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ASSESSMENT OF FLOOD IRRIGATION AND SPRINKLER IRRIGATION PRACTICED BY FARMERS FOR RED ONION (*Allium cepa* L) IN MONERAGALA DISTRICT

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ABSTRACT

Sprinkler irrigation has been promoted among the farmers as an efficient method to achieve high yields and for water saving. However, farmers have been using both flood and sprinkler irrigation with different irrigation intervals, regardless of recommendations. Thus, a study was conducted to assess the field performance of the flood and sprinkler irrigation methods practiced by farmers for the cultivation of red onions in Moneragala district. Eighteen farmers who practiced flood and sprinkler irrigation were selected and grouped based on their irrigation schedules for data collection. While farmers who practiced sprinkler irrigation applied water at irrigation intervals of 1, 2 and 3 days, irrigation intervals in flood irrigation were 3, 4 and 5 days. Data on water depletion level, total amount of water used and bulb yield were collected for three consecutive *yala* seasons. Results show that onion yields increased significantly as water depletion levels decreased. In sprinkler irrigation, high yields of 20 t/ha were obtained with the water use efficiency of 510 kg/ha-cm at daily irrigation with 0.2 water depletion level. The maximum water use efficiency in flood irrigation was 220 kg/ha-cm which is 48 % of that in sprinkler irrigation at the same depletion level. Sprinkler irrigation reduced labor requirement by about 55 man days and increased net returns by about Rs. 98,445 per hectare compared to flood irrigation. The unit cost of production was Rs. 12.97 per kg and Rs. 9.63 per kg under flood and sprinkler irrigation, respectively.

KEYWORDS: Onion, Sprinkler irrigation, Unit cost of production, Water depletion level, Water use efficiency.

INTRODUCTION

Irrigation is a critical input for increasing the agricultural production and productivity. It increases the production by many fold compared to the rainfed cultivation. Irrigation technology has been developed rapidly from bucket to sprinklers and emitters and from manual to automation over the last two decades. Introduction of modern irrigation technology, updating recent developments and their adaptation by local farmers are very important for enhancing food production.

With increasing demand for water by non-agricultural activities, irrigation has become a crucial factor in agricultural production (Seckler *et al.*, 1998). Hence, efficient and effective water management strategies are

required to be designed and implemented. In view of this, recent developments in hardware and software related to irrigation have been introduced to the farmers. Farmers have been trained on new water saving and better land utilization technologies in the recent past. The adaptability of new irrigation technology also has been increased (Sivanappen, 2001).

Micro irrigation, which includes sprinkler and drip irrigation, has become popular among the farmers in Sri Lanka, particularly in areas where water scarcity prevails. With the existing bi-modal, erratic and unreliable rainfall pattern in Sri Lanka, the introduction of micro irrigation technology to the farmer community will be highly beneficial. When compared to flood irrigation, where the water is applied to a vast area, micro irrigation is confined to a specific area, thus preventing unnecessary wastage of water and increasing the application efficiency up to 95 % (Sahay, 2001). During the early period (1986–1999), this technology had been recommended as a strategy for saving water. Subsequently, it was shown that micro irrigation not only saves water, but also increases the yield and reduces the labor requirement (Sivanappan, 1987).

The Department of Agriculture (DOA) together with the Provincial Agriculture System has initiated an action plan to introduce the sprinkler irrigation system under agro-wells. This has been extensively used for river basin cultivation on a large scale in the district of Monaragala. Farmers were given training by the government institutions and private companies on improved irrigation management practices. However, it was observed that farmers' practices deviated from recommendations. This may be due to technical and socio-economic factors such as the availability of water, knowledge and experiences of the farmer, financial limitation, land and labor availability, soil characteristics and personal preferences. Farmers do compromise between gain and loss or conveniences and difficulties. In this reality, a study on the system performance in terms of technical and socio-economic conditions is necessary to understand the farmers' behavior in adopting micro irrigation for formulation of future strategies.

Therefore, this study was conducted in the Moneragala district with the following objectives..

1. To compare field performance of the sprinkler and flood irrigation systems with respect to water use efficiency, labor use, effective land use and crop yield.
2. To analyze the financial benefits of both irrigation systems.

MATERIALS AND METHODS

Location of the study

The study was conducted at Thanamalwila in Monaragala District, during *yala* seasons of 1999, 2000 and 2001. This area is located in the low country dry zone, DL-1 in Kirindi oya basin. The soil found in this undulated terrain is Rhodustalf. Eighteen farmers who practiced flood and sprinkler irrigation under agro-wells were selected and grouped based on their irrigation schedules, for data collection. Number of farmers in each group with similar agronomic practices was three. Combinations of farmer groups were flood irrigation with 3, 4 and 5 day irrigation intervals and sprinkler irrigation with 1, 2 and 3 day irrigation intervals.

