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EFFECT OF TRICKLE AND FURROW IRRIGATION METHODS WITH WATER SAVING AND TURNIP YIELD

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The field experiments were carried out to compare two irrigation methods, namely trickle and furrow irrigation methods on profile water uptake in turnip crop. The total area (15.0ft × 30.0ft)was divided into two plots. The plot of 15×15ft was occupied by trickle irrigation method, while another plot of 15×15ftwasoccupied by furrow irrigation system. Water consumed in furrow irrigation method was 19872 liters, which was more than trickle irrigation method in which the consumed water was 2320 liters. The Yield of turnip by furrow irrigation method was 39732.05 kg/ ha while the Yield of turnip by Drip irrigation method was 42258.37 kg/ha. It observed that the yield of turnip by Drip irrigation method was 18.21 kilogram per liter as compared to furrow irrigation method while the production of turnip was 2.00 kilogram per liter. From this study it was found that micro trickle irrigation methods resulted in high yield than furrow irrigation method. The amount and plan of water uptake varied with irrigation methods. This could be provided valuable information on the aspect of agricultural management.

Key words: drip irrigation, furrow irrigation, water saving, yield, turnip crop.

INTRODUCTION

Pakistan possesses one of the world's largest integrated irrigation system; which is ranked 5th in Asia. In Pakistan, generally tradition flood irrigation methods (basin, border and furrow) are used to irrigate the crops in which the entire soil surface is almost flooded without considering the actual consumptive requirements of the crops. These practices have created the water logging and salinity and reduction in overall irrigation efficiency hardly up to 30% (Ishfaq, 2002).

Hamdy et al. (2003) mentioned that unwise use of irrigation water through furrow irrigation methods has farther constrained the cropping intensities and crop yields. The main reason for this injudicious use of water is to employ furrow water application practices like monitoring the crop canopy or using plant indicators etc., which only allows farmer to decide when to irrigate and amount of water is applied just near to the top edges of the bund of the field, which results the over irrigation. Thus appropriate time to the evapotranspiration requirements of crop is the application of water through proper irrigation scheduling. Its major advantages as compared to other methods include; higher crop yields, saving in water, increased fertilizer use efficiency, reduced energy consumption, tolerance to windy atmospheric conditions, reduces the labor cost, improved diseased and pest control, feasible for undulating sloppy lands, suitability on problems soils and improved tolerance to salinity (Michael, 2008). Yildrin and Korukcu (2000) reported that trickle irrigation generally achieves better crop yield and balanced soil moisture in the active

