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## **EFFECT OF TREATED WASTE WATER FROM FOOD PROCESSING INDUSTRIES IN TOMATO PRODUCTION THROUGH AUTOMATED DRIP IRRIGATION**

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**Abstract:** The Water is the necessary source for all forms of life. The existing trial was accompanied in Jain Irrigation System Ltd. Jalgaon (India), to check the feasibility of treated waste water from food processing industry in agriculture. The experiment was laid out in split plot design for tomato crop (*Lycopersicon esculentum*) with two treatments viz., treated fruit waste water (M1), treated and bore well fresh water (M2). Two emitter were selected viz., Model B2.0 (Non pressure compensating – S2) and Model C2.0 (Pressure compensating and compensating non leakage – S1). The different observations on each treatment were taken such as uniformity coefficient, plant height, yield, protein content and lycopene, fiber, carbohydrates content. The results showed that the highest uniformity coefficient (97.9 %) M1 (01 DAS), plant height (69.82 cm) M1, yield (35.42 t·ha<sup>-1</sup>), protein (0.92 %) M1 and lycopene (4.28%) M2. In conclusion, treated fruit waste water can be used as an unconventional source of irrigation after fresh water source, as it has positive effect on crop growth, yield and quality parameters, also less maintenance while operating automated drip system as compared with treated fruit waste water.

**Key words:** *waste water, uniformity coefficient, treated fruit waste water, bore well fresh water, tomato*

### **INTRODUCTION**

Paper Waste water management in India has become an extremely important area of focus due to increasing health awareness and population pressure. Despite the wastewater sector witnessing major growth in the last decade due to increasing

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government support and private participation, the scale of the problem remains enormous. For instance, it is estimated that less than 20% of domestic and 60% of industrial wastewater is treated. Metros and large cities (more than 100,000 inhabitants) are treating only about 29.2% of their wastewater; smaller cities treat only 3.7% of their wastewater. (Anoon)

Agricultural use of water accounts for nearly 70 per cent of the water used throughout the world, and the majority of this water is used for irrigation. The sources of irrigation water are limited and demand for agricultural products is increasing. Inadequate access to water is one of the biggest problems faced the world. India is one such nation where demand of water has continuously overlapped its supply. The total water demand in the country in 2003 was close to 465 BCM which has been increased to 634 BCM in 2013 (www.snpinfrasol.com, 2014). The waste water from industries varies greatly in both flow and polluttional strength. Industrial wastewater may contain suspended, colloidal and dissolved (mineral and organic) solids. These wastes may contain inert, organic or toxic materials and possibly pathogenic bacteria. It is necessary to pre-treat the wastes water prior to release to the agriculture or municipal system. Jain Irrigation has food processing facilities for dehydration of onion, vegetables and production of fruit purees, concentrates and pulp. The annual average availability of treated waste water generated from fruit processing is 200000 cubic meters and from onion dehydration plant is about 150000 cubic meters (Anonymous, 2012). Tomato (*Lycopersicon esculentum*) fruit, often described as a vegetable fruit is a true berry, a type of fleshy fruit characterized by its soft pulp, thin skin and many seeds. On a worldwide scale, tomato continues to increase in importance for consumption as a fresh crop, as a major constituent in many prepared foods and also as materials for research into the fundamental principles of growth and development in plantation. Economically, tomato tops the list in value among edible vegetables. Tomato fruits contain various minerals and vitamins (Decuypere, 2006). It is grown in 0.458 M ha area with 7.277 M mt production and 15.9 mt/ha productivity. The major tomato producing states are Bihar, Karnataka, Uttar Pradesh, Orissa, Andhra Pradesh, Maharashtra, Madhya Pradesh and West Bengal. In West Bengal, tomato is grown over an area of 43,600 ha with the production 0.588 M mt and productivity of 13.6 mt/ha. Tomato is rich source of vitamins A, C, potassium, minerals and fibers. . Tomatoes are used in the preparation of soup, salad, pickles, ketchup, puree, and sauces also consumed as a vegetable in many other ways. (Anon, 2011). However, major tomato cultivation area is spread in rain fed condition contributing around 80-82 per cent of annual production in *kharif*, whereas left over production come from *Rabi* and summer season under irrigated conditions. India is a second largest country to produce the tomato in the world. The tomato production in India 17,500,000 MT (FAOSTAT 2012). The world dedicated 4.8 million hectares in 2012 for tomato cultivation and the total production was about 161.8 million tonnes. The average world farm yield for tomato was 33.6 tonnes per hectare, in 2012.

