Gezira j. of agric. sci. 12 (2):110-119(2014)

Installation of a family drip irrigation system for the improvement of the livelihood of small-scale farmers in comparison with surface irrigation

Ahmed B. A. Khalifa[1], Mohamed A. Ali[2], I. V. Sijali[3]., Adil Y. Yagoub[2], Mohmed A. Eljali[4] and Abdelgadir H. Ali[4]

[1]Kassala and Gash Research Station, Kassala, Sudan.
[2]Agricultural Research Corporation, Wad Medani, Sudan.
[3]Kenya Agricultural Research Institute, Nairobi, Kenya.
[4]Ministry of Agriculture, Forestry and Irrigation, Kassala State, Kassala, Sudan.

ABSTRACT

Drip irrigation is one of the most efficient methods of water use for crop production. Family drip systems are suitable for small land areas ranging from 10-2000 m^2 to irrigate horticultural crops. The system is a complete drip irrigation unit. It operates by gravity from a tank placed one meter high. It is a closed pipe-gravity system, and solid seasonal installation, for growing vegetables, flowers and other horticultural crops on flat or minor slope land. This experiment was established to evaluate a family drip system in comparison with surface irrigation for onion production under north Kassala conditions (Talkouk Locality). The results indicated that family drip system saved irrigation water by 67% and 59%, and increased the total yield of onion by 43% and 34% in sites one and two, respectively, as compared to local surface irrigation. The highest irrigation water productivity (2.98 and 2.73 kg/m^3) was obtained under family drip system and the lowest values were 1.25 and 1.28 kg/m^3 under surface irrigation in sites one and two, respectively. Moreover, the family drip system scored higher net return and benefit cost ratio compared to the surface irrigation system.

INTRODUCTION

In the dry lands, water deficit is the most important factor limiting crop production. When irrigated, these areas may have a high yield potential because of the high solar radiation, favourable day and night temperatures and low atmospheric humidity, conditions that decrease the incidence of pests and diseases compared to areas in temperate zones (Sijali, *et al*., 2009). In recent years, there has been growing concern about the performance of conventional irrigation systems. The poor performance of irrigation projects seems to have contributed to stagnation in new irrigation development (Sijali, 2001). Drip irrigation can apply water precisely and uniformly at high irrigation frequency compared with furrow and sprinkler irrigation (Hanson and May, 2007). Mohammad *et al*. (2010) found that the drip and sprinkler irrigation methods were more effective and efficient than surface irrigation for improved land productivity. In the Sudan, drip irrigation

has not yet been used on a large scale for crop production. However, it is used in greenhouses and privately owned farms and gardens. Abdalla, (2003) surveyed some areas in the Sudan, which are adapted to drip irrigation to produce valuable crops.

The family drip system is a new technique used for irrigation of small and medium plots and backyard gardens or greenhouses of different shape and sizes from 10 m² up to 2000 m^2, to grow vegetables, orchards, fruit trees and row crops. The system being gravity-based does not require any energy source for its operation. It is suitable for all types of soils, climates, water sources flat land or slight slopes. It is used by smallholders including those having no previous experience with drip irrigation.

In Kassala State, due to climate changes, water scarcity, reduced land units and the problems of ground water, the family drip irrigation may be the solution among small scale farmers. For smallholder farmers, drip irrigation provides a means of maximizing returns of crop land by increasing the economic biomass production per unit of water and increasing cropping intensity. Vegetables are the main provider of vitamins, minerals and other microelements that play vital roles in mitigating food insecurity, malnutrition and poverty. The objective of this study was to install a family drip system and evaluate its efficiency in small areas and compare its performance with surface irrigation.

MATERIALS AND METHODS

The experiment was carried out at two villages of Talkok Locality under north Kassala conditions during 2013. The climate of the area is semi-arid with most of rainfall falling between July and October. The soil type is silt loam to silt-clay loam in texture. This experiment was established to evaluate a family drip system in comparison with local surface irrigation for onion production under north Kassala conditions (Talkouk Locality). A family drip system was installed. It consisted of a filter (12mm diameter), sub main (16mm diameter), drip lines (13mm diameter) connectors and end plugs (Fig.1). The system works with 1m high tank (20 liters capacity). The system was installed and tested to irrigate an area of 10 m^2. The quantities of water applied and irrigation water productivity in both irrigation systems were evaluated by numbers of containers. The plot size of surface irrigation was 10 m^2, of 5 parts each one was 2x1m. The water was brought by donkey from a well 100 meter far from the experiment site. In family drip system, the tank was refilled manually. Irrigation was applied every day in the family drip system while in local surface irrigation it was applied every 3 days.