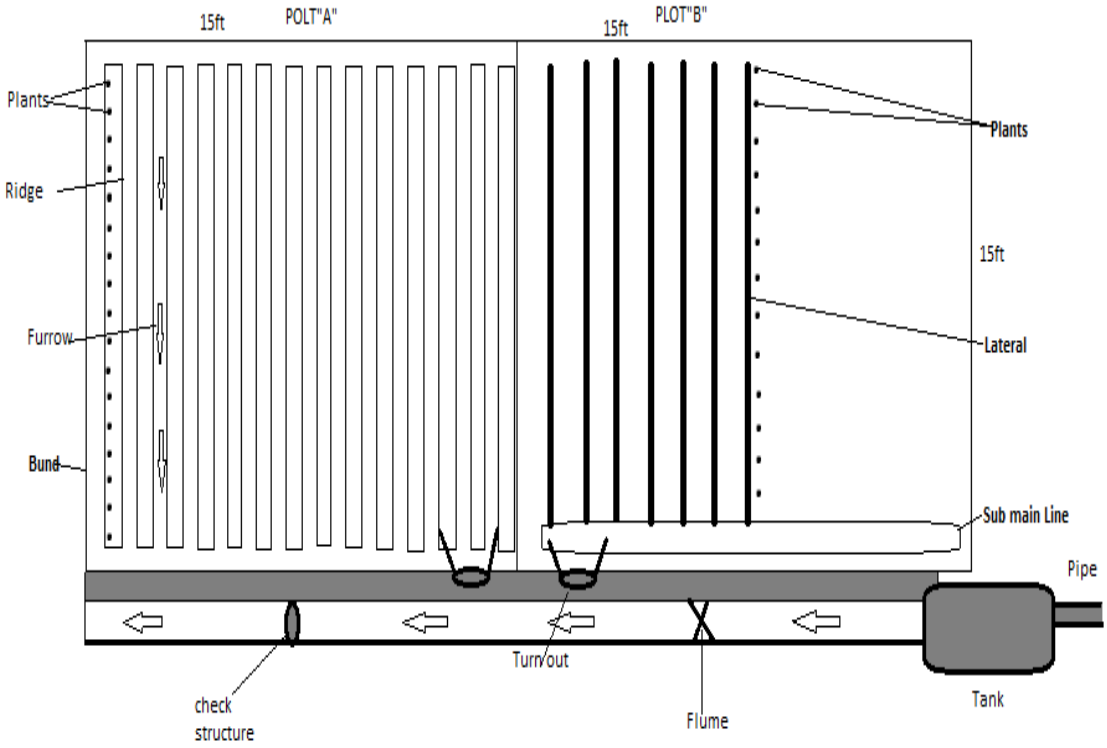

Figure 1. Lay out of experimental site

root zone with minimum water losses. On the average, trickle irrigation saves about 70 to 80% water as compared to conventional flood irrigation methods (Ishfaq, 2002). The objective of this study were to compare increase in yield of turnip crop, water saving and water use efficiency of drip and furrow irrigation methods and to suggest guidelines for farming community.

MATERIALS AND METHODS

An experiment was conducted during 2012 growing season of turnip crop at the field of department of Land and Water Management, Faculty of Agriculture Engineering, Sindh Agriculture University Tandojam, Pakistan. The land at experimental site was uncultivated for about one year. Therefore, it was ploughed twice by disk plough followed by rotavator and cultivator and then leveled. The total area (15.0ft × 30.0ft) was divided into two plots. The plot of 15×15 ft was occupied by trickle irrigation method, while another plot of 15×15 ft was occupied by furrow irrigation system as shown in Figure 1. In order to avoid the seepage of water from trickle to furrow water application practices plot a polyethylene sheet up to depth of 2ft was provided. The field laboratory was facilitated with micro irrigation system as rotary sprayers, trickles of 8 and 24 LPS. Data were recorded on following parameters i.e., Soil characteristics (soil texture, dry bulk density, infiltration rate), Water saving and increase in yield. Soil Characteristics like soil texture, dry bulk density and infiltration rate of the experimental site for the depth of 0-15, 15-30, 30-45, 45-60 cm are present in Table 1.

Micro trickle irrigation system was installed in the experimental field while this system comprised 38.1 mm dia. The irrigation network consisted of a main delivery pipe which was connected to 16 mm dia, while the lateral with 4 liter per hour trickle. The distance between row to row and plant to plant was kept 9.0 inch and 4.5 inch, respectively. In all total 15 laterals were laid on the ground surface along the lines of plants each 13ft long with 32 emitters. Figure 1

Coefficient of variation ofthetrickle irrigation system and emission uniformity was determined in order to ascertain the performance of system. For this purpose the containers were placed under emitters to collect the water flowing through them. The collected water in a

Table 1. Soil Characteristics of the experimental site

No	Parameters	Soil Characteristics
1	Soil texture	Sandy Loam
2	Dry Bulk Density	1.65g/cm3
3	Infiltration Rate	26 mm/hr

given time was then measured using a graduate cylinder. Coefficient of variation was calculated by thefollowing formula (ASAE. 2002);

Where,
Σ = standard derivation
Cv= Coefficient of variation
q_{av}= Average flow

$$Cv = \frac{\sigma}{q_{av}} \text{ x } 100$$

The formula was used to calculated emission uniformity (Keller, and Bliesner,1990).

$$EU = 100\left[1.0 - 1.27\frac{C_v U}{n^{\frac{1}{2}}}\right]\frac{q_m}{q_a}$$

Where,

σ = Standard deviation

$$\sigma = \sqrt{\frac{\Sigma^{n}_{i=1}(qi\text{-}qav)^2}{n}}$$

Cv= Coefficient of variation
n= No. of emitters
qm= Minimum flow
qa= Average flow

