588/ha) but the net return (Rs. 34916/ha) and benefit cost ratio (1.86) were higher under ordinary water application due to structured water irrigation incurred higher cost of cultivation by installation of structured water unit.

Table 23. Effect of structured water on post harvest soil properties

Treatments / Parameters	Ordinary Water	Structured Water
pH	7.91	7.93
EC (dS m^{-1})	0.48	0.49
Organic Carbon (%)	0.55	0.55
Available N (kg ha^{-1})	252	249
Available P (kg ha^{-1})	16.4	16.0
Available K (kg ha^{-1})	487	485

There was no difference in pH, EC and organic carbon content of post harvest soil samples. Regarding soil fertility, higher NPK content was recorded under ordinary water irrigation compared to structured water irrigation (Table 23).

Based on the results of first year field experiments, it is revealed that all the crops under study *viz.,* cotton, tomato and bhendi which were irrigated with structured water exhibited an increase in germination percentage, vegetative growth, yield and yield attributes. However the results to be confirmed in the second year.

V. Results (2014 – 2015)

Field experiments were conducted, employing sorghum and onion as test crops at farmer's field in Sulur, Coimbatore (Dt) and at farmer's field in Vellode, Erode (Dt) for confirmation of previous year results.

(v) Impact of structured water unit on water quality:

Irrigation Water samples for the proposed study was collected before and after treatment with structured water unit. These samples were analysed for pH, Electrical Conductivity and Total Dissolved Solids (TDS), Cations (Ca, Mg, Na, K) and Anions (CO_3, HCO_3, Cl, SO_4), Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). The results are furnished in Table 24 and Table 25.

Table 24. Characteristics of Structured and Ordinary Water (Location:Farmers field – (Sorghum) – Sulur)

Parameters	Ordinary Water	Structured Water
pH	6.97	7.13
EC (dS m^{-1})	7.10	7.12
TDS (mg l^{-1})	4544	4557
Calcium (cmol p+ kg^{-1})	9.3	9.7
Magnesium (cmol p+ kg^{-1})	4.1	4.4
Sodium (cmol p+ kg^{-1})	10.1	10.3
Potassium (cmol p+ kg^{-1})	0.6	0.8
Carbonates (cmol p+ kg^{-1})	-	-
Bicarbonates (cmol p+ kg^{-1})	7.8	7.7
Chloride (cmol p+ kg^{-1})	7.6	7.1
Sulphate (cmol p+ kg^{-1})	5.4	5.3
BOD (mg l^{-1})	29.2	28.6
COD (mg l^{-1})	88.6	88.2

Table 25. Characteristics of Structured and Ordinary Water (Location : Farmers field – (Onion) – Vellode)

Parameters	Ordinary Water	Structured Water
pH	8.30	8.56
EC (dS m^{-1})	2.20	2.24
TDS (mg l^{-1})	1408	1434
Calcium (cmol p+ kg^{-1})	8.2	8.9
Magnesium (cmol p+ kg^{-1})	4.0	4.6
Sodium (cmol p+ kg^{-1})	9.8	10.0
Potassium (cmol p+ kg^{-1})	0.5	0.6
Carbonates (cmol p+ kg^{-1})	-	-
Bicarbonates(cmol p+ kg^{-1})	8.2	8.2
Chloride (cmol p+ kg^{-1})	9.2	8.0
Sulphate (cmol p+ kg^{-1})	4.6	4.7
BOD (mgl^{-1})	28.2	27.6
COD(mgl^{-1})	87.5	83.1

Table 26. Initial soil characteristics of experimental field

Parameters	Farmers field Sulur	Farmers field Vellode
pH	7.94	8.30
EC (dS m^{-1})	0.50	0.62
Organic Carbon (%)	0.57	0.54
Available N (kg ha^{-1})	92	203
Available P (kg ha^{-1})	6.0	8.2
Available K (kg ha^{-1})	370	418

The initial soil characteristics of the experimental fields (farmer's field at Sulur and farmer's field in Vellode village is given in Table.26.

vi. Studies on the field efficacy of structured water unit on growth and yield of sorghum:

Table 27. Effect of structured water on germination and growth parameters of sorghum at 30 DAS

Treatments / Parameters	Ordinary Water	Structured Water	% increase over ordinary water
Germination (%)	74.50	85.80	15.17
Plant height (cm)	36.42	48.50	33.17
No. of leaves plant^{-1}	6.40	8.10	26.56
Leaf length (cm)	18.08	26.08	44.25
Leaf breadth (cm)	0.84	1.23	46.43
Root length (cm)	5.90	8.65	46.61
Root spread (cm)	2.55	3.30	29.41
Dry matter (kg ha^{-1})	414.8	597.8	44.12

The effect of treatments on germination and growth of sorghum at 30 DAS is presented in Table 27. Among the treatments, structured water irrigation recorded higher germination percentage (85.80), plant height (48.5cm), number of leaves plant^{-1} (8.10), leaf length (26.08 cm) and leaf breadth (1.23 cm), root length (8.65 cm), root spread (3.30 cm) and dry matter production (597.8 kg ha^{-1}) compared to ordinary water irrigation practice.