Onion (Baftem) was transplanted on the first week of October 2013 and harvested in the second week of February 2014. All the required horticultural practices were carried out as recommended by Agricultural Research Corporation (Mohmed, 1995). The recommended fertilizer dose was added through fertigation in family drip system and manually in the local surface irrigation.

The measured parameters were; onion yield, water applied and water productivity as the ratio of the crop yield to seasonal water applied according to Al-Jamal *et al*. (2001).

Benefit cost ratio analysis, as described by CIMMYT (1988), were used to evaluate the profitability of a family drip system compared to surface irrigation based on the field information and data collected.

Figure 1: Components of family drip system.

RESULTS AND DISCUSSION

Total yield of onion

Results showed significant differences in total yield of onion at both locations (Table 1). The higher yield ranged from 26.2 to 28.6 ton/ha under family drip system in the two locations compared to 19.5 and 20 ton/ha under local surface irrigation. For the family drip system, the percentage increase in total yield was equal to 43% and 34% in sites one and two, respectively, as compared to the local surface irrigation. These results revealed that higher yields were obtained under family drip irrigation as compared to local surface irrigation. Shashidhara *et al*. (2007) reported that drip irrigation increased yield of banana by 5.9% and 3.5%, respectively, compared to surface irrigation. On the other hand, Raina *et al*. (1998) reported that drip irrigation gave 49.5% higher yield than the surface irrigation in pea crop.

Table 1. Total yield of onion (kg/ha) of family drip system and local surface irrigation system.

Location one	Yield (kg/ha)
Family drip system	28600
Surface irrigation system	20000
SE	871.9
T. value	23.6
Significance level	*
Location two	
Family drip system	26200
Surface irrigation system	19500
SE	506.2
T. value	32.1
Significance level	*

* indicated significance at P≤ 0.05.

Total water applied for onion

The quantity of water applied to onion was 9600 m^3/ha under family drip system in both locations compared to 16000 m^3/ ha and 15238 m^3/ha for local surface irrigation in location one and two, respectively. Therefore, the percentages of applied water saving by family drip system were 67% and 59% for the location one and two, respectively, as compared to local surface irrigation. Similar results of irrigation water saving by drip irrigation system were reported by Khalifa *et al*. (2013) who reported that a drip irrigation system with 100% and 120% of ET_c increased the total yield of banana crop by 23% and 34% in sites one and two, respectively, compared to surface irrigation. On the other hand, a saving of water up to 50% by drip system as compared to surface method was reported by Bashour and Nimah (2004).

Irrigation water productivity (WP_{irri}) for onion

With drip irrigation system, productivity was maximized because there was no evaporation or runoff. Generally, our results indicated that the highest irrigation water productivity (2.98 and 2.73 kg/m^3) was obtained
under family drip system and the lowest values were 1.25 and 1.28 kg/m^3 under surface irrigation in sites one and two, respectively (Fig.2). The percentage increase in irrigation water productivity equal to 238% and 213%
in sites one and two, respectively, as compared to the local surface irrigation. These results are in agreement with those reported by Khalifa (2012). Narayanamoorthy (2003) reported that the water saving due to drip method of irrigation was 47% for sugarcane and nearly 30% for banana. Moreover, Sharmasarkar *et al*. (2001) reported that the amount of applied irrigation water with the drip system was lower than that applied by surface irrigation.