## MATERIAL AND METHODS

Field experiment was conducted during 30<sup>th</sup> January 2015 to 30<sup>th</sup> May 2015 in Rabi season. The experiment was located at Jain irrigation Systems Ltd. Jalgaon, India. The climate is semi-arid and the average annual rainfall is 690 mm. The maximum and

minimum temperature and ET during the cropping period was 33 °C and 12 mm day<sup>-1</sup> and the minimum was 9.5 °C and 3.8 mm day<sup>-1</sup> respectively. Soil texture of the experimental conducted site is sandy clay-loam. The total experimental area was about 1500 m<sup>2</sup> in the vicinity of food processing plant. The experiment was laid out in split plot design with 2 main treatments, 2 sub treatments with 5 replications are presented in the fig1. The raised beds of 1.2 m x 10 m were prepared for transplantation of tomato plant by maintaining plant and row spacing (30 cm x 40 cm). There were five replications for each treatment; Net plot size-9.2m x 8m and net plot area having about 720 m<sup>2</sup>. Variety- Synzenta-1389 (Hybrid Tomato) was used for transplanting. The irrigation system consists of automatic irrigation controller, EC and PH sensor, Temperature sensor, Soil moisture sensor, Weather station, 5000 litre storage tank, 2.5 hp pump, 63 mm water meter, 25 m<sup>3</sup>/hr. sand and disc filter, 40 mm control valves, 40 mm main line, 32 mm sub main lines, 16 inline laterals and other necessary details of treatment and sub treatments are explained below and depicted in plate1;

1. Main treatments (irrigation sources)

M1 - Treated fruit waste water (TFWW)

M2 - Bore well fresh water (BFW)

2. Sub treatment (emitter types – discharge 2 lph, emitter spacing 30 cm)

S1 - Pressure compensating, compensating non leakage emitter (Model C2.0)

S2 - Non pressure compensating emitter (Model B2.0)



Figure 1. Automated drip system and experimental tomato crop layout

*Determination of peak water requirement.* Amount of irrigation water applied to drip treatments were based on daily pan evaporation readings. The water requirement of the crop was calculated based on the following equation mentioned in Jain Irrigation Systems Manual (Anonymous, 2008).

$$Q = A \times B \times C \times D \quad (1)$$

Where

$Q$  [lpd] Quantity of water required,  
 $A$  [m<sup>2</sup>] Gross area per plant,  
 $B$  [-] Amount of area covered with foliage,  
 $C$  [-] Crop Coefficient.

$$D = K_p \times E_{pan} \quad (2)$$

Where

$K_p$  [-] Pan Coefficient

$E_{pan}$  [mm] Evaporation from Class A open pan Evaporimeter.

*Determination of uniformity coefficient (UC).* To determine the uniformity coefficient in drip irrigation the depth of water in the formula was replaced by discharge rate of drip and the discharge of emitter was measured by volumetric method for three minutes. The uniformity coefficient was calculated using equation:

$$UC=100 [1- D/M] \quad (1)$$

Where

$UC$  [%] Uniformity coefficient,

$D$  [lph] Average absolute deviation from the mean discharge rate,

$M$  [lph] Mean discharge rate.

Periodically observations on each treatment were taken for uniformity coefficient, plant height, yield, protein and fat content.

## RESULTS AND DISCUSSION

*Water analysis.* Treated waste water analysis revealed that all studied parameters were within permissible limit as declared by Maharashtra Pollution Control Board. Water analysis result should that the treated waste water from both fruit as well as onion processing industries was adding macro and micro nutrient in the water. Average value of waste water analysis is given in Table 1.

Table1. Quality of treated waste water and fresh water used for experiment

Parameter	Units	MPCB Norms	Different water treatment	
			TFWW	BFWF
TDS	Ppm	2100	810.67	788.30
pH		6.5-9.0	7.27	6.73
BOD	Ppm	30	8.83	0.56
COD	Ppm	250	78.03	0.93
Cl	Ppm	600	141.67	0.00
S	Ppm	1000	47.67	0.00
EC	ds/m	-	1.22	1.10
N	Ppm	-	2.23	0.48
P	Ppm	-	0.65	1.48
K	Ppm	-	44.23	50.94
Na	Ppm	-	175.67	23.36
Ca	Ppm	-	88.00	95.65
Mg	Ppm	-	53.67	34.35

*Soil analysis.* Soil samples were collected before sowing; the soil analysis results indicated that soil had clay loam texture with low bulk density and moderate field capacity. All the nutrients viz., major N, P, K, secondary Ca, Mg and S and micro nutrient Fe, Cu, Mn and Zn are comparatively higher in surface 10 cm soil with the exception of K which is higher in lower depths (Table 2).

