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Evaluate the Effect of Low Cost Drip Irrigation on the Yield and Production Efficiency of Onion Crops

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Abstract: *Evaluate the yield and irrigation production efficiency of onion crops with various irrigation scheduling using low cost drip and surface irrigation was carried out on sandy loam soil and agro climatic conditions of Bahir dar using experimental plots in the compounds of pre Kg schools of SOS, the research was conducted during the dry season of 2014-2015. To estimate the crop water requirements and irrigation scheduling calculations, CropWat Windows program Version 4.2 which is recommended by FAO were used. The experiment was laid in two factor randomized block design (irrigation schedule X irrigation method) with three replications. The experiment consists of four treatments which are 50%, 100%, 150% and 200% percentage pan evaporation replenishment. Low cost drip irrigation at 150% crop evapotranspiration gave significantly higher onion yield (16.75 t /ha), as compared to other treatments and surface irrigation treatments. The overall result showed that low cost drip irrigation methods resulted in higher marketable yield whereas surface irrigation methods gave considerably lower yield. The seasonal water applied/irrigation level and marketable yield of onion exhibited a strong quadratic relationship which in turn can be used for allocating limited water resource within the crop under different irrigation methods. It was concluded that low cost drip systems is highly economical for onion crop in this region.*

Keywords: *Surface Irrigation, Low Cost Drip Irrigation, Onion and Irrigation Production Efficiency*

1. INTRODUCTION

In drought –prone areas where water is aimed resource; it is not always feasible to apply the amounts of water required for achieving maximum yields. Water stored in tanks or ponds can become more effective by applying it at the critical stages of growth rather than by the conventional irrigation schedules. due to the limited volumes of water harvested and stored compared with crop water requirements ,improved benefits of these systems can be derived by incorporating efficient water application methods.

Farmers in dry lands of Ethiopia depend on erratic, unrealistic and low rainfall to produce staple food crops for their livelihoods. Huge proportion of the population (more than 85%) in Ethiopia is engaged in less productive agricultural activities. This low productive rain-fed small-holder agriculture is the main source of food supply in the country. Crop production is limited by water shortage which is caused low storage, insufficient utilization; inter annual and annual fluctuation in precipitation and high evaporation demand. Ethiopia has a surface area of 1.3 million square kilometers, of which 99.3 percent is a land area and the remaining 0.7 percent is covered with water bodies (MoWR, 2002). Using these water bodies, farmers change their living standard through irrigation.

To increase agricultural production and living standards in dry lands of Ethiopia, greater priority must be given to enhancing efficiency of water collection and utilization (Hillel, 2001 and Paul, 2002). Surface is the most common method of irrigation in this region. Due to increasing water scarcity caused by erratic rainfall and over exploitation of ground water, farmer in this region have no option except to adopt advanced irrigation methods that have been attempted to conserve water and use it efficiently. Technologies such as micro-irrigation techniques have been developed to precisely meter and apply water to plant roots, so that more crops can be grown for a given volume of water with superior in term of water saving, yield and production/ water use efficiency (Fekadu and Teshome, 1998; Michael, 1997; Isaya V. Sijali, 2001)

Reports showed that, low cost drip irrigation (LCDI) is in use in over 80 countries worldwide and the demand is growing fast. In Africa, it is being used in Kenya, Tanzania, Malawi, Zambia and Uganda (Isaya V. S, 2001). Elsewhere in the world, for example in India, resource-poor farmers have used LCDI systems with reported success (Isaya V. S, 2001). Micro irrigation systems have been found to be superior in terms of water and nutrient saving and higher productivity of many crops (Fekadu and Teshome, 1998). Micro irrigation system was found to result in 30 to 70% water savings in various orchard crops and vegetables along with 10 to 60% increases in yield as compared to conventional methods of irrigation (Baye, B., 2011). However, the conventional drip systems are expensive and cannot be afforded by smallholder poor farmers. To solve this problem a number of innovative options have been developed in different parts of the world (Isaya V.S., 2001 and in PostelS. et. al., 2001). The aims of these innovations are being to improve the distribution and application of water. It is wise to make efficient use of water and bring more area under irrigation through limited water resources. This can be achieved by introducing advanced methods of irrigation and improved water management practices (Meseret, et al., 2012).