Table. 28. Effect of structured water on growth parameters of sorghum at 60 DAS

Treatments / Parameters	Ordinary Water	Structured Water	% increase over ordinary water
Plant height (cm)	197.82	250.14	26.45
No. of leaves plant^{-1}	8.60	10.20	18.60
Leaf length (cm)	43.40	55.10	26.96
Leaf breadth (cm)	2.30	2.80	21.74
Root length (cm)	9.20	11.20	21.74
Root spread (cm)	5.30	6.70	26.42
Dry matter (kg ha^{-1})	5366.4	6338.5	18.11

The treatments favourably influenced the growth parameters of sorghum at 60 DAS (Table 28). Structured water irrigation recorded the higher plant height, number of leaves plant^{-1}, leaf length, leaf breadth, root length, root spread and dry matter production in structured water irrigation compared to ordinary water application.

Table 29. Effect of structured water on growth parameters of sorghum at 90 DAS

Treatments / Parameters	Ordinary Water	Structured Water	% increase over ordinary water
Plant height (cm)	247.80	300.10	21.11
No. of leaves plant^{-1}	11.30	13.10	15.93
Leaf length (cm)	48.40	58.10	20.04
Leaf breadth (cm)	3.30	4.20	27.27
Root length (cm)	11.60	13.20	13.79
Root spread (cm)	7.40	8.90	20.27
Dry matter (kg ha^{-1})	6699.7	8116.3	21.14

Among the treatments structured water irrigation recorded the higher plant height (300.10 cm), number of leaves plant^{-1} (13.10 cm), leaf length (58.10 cm), leaf breadth (4.20 cm), root length (13.20 cm), root spread (8.90 cm) and dry matter production (8116.3 kg ha^{-1}) compared to ordinary water application (Table 29).

Table 30. Effect of structured water on sorghum grain yield (kg ha^{-1})

Treatments / Parameters	Ordinary Water	Structured Water
Grain Yield	3180	3274

The results of sorghum yield (Table 30) revealed that sorghum grain yield was higher under structured water irrigation (3274 kg ha^{-1}) over ordinary water irrigation (3180 kg ha^{-1}).

Table 31. Effect of structured water on nutrient uptake (kg ha^{-1}) of sorghum at harvest

Treatments / Parameters	Ordinary Water	Structured Water
N	60.18	75.98
P	16.33	21.89
K	66.00	83.57

The effect of treatments on nutrient uptake of sorghum is presented in Table 31. The results showed that the structured water irrigation practice recorded higher nutrient uptake at harvest *viz.,* N (75.98 kg ha^{-1}), P (21.89 kg ha^{-1}) and K (83.57 kg ha^{-1}) when compared to ordinary water irrigation.

Table 32. Effect of structured water on post harvest soil properties

Treatments / Parameters	Ordinary Water	Structured Water
pH	7.94	7.94
EC (dS m^{-1})	0.50	0.50
Organic carbon (%)	0.57	0.59
Available N (kg ha^{-1})	98	92
Available P (kg ha^{-1})	6.5	6.0
Available K (kg ha^{-1})	380	370

With regard to post harvest soil properties there was no difference in pH, EC, organic carbon and NPK content between treatments (Table 32).

vii. <u>Studies on the field efficacy of structured water unit on growth and yield of onion</u>:

Table 33. Effect of structured water on germination and growth parameters of onion at 30 DAP

Treatments / Parameters	Ordinary Water	Structured Water	% increase over ordinary water
Plant height (cm)	30.44	30.99	1.81
No. of leaves/ plant	22.80	27.10	18.86
Leaf length (cm)	21.11	25.54	20.99
Leaf breadth (cm)	0.33	0.34	3.03
Leaf dry weight (kg ha^{-1})	337.3	408.7	21.17

The effect of treatments on growth of onion is presented in Table 33. The results showed that structured water irrigation practice recorded higher plant height (30.99 cm) at 30 DAP. Irrigation with ordinary water recorded the lowest plant height (30. 44 cm). Number of leaves per plant, leaf length, leaf breadth and leaf dry weight were also highly influenced by structured water irrigation compared with ordinary water application.