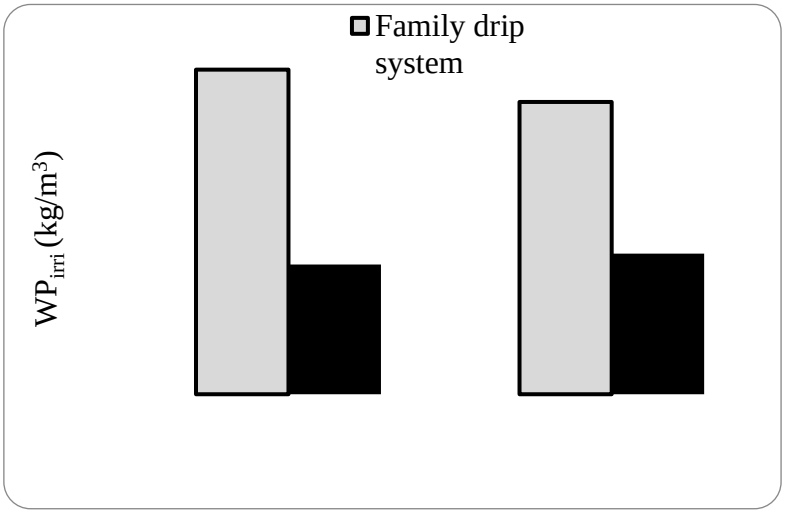

Figure 2. Irrigation water productivity (WP_{irri}).

Economic analysis for onion

The results of the economic analysis revealed that the family drip system had the highest benefit cost ratio compared to the surface irrigation system in both locations (Table 2). These results indicated that the fixed cost was higher in family drip irrigation but associated with sustainable yield over the long run. These results are in agreement with those reported by Basavarajappa *et al*. (2010) who found that drip irrigation had higher benefit

cost ratio as compared to surface irrigation. Moreover, Shashidhara *et al*. (2007) found that drip irrigation had higher benefit cost ratio as compared to surface irrigation.

Table 2. Crop budget analysis and benefit cost ratio of family drip system and local surface irrigation system.

Treatments	Yield (kg/ha)	Gross return (SDG)	Variable cost (SDG)	Gross profit margin	Fixed cost (SDG)	Total cost (SDG)	Net profit (SDG)	Benefit cost ratio
FDI								
L1	28600	85800	22814	62900	34286	57100	28614	1.50
L2	26200	78600	22457	56114	31429	53886	24686	1.46
SI								
L1	20000	60000	19000	41000	24000	43000	17000	1.40
L2	19500	58500	18167	40405	23429	41595	16976	1.40

FDI = family drip irrigation, L1 Location one, L2 Location2.
SI= Surface irrigation.

CONCLUSION

Family drip irrigation system for small area in north Kassala State proved to be of significant value for the improvement of the livelihood of rural people compared to currently used surface irrigation system.

ACKNOWLEDGEMENTS

The authors are in full praise and thanks to "Allah" who gave them the power, health and patience to conduct this study. Sincere acknowledgments are to be recognized and credited to the IAEA Regional Project RAF/50/58 "Enhancing the Productivity of High Value Crops and Income Generation with Small-Scale Irrigation Technologies.

REFERENCES

Abdalla, N. A. 2003**.** Drip Irrigation System Performance. A Case Study: Oumdom Farm. M.Sc. Thesis, Deptartment of Agricultural Engineering, Faculty of Agriculture, University of Khartoum, Sudan.

Al-Jamal, M. S., S. Ball and T. W. Sammis. 2001. Comparison of sprinkler, trickle and furrow irrigation efficiencies for onion production. Agricultural Water Management 46: 253-266.

Basavarajappa H. B., B. S. Polisgowdar and M. G. Patil. 2010. Effectiveness and cost economics of fertigation in brinjal (*Solanum melongena* L.) under drip and furrow irrigation. Karnataka Journal of Agricultural Science 24(3): (417-419).

Bashour, I. and M. Nimah. 2004. Fertigation potentials in the near east region. IPI regional workshop on potassium and fertigation development in West Asia and North Africa; Rabat, Morocco.

CIMMYT**.** 1988. From Agronomic Data to Farmer Recommendations. An EconomicTraining Manual. Completely Revised Edition, Mexico, D.F. Hanson, B. and D. May. 2007. The effect of drip line placement on yield and quality of drip-irrigated processing tomatoes. Irrigation and Drainage System 21:109-118.

Khalifa, A. B**.** 2012. Comparison of Surface and Drip Irrigation Regimes for Banana (*Musa* AAA) cv. Grand Nain in Gezira, Sudan. M.Sc. Thesis, Agricultural Research Council. Sudan Academy of Sciences, Khartoum, Sudan.

Khalifa, A. B., M. A. Ali., M. 1. Ibrahim., B. A. Shaker and O. Hassan. 2013.

Comparison of surface and drip irrigation regimes for banana (*Musa* AAA) cv. Grand Nain in Gezira.The 54 Meeting of the National Crop Husbandry Committee, Agricultural Research Corporation. Wad Medani. Sudan.

