JOURNAL OF AGRICULTURE AND BASIC SCIENCES
ISSN Online: 2518-4210
http://www.jabsjournal.com/

Full Length Research Article

Evaluation of different irrigation methods for water productivity and marketable yield of potato

Syed Ijaz-ul-Hassan[*1], Habibullah Habib[2], Muhammad Akram[2], Hafiz Shoukat Ali[2], Muhammad Naveed Ahsan[2], Muhammad Imran[2] and Iqra Ibrar[1]
[1]Potato Research Institute, Sahiwal
[2]Water Management Research Farm, Renala Khurd, District Okara
Corresponding author**:** syedejazqutbi@gmail.com

Abstract

Irrigation methods significantly affect the yield and quality of Potato. Scarcity of Scarcity of water resources is a major limiting factor in potato cultivation inclusive cropping scheme. The study was conducted at Water Management Research Farm, Renala Khurd, District Okara with the aim to determine the effect of different irrigation methods (Drip & Furrow) on Potato yield, tubers sizes and water productivity / water use efficiency. The results of this experiment revealed that the yield was higher under drip irrigation as compared to furrow irrigation. Higher proportions of medium and large size of tubers were obtained in case of drip while small size tubers were comparatively more under furrow irrigation. Water productivity value was 17.28 kg/m^3 with drip and 4.29 kg/m^3 with furrow irrigation method. These results are of considerable importance to farmers to achieve more efficient and rational use of water and to obtain good quality potato yield having good market value under limited water availability environment.

Keywords: Water availability, Furrow Irrigation, Potato Tuber size, small size tubers, management,water use efficiency

Introduction

Potato is being planted on large scale in the world, with a production potential of about 487.39 million tons from 32.56 million hectares (FAO, 2017). Potato is one of the main food and cash crop in Pakistan. It is grown on 0.17 million hectares with a total production of 4.0 million tones. Potato cultivation is strongly concentrated in Punjab where over 95% of the potato production originates currently (Agriculture Statistics of Pakistan 2017). The total production of potato in Pakistan was 1.666 million tons in 2000-01 that increased to 3.55 million tones up to 2011-12. Potato has higher energy and nutrient strata than wheat and rice. Although potato production in Pakistan has increased many folds but it's per hectare yield is still far below than the yield of other countries of the world (FAO data based; Agriculture Statistics of Pakistan 2017). Potato is the main cash crop and second major food crop after maize in Okara, Sahiwal, Pakpattan, Sialkot, Kasur, Chiniot and Lahore. These are suitable area for potato production because of their high altitude with cool climate and adequate rainfall. Restriction of potato cultivation in some other environmentally suitable areas is scarcity of water. Previous studies have shown that water is the most important limiting factor for potato production and it is possible to increase production levels by well scheduled irrigation programs throughout the growing season (Boujelben*et al*., 2001; Deblonde&Ledent, 2001; Chowdhury *et al*., 2001; Faberio*et al*., 2001; Panigrahi*et al*., 2001; Ferrira&Carr, 2002; Kashyap & Panda, 2003;). Considering that irrigation water is costly, exploitable and limited in semi-arid areas, it is crucial to maximize water savings and water productivity. This may be defined as the ratio between the crop yields achieved and crop water consumption or evapo-transpiration (Pereira *et al*., 2012)

The major objective of this trial was to evaluate drip and furrow irrigation for water productivity of potato.

Materials and Methods

Experiment Site and field condition:

The study was carried out at Water Management Research farm Renala Khurd, district Okara, Punjab, Pakistan (altitude 170 m, 73°36 E and 30°53″ N) during cropping season of 2018-19. Chemical and physical properties of soil are listed in table 1 & 2.

Experimental Design and Irrigation Treatments

The study carried out followingrandomized complete block design (RCBD) with four replicates. Uniform size seed of potato's cultivar "Karuda" were planted on 29-10-2018. Plot size was maintained 14 m x 4.30m for each treatment. A buffer zone spacing of 60 cm was provided to prevent water and fertilizer flow between neighboring plots. The plant to plant distance was maintained as 15 cm, whereas paired row to row distance was maintained as 60 cm. The

drip lateral was placed between the paired rows. All other standard agronomic and cultural practices were adopted up to maturity of the crop. Recommended dose of N:P:K was applied as per schedule during crop raising to each experimental plot. In drip irrigation system, nutrients were applied as fertigation, while in furrow irrigation system, broadcasting was done.

Data Collection and Evaluation

Potato crop was harvested after 128 days of sowing. Data regarding tuber yield and water productivity were collected per plot basis while other parameters i.e. small, medium and large sized tubers were taken in %age from the sample of 100 randomly selected potatoes from each plot.