Table 2. Soil characteristics of the experimental plot before treatment

<b>Parameters</b>	<b>Range</b>	<b>Soil Sampling</b>
<i>N (kg/ha)</i>	280 – 560	163.07
<i>P (kg/ha)</i>	23 – 56	2.23
<i>K (kg/ha)</i>	130 – 336	126.79
<i>Ca (%)</i>	0.05 -0.41	0.12
<i>Mg (%)</i>	0.01 – 0.05	0.08
<i>Fe (ppm)</i>	5 – 10	4.77
<i>Mn (ppm)</i>	5 – 10	3.52
<i>Zn (ppm)</i>	0.5 – 1.0	0.37
<i>Cu (ppm)</i>	0.2 – 0.4	2.41
<i>S (ppm)</i>	10 – 20	7.06
<i>Sand (%)</i>	-	34.48
<i>Silt (%)</i>	-	33.32
<i>Clay (%)</i>	-	32.19
<i>Bulk density (gm/cc)</i>	-	1.30
<i>Field capacity (%)</i>	-	35.98
<i>Permanent wilting point (%)</i>	-	21.96
<i>Texture</i>	-	Clay loam

*Uniformity coefficient.* In this study we compute statistical parameters and analyse uniformity of the subsurface drip system. The data pertaining to uniformity coefficient of drip irrigation system at different stages (01, 30, 60, and 90 DAS) of crop growth as influenced by different irrigation treatments and different emitter types as well as their interactions are presented in the Fig.1. There was significant effect of different irrigation treatments on the uniformity coefficient throughout the experiment, except at the end of experiment i.e. 90 DAS, there was not much difference in the uniformity under each treatment due to maintenance of automated drip system. The highest uniformity coefficient about was 97.09 per cent (01 DAS) was observed under TFWW. On the contrary there was no any significant effect among the different emitter types, hence the highest uniformity coefficient of 97.4 per cent was observed under Model C2.0 type emitter (01 DAS). On the contrary, lowest uniformity coefficient of 88.60 per cent (90 DAS) was observed under Model B2.0 type emitter. Uniformity coefficient of emitters was within permissible limit throughout the experiment due to regular maintenance of all the components of automated drip irrigation system. The special care was taken to increase the clogging resistance of emitters by regular chlorine and acid treatment. The similar results were observed by Capra and Scicolone (2004).

*Plant height.* Plant height is an important character of vegetative phase and indirectly influences the yield components. The data pertaining to plant height at different stages 15, 30, 60, and 90 DAS of crop growth was not influenced by different irrigation treatments and different emitter types as well as their interactions are presented in the Fig.4.

There was no significant effect of different irrigation treatments on plant height during all stages of plant growth. Under BFWW, highest plant height was 69.8 cm (60DAS) and lowest plant height was 14.4 cm (15DAS). But at harvesting stage i.e. after 90DAS the plant height was declining from 69.8 in TFWW and 67.6 cm in BFWW. This may be due to non-function able leaves and stem.