Small-scale, LCDI systems that can be easily afforded and managed by poor farmers contribute significantly to the endeavors of ensuring food self-sufficiency at household level. Thus alternative methods such as low-cost smallholder irrigation technologies are vital and attractive. Irrigation scheduling is a critical management input to ensure adequate soil moisture for optimum yield, quality and water use efficiency. Numerous irrigation-scheduling approaches have been developed in the past under wide range of irrigation system and management, soil, crop and climatic condition (Steel *et al.* (1997).

In order to optimize crop production in limited water resource condition, it is important to understand the relationship between water applied and crop production. The relationship between water applied and crop yield is defined as water production function. Improper irrigation management practices do not only waste scarce and precious water resources but also decrease marketable yield and economy stated in FAO (2002) .Information of water production function is important for assessing the priorities for allocating limited irrigation water within and between the crops. The objectives of this study is to investigate the effect of low cost drip irrigation on marketable yield, irrigation production efficiency and economic return of onion crop and to study the condition of factor that lead to successful adoption of low cost drip irrigation system for onion

2. MATERIALS AND METHODS

2.1. Description of the Study Area

The experiment was conducted at the experimental site of SOS elementary school Bahir dar. It lies at 11.36 °N latitude and 37.25° E longitude; and altitude of about1770 meters above sea level. The soil is sandy loam with sand, silt and clay in proportion of 55.37%, 35.98% and 8.65% respectively. The initial available soil moisture and initial soil moisture depletion of the irrigation plots are 20.5mm/m depth and 35% respectively with 300mm/day infiltration rates. The soil moisture content at field capacity was 31.54 % on dry weight basis. The average bulk density of soil was 1.64 g/cm3.

2.2. Materials Used

The material used for the experiment was hosepipe with the temporary water transfer (from water source) near to the plot to fill the barrel volume of 200lit. The water is lifted manually by labor to fill the bucket. Woods for pillars of bucket at 1.70m heights from the point where the blind hose was situated to maintain the distribution uniformity were used. A low cost drip irrigation system consists of PVC tubing (mainline, sub main, laterals and emitters), a valve, pressure regulator, filters pressure gauge and application components. Screen filter was installed to minimize dripper blockage. PVC pipes of 50 mm diameter and LDPE of 12 mm diameter were used for main/ sub-main and laterals lines respectively. Each dripper/ emitter discharges with the capacity of 1.1 l/hr.

2.3. Meteorological Data

Bahir dar metrological station which has average rainfall, average temperature, relative humidity, wind speed and sunshine hour recorded data obtained from Bahir dar metrological station office.

2.4. Experimental Methodology

The study was conducted at SOS elementary school Bahir dar during off season (2014/15 cropping season).The experiment was laid in two factor randomized block design (irrigation schedule X irrigation method) with three replications. The experiment consists of four treatments which are 50%, 100%, 150% and 200% percentage pan evaporation replenishment. The area of each experimental plot will be $4m^2$ (2m*2m) .A buffer zone spacing of 1.0m and 0.5m was provided between the plots and blocks. There was total of 24 plots having a total area of $96m^2$.Among the 24 plots, 12 plots were received irrigation through surface method and the remaining 12 experimental plots were received irrigation through low cost gravity based drip irrigation methods (figure 1), there are four laterals from each plot and 13 emitter's points with the spacing of is 15 cm each

Figure1. *Schematic layout of irrigation plots*

The crop was sown in the nursery and transplanted after 30-35 days. The crop was planted in rows or on raised beds with spacing of 0.3*0.3m.Optimum soil temperature for germination will be 15 to 25 degree centigrade. Fertilizer was applied 60 to 100 kg/ha N, 25 to 45 kg/ha P and 45 kg/ha to 85kg/ha K as per the requirements.