Following parameters were collected / recorded

- Yield: Kg/ha
- Tuber size:
  - S1 Smaller than 35 mm
  - S2 Between 35-55 mm
  - S3 Larger than 55 mm
- Water Productivity: Yield in Kg/m^3 of irrigation water

Statistical Analysis

All the collected data were analyzed by utilizing statistical software Statistix 8.1 (Statistix Analytical Software, Tallahassee, Florida), while the differences amongst treatments were separated according to least significant difference (LSD) test at a 5% probability level.

Results

Tuber Yield

Tuber yield was studied for each treatment. Results are given in table 3. The potato tuber yield (Kgha-1) was not significantly affected by irrigation methods ($p>0.05$). However, its trend is upward with drip irrigation system.

Tuber Sizes

The effect of irrigation treatments on the qualitative component (Sizes) are shown in table 4. The percentage of medium and large size (S2 & S3) of tubers were gained more in case of drip (IM 1) while small size tubers (S1) were comparatively more under furrow irrigation (IM 2)

Water Productivity

The results of water productivity (tuber yield in Kg/m^3) are shown in Table 5. The results revealed that the furrow irrigation method used higher amount of water to produce per unit potato than drip irrigation method.

Discussion

The yield obtained in result of drip irrigation is higher (27998 Kg/ha) than furrow irrigation (25725 Kg/ha) but statistical affect is insignificant ($p>0.05$) between both treatments. The medium and large sizes potatoes have good market value. The sizes of potatoes are significantly affected by water application methods. The results of present study indicated that higher percentage of large and medium size potatoes were obtained under drip irrigation as compared to furrow irrigation while higher percentage of small sized potato were resulted in case of furrow irrigation as compared to drip irrigation, indicating that both excess and deficit water had adverse effect on quality and yield of potato. The results expressed that the field irrigated with drip produced 84.50% marketable potato while furrow irrigated field produced 75.25% marketable produce. Other researchers have also reported the same results (Shock *et al*., 2003; Ferreira &Carr, 2002; Kashyap & Panda, 2003; Yuan *et al*., 2003; Kang *et al*., 2004). Onder*et al*., (2005) reported that the number of tuber per plant was not significantly affected by irrigation methods but highest values of tuber weight were recorded for the drip irrigation treatment. Higher percentage of good quality potato in drip irrigation may be due to the fact that drip irrigation system enhances the nutrient availability by providing nutrients as fertigation (Hartz and Hoch muth, 1996), where as in furrow irrigation, fertilizer is applied as basal dose and split dose, which is always vulnerable to leaching. As a result, often crop suffers from inadequate supply of nutrients.

The results relating to water productivity revealed that the furrow irrigation method used higher amount of water to produce per unit potato than drip irrigation method. Water productivity values with drip irrigation and furrow irrigation were 17.29 kg/m^3 and 4.29 kg/m^3respectivelymeans water productivity of potato under drip is higher than water productivity of potato with furrow irrigation method. It clearly shows the superiority of drip irrigation system with respect to the judicious use of water and quality production of potato. Our results corroborate the finding of previous researchers. Several authors reported that water productivity values for tuber yield that are higher under deficit than under adequate irrigation (Darwish *et al*., 2006; Fabeiro*et al*., 2001; Islam *et al*., 1990; Kashyap and Panda, 2003; Onder*et al*., 2005; Badr*et al*., 2012). Kang *et al*., (2004) and Onder*et al*., (2005) also registered similar WUA values for potato. Hence, it is not advisable to apply excess water. Higher application of water may lead to non-Et uses like deep *perculation* and excess soil moisture. Efficient and economical management of precious water is prime concern for farmers. Results of this study indicate that drip irrigation system saved considerable amount of water than the present furrow irrigation practices.

Conclusion

This research was conducted to address water productivity issues of potato crop. The results showed 27998 Kg/ha yield, 17.28 Kg/m^3 water

productivity and 84.20% marketable yield ofpotato produced with drip irrigation system, whereas furrow irrigation method produced 25725 Kg/ha yield, 4.29 Kg/m3 water productivity and 75.25 % marketable yield. Our research demonstrated that drip irrigation system is best adopted irrigation method for both marketable yield and greater water productivity. Drip irrigation system achieves more efficient and rational use of water and potato could grow in very limited water availability environment.

References

Badr, M.A., W.A. El-Tohamy andA.M. Zaghloul. 2012. Yield and water use efficiency of potato grown under different irrigation and nitrogen levels in an arid region. *Agric. Water Manage.* 110: 9–15.

Boujelben, A.,K.B. Mbarek and A.B.Aid. 2001. Comparative study of the drip and furrow irrigation on seasonable potato crop. *Tropicultura*.19: 110-115.