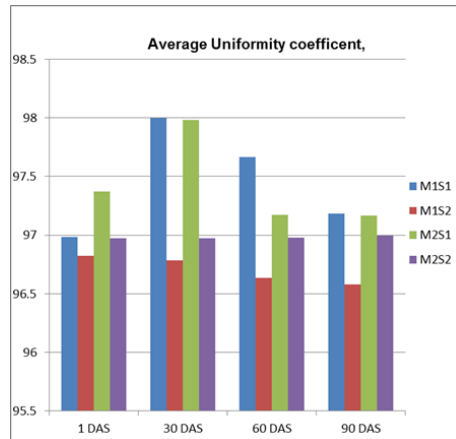


Figure 2. Average Uniformity coefficient

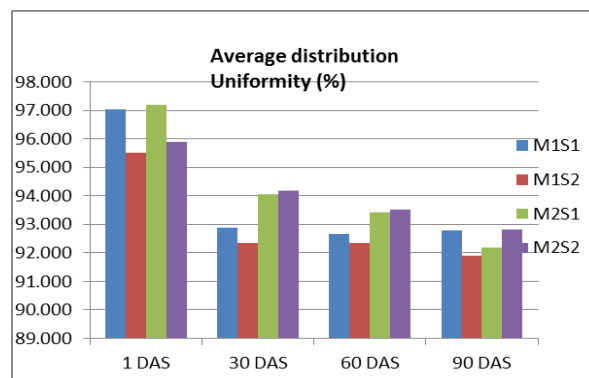


Figure 3. Effect of different irrigation treatments on uniformity coefficient

There was no significant effect of emitter types on plant height during all stages of plant growth. Under S1 emitter type, highest plant height was 69.8 cm (60DAS) and lowest plant height was 14.0 cm (15DAS) under S1 type emitter. But at harvesting stage i.e. after 90das the plant height was declining from 67.6 in M1 and 69.3 cm in M2. This may be due to non-function able leaves and stem. The interaction effects due to different irrigation treatments and emitter types on plant height during all stages of plant growth were found to be non-significant except S1 type of emitter at 15 DAS showed significant growth in plant height.

As a result of this may be due to the nitrogen, potassium nutrient increase the plant height. Higher nitrogen and potassium uptake in sandy clay loam soil is an evidence for this.

*Yield . Number of fruit per cluster.* The data pertaining to number of fruit cluster/ plant at different stages 45, 60 and 90 DAS of crop growth was influenced by different irrigation treatments and different emitter types as well as their interactions are presented in the Fig. 5.

There was no significant effect of different irrigation treatments on number of fruit cluster/ plant during all stages of plant growth. Under BFWW, highest number of fruit cluster/ plant of were 6.3 (60DAS) and lowest number of fruit cluster/ plant was 4.1 (45DAS). But at harvesting stage i.e. after 90DAS the number of fruit cluster/ plant was declining from 5.7 in TFWW and 6.2 in BFWW.

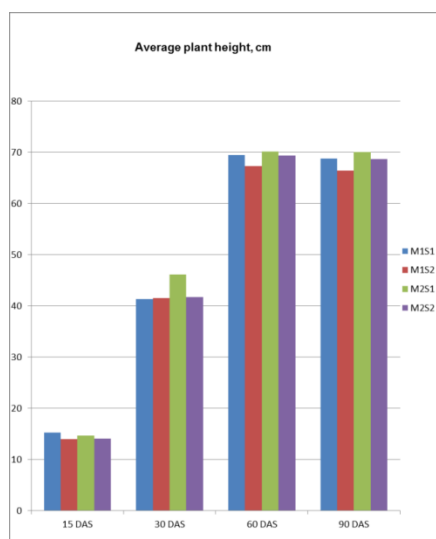


Figure 4. Effect of different irrigation treatments on tomato plant height

There was no significant effect of emitter types on number of fruit cluster/ plant during all stages of plant growth. Under S1 emitter type, highest number of fruit cluster/ plant was 6.1 (60DAS) and lowest number of fruit cluster/ plant was 2.9 (30DAS) under S2 type emitter. But at harvesting stage i.e. after 90DAS the number of fruit cluster/ plant was declining from 6.1 in S1 and 5.9 in S2.

The interaction effects due to different irrigation treatments and emitter types on number of fruit cluster/ plant during all stages of plant growth were found to be non-significant.

The data pertaining to weight per tomato influenced by different irrigation treatments and different emitter types as well as their interactions are presented in the Table 4.16 and Fig 4.10.

Non Significantly weight per tomato was observed under BFWW was about 81 gm. On the contrary, lowest weight per tomato 70 gm was observed under TFWW. Among the different emitter types, Non significantly highest weight per tomato 80.8 gm was observed under S2 type emitter. On the contrary, lowest weight per tomato was about 79.7 gm under S1 type emitter.

The interaction effects due to different irrigation treatments and emitter types on weight per tomato during all stages of plant growth were found to be non-significant. The data pertaining to grain yield influenced by different irrigation treatments and different emitter types as well as their interactions are presented in the Fig 3. Significantly highest Tomato yield was observed under BFWW was about 9.92 t ha<sup>-1</sup>.

On the contrary, but among treated waste water TFWW (8.34 t ha<sup>-1</sup>) has significant effect on tomato yield. Among the different emitter types, significantly highest tomato yield of 9.04 t ha<sup>-1</sup> was observed under Model C2.0 type emitter. On the contrary, lowest tomato yield was 7.15 t ha<sup>-1</sup> in Model B2.0 type emitter. Interaction effects due to different irrigation treatments and emitter types on tomato yield were found to be significant. The more difference in the tomato yield was observed in the BFWW followed by TFWW. The maximum tomato yield was observed in the Model C2.0 type emitter (10.56 t ha<sup>-1</sup>) in BFWW. This may be due the treated waste water was carrying impurities were affecting the emitter performance and still the pressure compensating emitter were better than non-pressure compensating emitter in case of uniformity. Also the treated waste water was adding macro as well as micro nutrient to the soil and which was available during its growth period. Similar findings was observed by Hassanli *et al.* (2010)