2.5. Estimation of Crop Water Requirement

The actual crop evapotranspiration was (ETa) computed by multiplying the reference evapo-transpiration (ETo) with crop coefficient (Kc) for different growth stages of the crop (Table 1). ETo was calculated on a daily basis from daily meteorological data (maximum and minimum temperature, relative humidity, wind speed and sunshine hours) using the CROPWAT 4.0 model (Rome, Italy). The model uses FAO Penman -Monteith equation, which was accepted as standard method to calculate reference evapotranspiration (Allen et al. 1998). The Kc for different growth stages of onion determined locally by lysimeter study were used in the calculation of actual crop evapotranspiration. Thus, volumetric water required for onion plant was computed as (shown table 1):

Table1. *Estimated water requirement for different growth stages of onion*

Stage	Duration (day)	Kc	ETo(mm/day)	ETa(mm/day)
Initial	20	0.70	3.40	2.38
Development	30	0.88	3.98	3.5024
Mid season	30	1.05	4.40	4.62
Late season	15	0.95	4.6	4.37

ETa = Kc × ETo --------------------------- **(Equation 1)**

Where, Kc – crop coefficient; ETo- evapotranspiration; ETa-actual crop evapotranspiration

3. Results and Discussions

3.1. Yield and Irrigation Production Efficiency of Dry Onion

Yield and irrigation production efficiency of onion is influenced by different irrigation methods and schedules are presented in (Table 2 and Table 3) also irrigation level significantly influences the marketable yield of onion. The mean marketable yield of onion for different irrigation schedules ranges from 7.915 to 16.75 t/ha. The higher mean marketable yield of onion 16.75 t/ha was obtained when irrigation during crop growing seasons was applied at 150% of the irrigation water requirement. A farther increase in irrigation level resulting from 200% of irrigation water requirement reduce the marketable yield of onion 10.32 t/ha significantly due to significant reduction in yield. The irrigation level had marked effect on irrigation production efficiency of onion ranges from 1.86 to 5.72 kg/m^3. The significant higher irrigation production efficiency 5.72 kg/m^3 was recorded with irrigation at 50%of the irrigation water requirement. Because reduction in marketable yield was less as compared with seasonal water applied. The minimum irrigation production efficiency 1.86 kg/m^3 was recorded when irrigation during 200% of irrigation water requirement.

Table2. *Effect of irrigation schedules and irrigation method on the yield, and irrigation production efficiency*

Treatments	**Marketable yield and irrigation production efficiency of dry onion Treatments**	
Irrigation schedules (Water applied in percentage, %)	**Mean marketable yield , t/ha**	**Mean irrigation production efficiency , Kg/m^3**
50	7.915	5.72
100	13.49	4.87
150	16.75	3.89
200	10.325	1.86
CD(0.05)	0.281	0.0025
	Irrigation methods	
LCD	14.05	4.82
Surface	9.9	3.36
CD(0.05)	0.75	0.75
	Interaction	
CD (0.05)	0.549	0.549

Table3. *Summarized results of irrigation methods vise Seasonal water applied, Yield, and Irrigation production efficiency*

	Treatment							
	LCDI				**Surface irrigation**			
	50%	***100%***	***150%***	***200%***	***50%***	***100%***	***150%***	***200%***
Seasonal water applied (mm)	138.4	276.8	415.2	553.6	138.4	276.8	415.2	553.6
Marketable yield (t/ha)	9.84	14.98	17.89	13.5	5.99	12.0	14.46	7.15
Irrigation production efficiency (kg/m^3)	7.11	5.41	431	2.43	4.32	4.33	3.48	1.29

The mean marketable yield of onion was significantly higher for drip irrigation method followed by surface irrigation method Drip irrigation methods resulted in significantly higher irrigation production efficiency 4.82 kg/m^3. The surface irrigation method resulted in minimum. Irrigation production efficiency of 3.36 kg/m^3 obtained due to considerably lower marketable yield of onion.

3.2. Water Supply and Yield of Dry Onion

The relationship between seasonal and marketable yield of dry onion for drip and surface irrigation method are presented in (figure 2) In spite of some variation the seasonal water applied and marketable yield of dry onion for drip R^2 = 0.961 and surface R^2 = 0.959 irrigation methods exhibited strong quadratic relationship. The marketable yield of onion increased with increase in seasonal water applied up to 400mm for drip and surface irrigation method and there after yield tended to decline (figure 3)