Chowdhury, S.R.,E. Antony, R. Singh, A.K.Thakur and H.N.Verma. 2001. Leaf area development and its relationship with tuber yield in sweet potato under different irrigation regimes. *Orissa J. Hortic.* 29: 20-23.

Darwish, T.M., T.W. Atallah, S. Hajhasan and A. Haidar. 2006. Nitrogen and water use efficiency of fertigated processing potato. *Agric. Water Manage.* 85: 95–104.

Deblonde, P.M.K. andJ.F. Ledent. 2001. Effects of modarete drought conditions on green leaf number, stem height, leaf length and tuber yield of potato cultivars. *Eur. J. Agron.* 14: 31-41.

Fabeiro, C., F.M.S. Olalla, J.A.D. Juan. 2001. Yield and size of deficit irrigated potatoes. *Agric. Water Manage*. 48: 255–266.

FAOSTAT, 2017. Food and Agricultural Organization of the United Nations. Statistic Division, Accessed 21 June 2017.

Ferreira, T.C. andM.K.V. Carr. 2002. Response of potatoes (*Solanum tuberosum* L.) to irrigation and nitrogen in a hot, dry climate: I. Water use. *Field Crops Res*. 78: 51-64.

Govt. of Pakistan, 2017. Agricultural Statistics of Pakistan, Ministry of National Food Security & Research Islamabad.

Hartz, T.K. and G.J. Hochmuth. 1996. Fertility management of drip irrigated vegetables. *Hortic. Technol.* 6: 168-71.

Islam, T., H. Sarker, J. Alam and H. Rashid. 1990. Water-use and yield relationships of irrigated potato. *Agric. Water Manage*. 18: 173–179.

Kang, Y.,F.X. Wang,H.J. Liu and B.Z. Yuan. 2004. Potato evapotranspiration and yield under different drip irrigation regimes. *Irrigat. Sci*. 23: 133-143.

Kashyap, P.S. andR.K. Panda. 2003. Effect of irrigation scheduling on potato crop parameters under water stress conditions. *Agric. Water Manage*.59: 49-66.

Onder, S., M.E. Caliskan, D. Onder and S. Caliskan. 2005. Different irrigation methods and water stress effects on potato yield and yield components. *Agric. Water Manage.* 73: 73–86.

Panigrahi, B.,S.N. Panda andN.S. Raghuwanshi. Potato water use and yield under furrow irrigation. *Irrigat. Sci*.20: 155- 163.

Pereira, L.S., I. Cordery and I. Iacovides. 2012. Improved indicators of water use performance and productivity for sustainable water conservation and saving. *Agric. Water Manage.* 108: 39–51.

Shock,C.C.,E.B.G. Feibert andL.D. Saunders. 2003. Umtailla Russet and 'Russet Legend' potato yield and quality response to irrigation. *Hortic. Sci.*38: 1117-1121.

Yuan, B., S. Nishiyama and Y. Kamg. 2003. Effects of different irrigation regimes on the growth and yield of drip-irrigated potato. *Agric. Water Manage*. 63: 153–167.

Table1. Chemical properties of the soil at experimental site

Soil Depth (cm)	Ec (mScm-1)	pH	O.M (%)
0-15	1.8	7.6	0.91
15-30	1.9	7.6	0.70

Table2. Physical characteristics of the soil at experimental site

Soil Depth (cm)	Soil Texture	Saturation (%)
0-15	Loam	40
15-30	Loam	40

Table3. Potato tuber yield against each treatment

Sr. No.	Treatment	Yield (Kg/ha)
1	IM 1	27998 a
2	IM 2	25725 a

IM 1: Irrigation with Drip System
IM 2: Irrigation with Furrow method

Table4. Effect of irrigation treatments on the qualitative component (Sizes)

Sr. No.	Treatment	Sizes	%age
1	IM 1	S1 (Smaller than 35 mm)	16.50
2	IM 1	S2 (Between 35-55 mm)	68.25
3	IM 1	S3 (Larger than 55 mm)	15.25
4	IM 2	S1 (Smaller than 35 mm)	24.75
5	IM 2	S2 (Between 35-55 mm)	66.75
6	IM 2	S3 (Larger than 55 mm)	8.50

IM 1: Irrigation with Drip System
IM 2: Irrigation with Furrow method

Table5. Means of water Productivity (tuber yield in Kg/m^3)

Sr. No.	Treatment	Means of Water Productivity (Kg/m3)
1	IM 1	17.28 a
2	IM 2	4.29 b

IM 1: Irrigation with Drip System
IM 2: Irrigation with Furrow method.