For furrow irrigation system, furrow and ridges were prepared by furrow maker. The row to row and plant to plant distance was same as in trickle irrigation. In all the total number of furrow and ridges was 7 and 15, respectively. The length of each furrow and ridge was 15ft while each ridge was comprised of 32 plants. To determine the soil texture, dry bulk density and infiltration rate the composite soil samples were collected at the depth of 0-15, 15-30, 30-45, 45-60 cm. The following procedures were adopted for the analysis of each parameter. Soil texture was determined by Bouyoucous Hydrometer Method in the laboratory of land and water management department. To determine the bulk density of the soil, composite soil sample were taken at the depth of 0-15, 15-30, 30-45, and 45-60cm with the help of tube sampler of known diameter from both plots of experimental field. These samples were labeled, packed and brought to the laboratory where they placed in an oven for 24 hours at 105 degree centigrade. After 24 hours dry weight of each sample was measured with the help of electric balance. Then following relation was used to calculated dry bulk density of the soil(Michael A.M.2008).

Dry bulk density (pd) = Dry weight of soil
Total Volume of soil

The field capacity of the soil was determined by Veihmeyer and Hendricksen method. Infiltration rate of the soil was determined by double ring infiltration meter while to determine the quality of irrigation water, water samples were collected at started, middle and end of the experiment. These samples were analyzed for EC, PH. For sowing of crop soaking dose of 100 mm was applied to each experiment plot. When the soil came in the workable condition, broad costing of turnip seed (shiny seed) 200gm was done. All the other cultural practices such as fertilization were carried out as per recommendation. As recommended by Michael (2008) irrigation water was applied at 50% deficit of soil moisture content, and the subsequent irrigations were applied accordingly. Therefore in trickle irrigation system, water was applied to soil at the rate of 4lit per hour through all emitters. When the soil reached at the field capacity condition, turnip seedlings were sown by hand under

each emitter. Likewise in furrow irrigation system, water was applied to all furrows, when the soil reached at the field capacity condition, turnip seedlings were sown by hand. Irrigation water was measured using cutthroat flume in furrow irrigation system. While in trickle irrigation system water was measured by flow meter installed in the starting end of lateral line. Following formula was used to identify soil moisture deficit level (Yildirim, O. and A. Korukcu, 2000).

SMD = θf– θo

$$\Theta = \frac{(Ww-Wd)}{Wd} \times 100$$

Where;
SMD =Soil moisture deficit level
θf= Moisture content at field capacity (%)
θo=Moisture content at 50% SMD
θ.=Moisture content on dry weight basis (%)
Ww=Wet weight of soil (g)
Wd= Oven dry weight of soil(g)

To determine water application depth the following formula was used; R=FC-MC/100. Fertilizers were applied to each plot as recommended by OFWM- VI (2005). The following fertilizers were applied(Folibor) 250ml after 40 days of sowing,(N-8%, P2O2-8%, K2O-6%).Water saving in the trickle over furrow irrigation system in percent was calculated as under;

$$WS(\%) = \frac{(Wa-Wb)}{Wa} \times 100$$

Where,
WS = Water saving (in %)
Wa = Total water used in furrow irrigation system (m3/ha)
Wb = Total water used in trickle irrigation system **(**m3/ha**)**
For yield of crop,after picking the turnips were packed in polyethylene bags. The yield was then measured in kg/ha for each trickle and furrow irrigated plot.The increase in yield (%) was computed as under (ASAE. 2002);

$$\textbf{Increase in yield (\%)} = \frac{\textbf{(Y1 – Y2)}}{\textbf{Y1}} \times \textbf{100}$$

Where,
Y1 = Total yield obtained in trickle irrigation system (kg/ha)
Y2 = Total yield obtained in furrow irrigation system (kg/ha)
The water use efficiency (WEU) of trickle furrow irrigation systems were calculated by using following expression;

$$\textbf{WEU} = \frac{\textbf{Y}}{\textbf{WR}}$$

Where,
WEU = Water use efficiency (Kg/m3)
Y = Yield of crop (Kg/ha)
WR = Total water consumed for crop production (m3/ha)