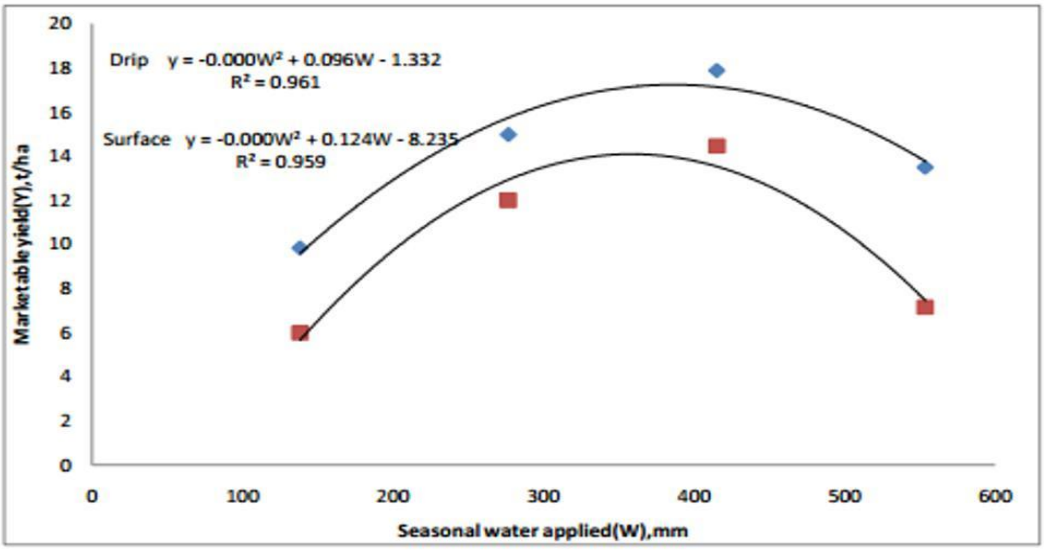

Figure2. *Relationship between water applied (W) and yield (Y) of dry onion for different irrigation method*

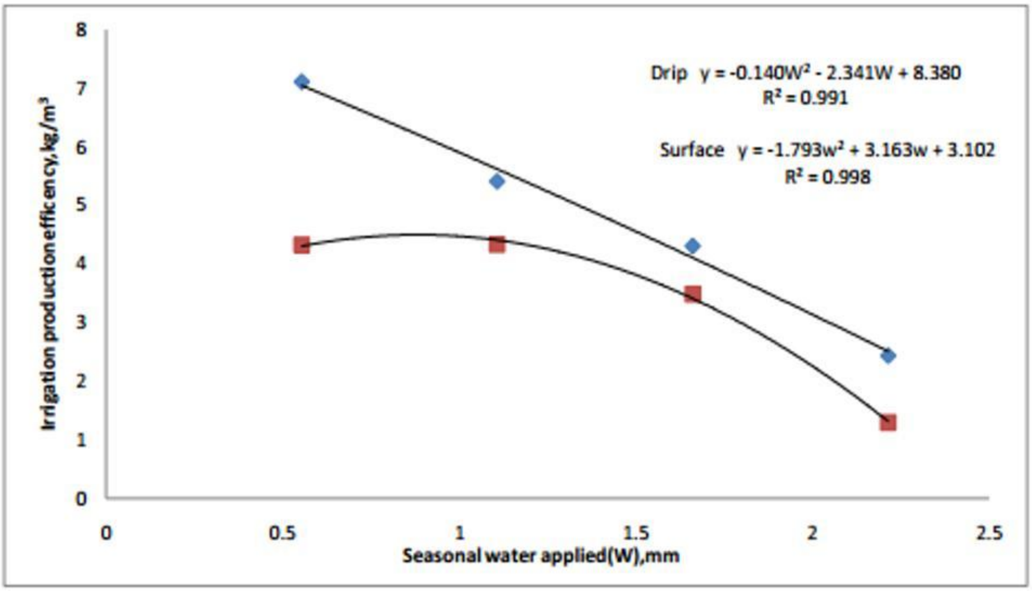

Figure3. *Relationship between water application in m^3 and irrigation production efficiency for Different irrigation methods*

4. CONCLUSION

The experimental result shows that irrigation at 150% of irrigation water requirement gave a significantly higher marketable yield of dry onion, but irrigation production efficiency was higher when crop was irrigated at 50% of irrigation water requirement. Drip irrigation resulted in highest marketable yield and irrigation production efficiency than surface irrigation method.

Finally, overall result clearly suggests that in order to obtain higher marketable yield and irrigation production efficiency of onion during the growing season. (Oct to May) the crop should be irrigated at 150% of irrigation water requirement furthermore the irrigation management approach is the most common simple and can be easily adopted for onions.

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