Mohammad, A., S. Ali., B. Majid., A. A. Naseri., B. N. Saeed and M. Golabi. 2010. Comparison of different irrigation methods based on the parametric evaluation approach in Dosalegh plain: Iran. Agricultural Water Management 97: 1093-1098.

Mohmed, M. B. 1995. Vegetables production in central Sudan. IPM Project. Funded by the Government of the Netherlands and Agricultural Research Corporation, Wad Medani, Sudan.

Narayanamoorthy, A. 2003. Averting water crisis by drip method of irrigation: A study of two water intensive crops. Indian Journal of Agricultural Economics 58(3): 427-437.

Raina, A. N., B. C. Thakur and A. R. Bhournal. 1998. Effect of drip irrigation and plastic mulch on yield, water use efficiency and benefit cost ratio of pea cultivation. Journal of the Indian Society of Soil Science 46(4): 562-567.

Sharmasarkar, F., S. Sharmasarkar., S. D. Miller., G. F. Vance and R. Zhang. 2001. Assessment of drip and flood irrigation on water and fertilizer use efficiency for sugar beets. Agricultural Water Management 46: 241-251.

Shashidhara, K. K., A. Bheemappa., L. V. Hirevekanagoudar and K. C. Shashidhar. 2007. Benefits and constraints in adoption of drip irrigation among the plantation crop growers. Karnataka Journal of Agricultural Science 20(1): 82- 84.

Sijali I.V. 2001. Drip Irrigation: Options for smallholder farmers in Eastern and Southern Africa. Technical Handbook No. 24, 2001. Kenya.

Sijali, I., M. Radiro., S. Obanyi., F. Kaburu., E. Komba., J. Gacheru., E. Muriuki., P. Kahiga and A. Wanyonyi. 2009. Family garden drip irrigation kits general manual for one eighth and quarter acre drip irrigation kit systems. Irrigation and Drainage Research Programme, Small Scale Drip Irrigation Development Project, Kenya Agricultural Research Institute, Kenya.

تركيب نظام الري بالتنقيط العائلي لتحسين أوضاع مزارعي المساحات الصغيرة مقارنة مع الري السطحي

احمد بابكر احمد خليفة[1]، محمد احمد علي[2]، سيجالي اسايه[3]، عادل يوسف يعقوب[3]، محمد عبد الله الجعلي[4] و عبد القادر حاج علي[4]

[1] محطة بحوث كسلا والقاش ، كسلا، السودان.
[2] هيئة البحوث الزراعية، واد مدني، السودان.
[3] المعهد الكيني للبحوث الزراعية، نيروبي، كينيا.
[4] وزارة الزراعة والغابات والري والثروة الحيوانية ولاية كسلا، كسلا، السودان.

الخلاصة

الري بالتنقيط هو أكثر الطرق كفاءة في استخدام المياه لإنتاج المحاصيل. نظام الري بالتنقيط العائلي هو نظام يناسب المساحات الصغيرة التي تتراوح مساحتها بين 10 الي 2000 متر مربع, لري المحاصيل البستانية. النظام هو وحدة ري بالتنقيط كاملة؛ يعمل بالجاذبية من خزان وضع علي ارتفاع 1 متر. هو نظام ذو انابيب مغلقة للجاذبية ويمكن تركيبة كل موسم بسهولة لزراعة الخضرواتِ والزهور والمحاصيل البستانية الأخرى على الأراضِي المنحدرة والمستويةِ أَو البسيطةِ. تأسست هذه التجربة لتقييم نظام الري بالتنقيط العائلي مقارنة مع الري السطحي المحلي لإنتاج البصل تحت ظروف شمال كسلا محلية تلكوك. اشارت النتائج إلى أن نظام الري بالتنقيط العائلي حفظ مياه الري بنسبة 67٪ و 59٪، وزيادة الانتاجية بنسبة 43٪ و 34٪ في الموقع الاول والثاني على التوالي مقارنة مع الري السطحي المحلي. ايضا تم الحصول على أعلى إنتاجية لمياه الري (2.98 و2.73 كيلوجرام متر مكعب) تحت نظام الري بالتنقيط العائلي وكانت أقل القيم (1.25 و 1.28 كيلوجرام متر مكعب) تحت الري السطحي في الموقعين الاول والثاني. علاوة على ذلك، سجل نظام الري بالتنقيط العائلي اعلي عائد ومنفعة مقارنة لنظام الري السطحي.