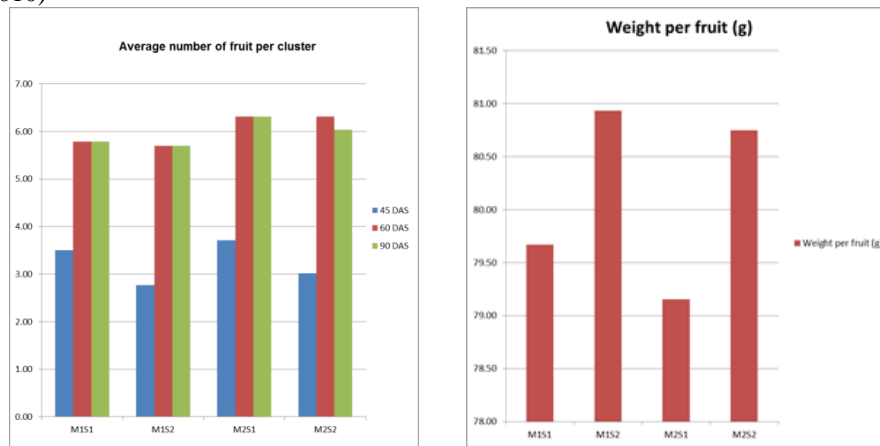


Figure 5. Effect of different irrigation treatments on tomato yield

**Quality parameters.** The influence of different irrigation treatments and different emitter types as well as their interactions on quality parameters of tomato such as protein, carbohydrates, fats, ash, crude fiber and energy are presented. Quality of Tomato depends on amount of protein, lycopene, fiber and carbohydrates content within it. TFWW is containing maximum amount of protein (0.92%). This may be due to the essential micro nutrient present in the treated waste water from fruit processing plant was available during growing period.

## CONCLUSIONS

- Please Model C2.0 type of emitter was having better performance throughout the experiment than Model B2.0 type emitter. It was observed that UC were more than 90 per cent for Model C2.0 type of emitter under TFWW and BFWW. Performance of automated drip irrigation system was within the permissible limit for TFWW, due to chlorine and acid treatment for BFWW.



- Maximum yield was obtained under Model C2.0 type emitter in BFWW; whereas minimum yield was obtained under Model B2.0 type emitter in TFWW.
- The yield obtained under TFWW was 31.01t ha<sup>-1</sup> under Model C2.0 type emitter and yields obtained Model B2.0 type emitter used BFWW was 35.42 t ha<sup>-1</sup> under the automated drip irrigation system.
- Maximum yield was obtained under Model C2.0 type emitter in BFWW; whereas minimum yield was obtained under Model B2.0 type emitter in TFWW.
- Percentage of protein, carbohydrates, lycopene, sugar and moisture content in the tomato was increased under treated fruit waste water.

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**UPOTREBA TRETIRANE OTPADNE VODE IZ PREHRAMBENE  
INDUSTRIJE U PROIZVODNJI PARADAJZA  
KROZ AUTOMATIZOVANO NAVODNJAVANJE**

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**Sažetak:** Voda je neophodna za sve forme života. Ovo istraživanje je izvedno radi provere održivosti primene tretirane otpadne vode iz prehrambene industrije u poljoprivredi. Ogljed je postavljen na parcelama paradajza (*Lycopersicon esculentum*) sa dva tretmana, tretirana otpadna voda od voća (M1) i sveža voda iz bušenog bunara (M2). Dva modela su izabrana, Model B2.0 (Bez kompenzacije pritiska – S2) i Model C2.0 (Pritisak kompenzacije – S1). Ispitivani su koeficijent ujednačenosti, visina biljaka, prinos, sadržaj proteina, likopena, vlakana i ugljenih hidrata. Rezultati su pokazali da je najviši koeficijent ujednačenosti (97.9 %) M1 (01 DAS), visina biljaka (69.82 cm) M1, prinos (35.42 t·ha<sup>-1</sup>), protein (0.92 %) M1 i likopen (4.28%) M2. Zaključeno je da tretirana otpadna voda može biti upotrebljena kao izvor za navodnjavanje posle sveže vode.

**Ključne reči:** *otpadna voda, koeficijent ujednačenosti, tretirana otpadna voda, voda iz bunara, paradajz*

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