Table 34. Effect of structured water on growth parameters of onion at 60 DAP

Treatments / Parameters	Ordinary Water	Structured Water	% increase over ordinary water
Plant height (cm)	44.84	48.85	8.94
No. of leaves/ plant	37.7	41.2	9.28
Leaf length (cm)	29.64	29.98	1.15
Leaf breadth (cm)	0.44	0.46	4.55
Leaf dry weight (kg ha^{-1})	781.8	863.1	10.40

Among the different irrigation treatments structured water irrigation recorded higher growth parameters *viz.,* plant height, number of leaves per plant, leaf length and leaf breadth and leaf dry weight at 60 DAP (Table 34). The lowest growth parameters were observed under ordinary water irrigation.

Table 35. Effect of structured water on growth parameters of onion at 90 DAP

Treatments / Parameters	Ordinary Water	Structured Water	% increase over ordinary water
Plant height (cm)	44.92	49.90	11.09
No. of leaves/ plant	39.10	44.10	12.79
Leaf length (cm)	30.53	30.79	0.85
Leaf breadth (cm)	0.44	0.46	4.55
Leaf dry weight (kg ha^{-1})	1125.2	1196.8	6.36

Regarding different treatments, irrigation with structured water recorded maximum plant height (49.90 cm), number of leaves per plant (44.10), leaf length (30.79 cm), leaf breadth (0.46 cm) and leaf dry weight (1196 kg ha^{-1}) when compared to ordinary water irrigation (Table 35).

Table 36. Effect of structured water on onion bulb yield

Treatments / Parameters	Ordinary Water		Structured Water	
	kg $plot^{-1}$	kg ha^{-1}	kg $plot^{-1}$	kg ha^{-1}
Bulb yield	39	6964	30	5357

The effect of treatments on yield of onion is presented in Table 36. The onion bulb yield recorded for ordinary and structured water irrigation was 6964 kg ha^{-1} and 5357 kg ha^{-1} which might be due to crop damage and higher rainfall during later stage of crop growth.

Table 37. Effect of structured water on post harvest soil properties

Treatments / Parameters	Ordinary Water	Structured Water
pH	8.30	8.32
EC (dS m^{-1})	0.62	0.63
Organic carbon (%)	0.54	0.56
Available N (kg ha^{-1})	203	214
Available P (kg ha^{-1})	8.2	7.8
Available K (kg ha^{-1})	418	425

Regarding pH, EC, organic carbon and NPK content of soil, higher values were registered with application of structured water irrigation compared to ordinary water irrigation (Table 37).

viii. <u>Studies on the field efficacy of structured water unit on growth and yield of tapioca</u>:

Table 38. Effect of structured water on yield and quality of tapioca

Treatments / Parameters	Ordinary Water	Structured Water	% yield increase over Ordinary water
Tuber yield (t ha^{-1})	12.70	15.12	**19.06**
Starch content (Point)	24	27	

The effect of treatments on yield and quality of tapioca is presented in Table 38. The tuber yield recorded in structured water irrigation (15.12 t ha^{-1}) was higher over ordinary water irrigation (12.70 t ha^{-1}) with 19.06% increased yield (Table 38).

The quality of tapioca results (Table 38) showed that structured water irrigation practice recorded higher starch content (27 points) when compared to ordinary water irrigation (24 points).