RESULTSAND DISCUSSION

Coefficients of variation and emission uniformity of randomly selected laterals were determined in order to test the performance of the trickle irrigation system (Table 2). The results showed that the coefficient of variation randomly selected laterals was 0.3291, 0.3784 and 0.4085 respectively. Similarly the emission uniformity of randomly selected laterals was 92.14, 90.81and 90.37%, respectively. These results suggested that the system was working satisfactory according to its design. To find out the quality of irrigation water used in drip and furrow irrigation methods, three water samples were taken at start, middle and end of the experiment are presented in Table 3. It indicated that irrigation water used through the experiment was suitable for irrigation.

Total volume of water applied to the turnip crop under furrow and trickle irrigation system are presented in Table 4. The total volume of water applied to turnip crop under trickle irrigation system was 2320lits, while total volume of water applied to the crop under furrow irrigation system was 19872lits. From the result, it observed that total volume of water used under trickle irrigation system was less then furrow irrigation system. The drip irrigation system reduced the water consumption to 50%. These results reveal that the total volume of water used under trickle irrigation system was less as compared to the furrow irrigation system as shown in Figure 2. Yields and water using for turnip crop under furrow and drip irrigation are presented in Table 5. The result showed that the total yield of crop under trickle irrigation system was 42258.37 Kg/ha while total yield of crop under furrow irrigation was 39732.05Kg/ha. These results determines that total yield of crop under trickle irrigation system was more as compared to furrow irrigation. There was a little difference in yield but the water saving is more in trickle as compared to furrow irrigation system as also shown in Figure 3. Our results exhibited that water use efficiency in summer and winter vegetable crops were significantly higher in trickle than furrow irrigation methods. Our results also in the agreement with Sammis (1980) who reported that the yield under trickle irrigation was more by trickle irrigation as in comparison to the yield by furrow methods.

Table 2. Minimum discharge, average discharge, standard deviation, coefficient of variation and emission uniformity for laterals No1, 7 and 15.

Lateral No.	Minimum Discharge qm (lit/hr)	Average Discharge qav	Σ(q-qav)2	Standard deviation σ	Coefficient of Variation (Cv.)	Emission of Uniformity (EU)
1	3.96	3.98	0.0055	0.0131	0.3291	92.14
7	3.96	3.99	0.0073	0.0151	0.3784	90.81
15	3.97	3.99	0.0085	0.0163	0.4085	90.37

Table 3. Irrigation water quality

Sample No.	ECw (ds/m)	Ph	SAR	RSC
1	1359	7.6	6.69	Nil
2	1355	7.6	6.65	Nil
3	1348	7.6	6.64	Nil

Table 4. Date-wise volume of water applied (WA) to turnip crop under trickle and furrow irrigation system

Irrigation (No)	Trickle irrigation system			Furrow irrigation system		
	Irrigation (date)	Moisture Content (%)	WA (lit)	Irrigation (date)	Moisture Content (%)	WA (lit)
Soaking dose	24, 12, 2012			24, 12, 2012		6000
1st	07, 01, 2012	11	240	07, 01, 2012	10	2208
2nd	18, 01, 2012	13.23	240	18, 01, 2012	16.02	2208
3rd	08, 02, 2012	13.40	220	08, 02, 2012	14.52	2208
4th	14, 02, 2012	12.09	240	14, 02, 2012	15.01	2208
5th	23, 02 2012	11.07	260	23, 02 2012	11.9	2208
6th	03, 03, 2012	11.05	280	03, 03, 2012	15.89	2208
7th	08, 03, 2012	13.05	240	08, 03, 2012	13.8	2208
8th	14, 03, 2012	11.09	300	14, 03, 2012	15.70	2208
9th	20, 03, 2012	12.05	300	20, 03, 2012	16.03	2208
TOTAL			**2320**			**19872**