VI. Salient Findings

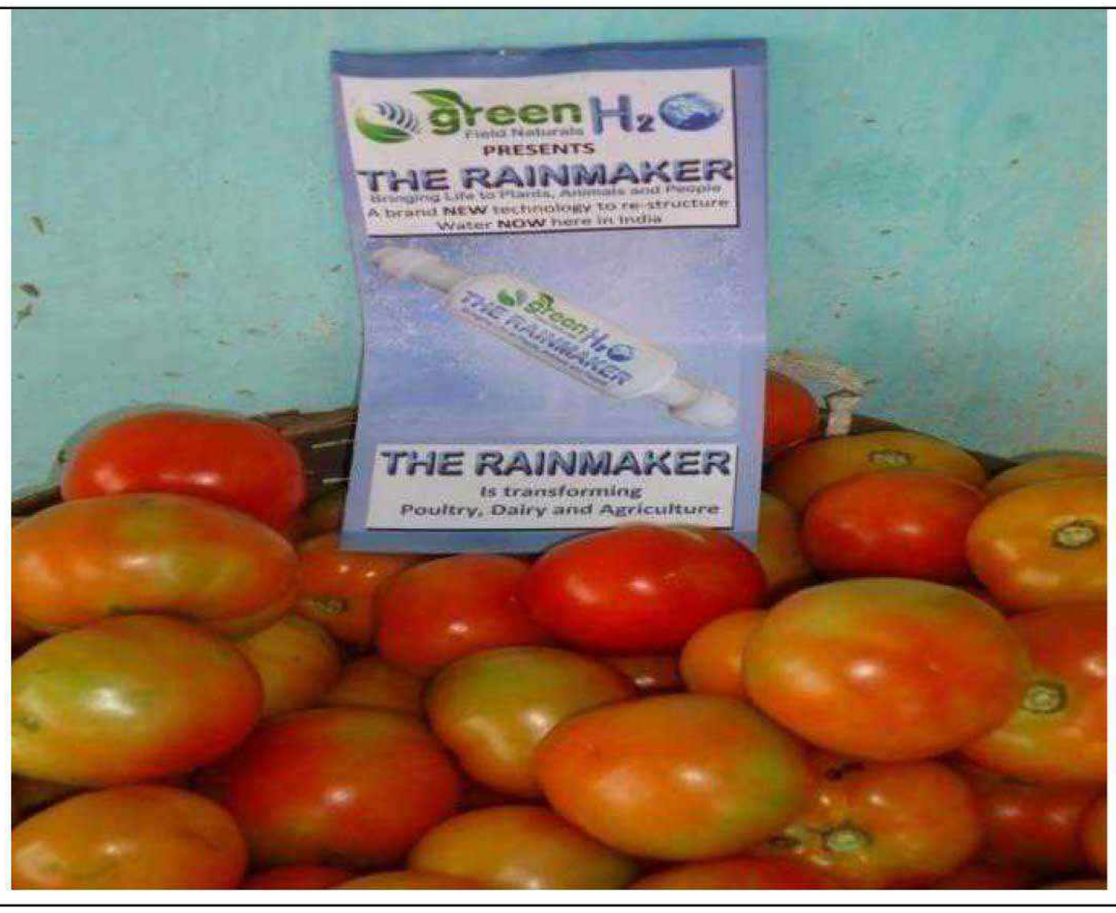
- Irrigation Water samples were collected before and after treatment with structured water unit and analysed for chemical properties *viz.,* pH, Electrical Conductivity and Total Dissolved Solids (TDS), Cations (Ca, mg, Na, K) and Anions (CO_3, HCO_3, Cl, SO_4), Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). There is no difference in the chemical properties between structured water and ordinary water.
- Regarding the field experiment on cotton, the growth, yield attributes, yield and quality was higher under application of 100% structured water with the seed cotton yield increase of 36.6% over ordinary water irrigation.
- In tomato also the growth, yield, economics and quality was favourably influenced by the irrigation practices. Among the practices, structured water irrigation recorded higher growth and yield with the increase of 39.55% fruit yield over ordinary water irrigation. The economic returns showed that structured water irrigation recorded the highest net return but ordinary water irrigation recorded higher BCR (2.32) than structured water irrigation because of lesser cost of cultivation. The highest cost of cultivation in structured water irrigation is due to initial investment on structured water unit.
- With regard to bhendi, the growth, yield and economics was higher in structured water irrigation with 35.84 % yield increase over ordinary water application. Economic return showed similar trend as that of tomato crop with higher BCR of 1.86 in structured water irrigation.
- In sorghum, the growth parameters and yield was higher in structured water irrigation with 3.0 % yield increase over ordinary water application.
- Tapioca also showed higher yield under structured water irrigation with 19.06% increased yield over ordinary water irrigation.
- Regarding the nutrient uptake of crops, the structured water irrigation practice recorded higher nutrient uptake (NPK) when compared to ordinary water irrigation.
- Drip uniformity co-efficient indicated that 100% structured water irrigation recorded higher drip uniformity co-efficient (92.78%) than the ordinary irrigation management practices.

Based on the results of field experiments, it is revealed that the crops under study *viz.,* cotton, tomato, bhendi, sorghum and tapioca which were irrigated with structured water exhibited an increase in growth and yield.

Structured water unit installation

Field Photos – Structured Water Trial on Cotton

Field Photos – Structured Water Trial on Tomato



Field Photos – Structured Water Trial on Bhendi

Field Photos – Structured Water Trial on Sorghum and Onion

Field Photos – Structured Water Trial on Onion

Visit made by Company Persons