Table 5. Yield of turnip under trickle and furrow irrigation system

Irrigation system	No of plants as per row	Total plants	Average weight as per plant (kg)	Average weight as per row (kg)	Total weight of plants (kg)	Total weight of plants (kg/ha)	Difference (kg)
Trickle	32	480	0.184	5.88	88.32	42258.37	5.28
Furrow	32	480	0.173	5.536	83.04	39732.05	

Table 6: Water saving, increase in yield and water use efficiency in trickle over furrow irrigation method

Water saving (%)	Increase in Yield (%)	Water Use Efficiency (%)	
		Trickle irrigation	Furrow irrigation
88.32	5.97	0.038	0.004

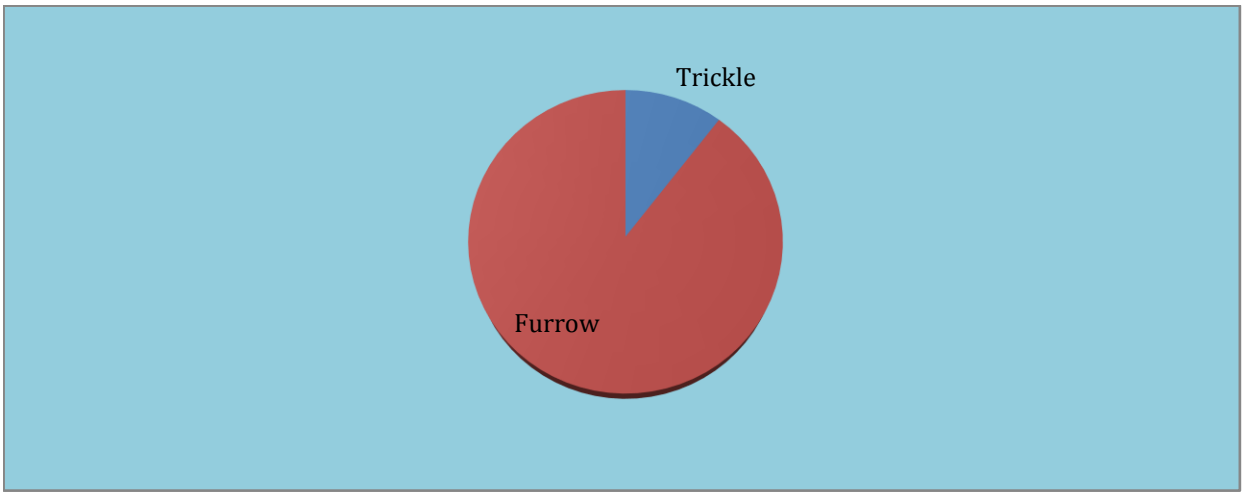

Figure 2: Total water used in furrow and trickle irrigation system

Increase in yield of turnip crop, water saving and water use efficiency in trickle over furrow irrigation method are depicted in Table 6. The result exhibited that water saving in trickle over furrow irrigation method was 88.32 % while increase in yield of turnip crop in trickle over furrow irrigation method was 5.97%. Whereas water use efficiency observed in trickle irrigation was 0.038 as compared to 0.004 in furrow irrigation method. Therefore, it was observed from Figure 4 that trickle irrigation method used less water and gave higher yields than furrow irrigation method.

CONCLUSIONS

The drip irrigation system has major advantages that were watering high efficiency, use less water pressure,

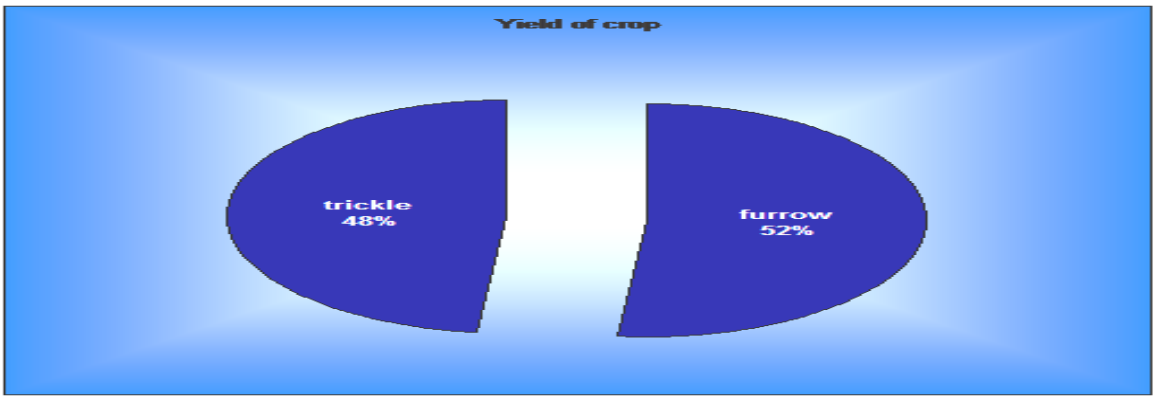

Figure 3: Yield of crop in furrow and trickle water irrigation system

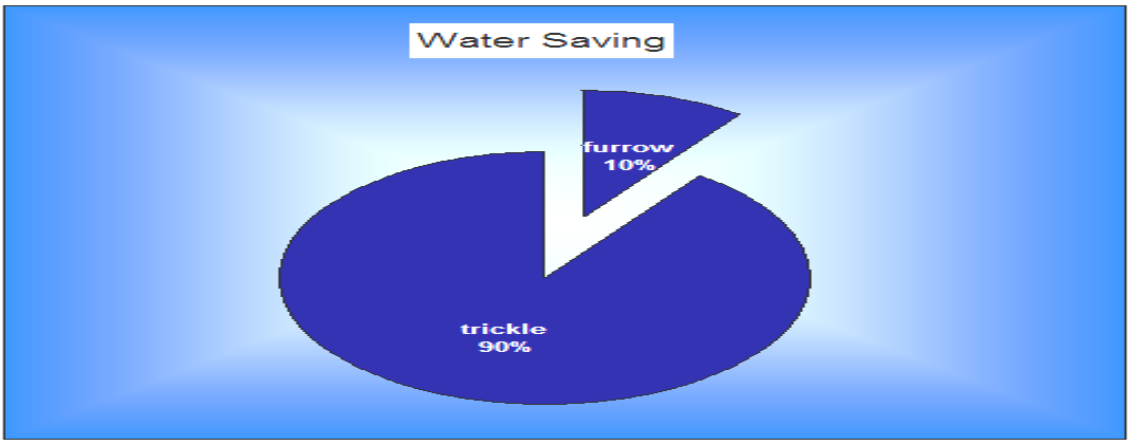

Figure 4: Water saving of trickle over furrow irrigation method

high yield, saving water. It provides higher crop yields when compared to the furrow irrigation system to the same of planting areas and quantity of water. The drip irrigation system could provide better performance than the furrow irrigation system. Trickle irrigation method saved 88.32% water and gave 5.97% more yield as compared to that furrow irrigation method. Higher water use efficiency about0.038 % was obtained in trickle irrigation method; whereas lower water use efficiency about 0.004% was obtained in furrow irrigation method.

REFERENCES

ASAE (2002). Design and installation of micro irrigation systems. ASAE EP 405.1 Dec.01, pp. 903–907.
Hamdy A, R. Ragab and E.S. Munoz, (2003). Coping with water scarcity, water saving and increasing water productivity. Irrigation and Drainage. 52:3-20.
Ishfaq M., (2002). Water new technology. Global Water Institute, Lahore, Pakistan.
Keller J., and R.D. Bliesner, (1990). Sprinkler and trickle irrigation, Van Nostrand Reinhold, New York.
Michael A.M., (2008). Irrigation Theory and Practice, Second edition (revised and enlarged) Vikas Publishing House Pvt.Ltd, Delhi, India.
Sammis T.W., (1980). Comparison of sprinkler, trickle andfurrow irrigation method for row crops, Agron. J., No. 72, pp.701-704.
Yildirim O. and A. Korukcu, (2000). Comparison of drip, sprinkler and surface irrigation systems in orchards.Faculty of Agriculture, University of Ankara, Ankara Turkey. 47p.