Agronomic Practices

All agronomic practices were followed according to DOA recommendations (Technoguide, 1997). Land was divided into 20 x 30 m size plots surrounded by small bunds for flood irrigation. The plot preparation was not required for sprinkler irrigation. Red onion (Jaffna local) was planted in the plots and fields. Urea, Triple Super Phosphate and Muriate of Pottash were applied manually according to the DOA recommendation. However, in sprinkler irrigation, Urea and Muriate of Potash were applied through the fertigation unit and Triple Super Phosphate was applied as a basal application manually.

Flood irrigation

Water from the Agro-well was pumped to flood irrigate the plots in flood irrigation. Water was delivered from plot to plot once the initial plot was filled with water. The amount of water used was measured.

Sprinkler irrigation

The sprinkler system includes water pump, pressure control unit, fertigation, main and sub main, laterals and micro sprinklers. Polyethylene Vinyl Pipe was used for main and sub main lines. Linear low-density polyethylene pipe (LLDPE) was used for the laterals. Laterals and sprinklers were spaced at 5 m intervals.

Soil moisture measurement

Moisture potential of the soil was measured using tensiometers installed at the depth of 10 – 16 cm. Moisture depletion level of available water was calculated based on the field capacity of the soil and the tensiometer reading prior to irrigation. The irrigation schedule and the moisture measurements were obtained during the peak water demand of the crop.

Effective land area

Effective land area was considered as the area used for planting.

Economic data

Capital cost of sprinkler irrigation system, water pump, machinery and other inputs, labor usage and yield were obtained from the relevant farmers during the study period. Separate farm records were maintained for each farm to collect this information.

RESULTS AND DISCUSSION

Irrigation interval and water depletion level

Schematic representation of water depletion patterns under different irrigation frequencies for flood irrigation and sprinkler irrigation is shown in Figure 1 and Figure 2 respectively. Water applied up to the bund height of the plots in flood irrigation lead to the ponded water condition (PW) in the field. This was not the situation in sprinkler irrigation.

Table 1 shows the water depletion level, bulb yield and water use efficiency for flood irrigation system. The amount of water applied was the same regardless of irrigation interval because the plots were filled and kept for a long time. One way analysis of variance (ANOVA) was performed to test the effect of irrigation interval for each type of irrigation on yield and water use efficiency. The results of the ANOVA showed that the irrigation intervals were significant ($P<0.05$) sources of variations in yields and water use efficiency. The yield and water use efficiency significantly varied with different water depletion levels. The yield increased as water depletion prior to irrigation decreased.

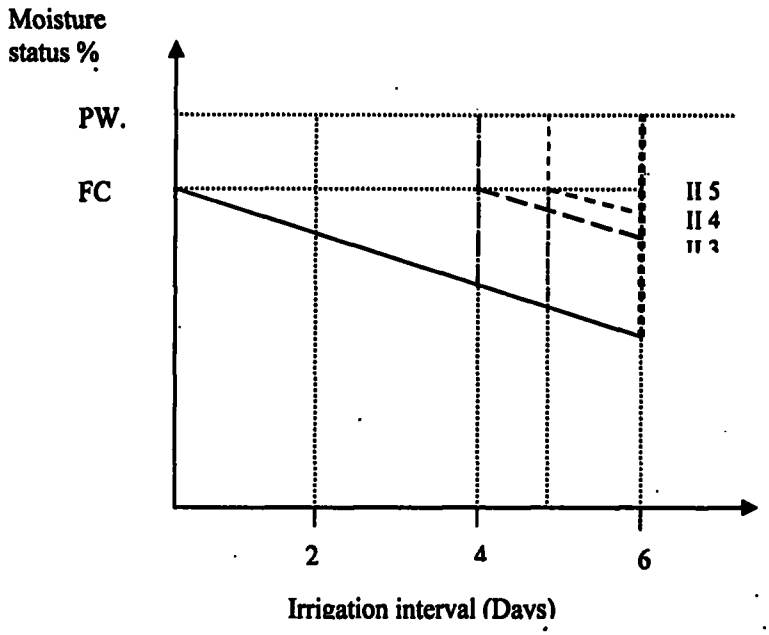

Figure 1. Illustration of irrigation schedule under flood irrigation (FC-Field capacity; PW - Ponded water; II – Irrigation interval.

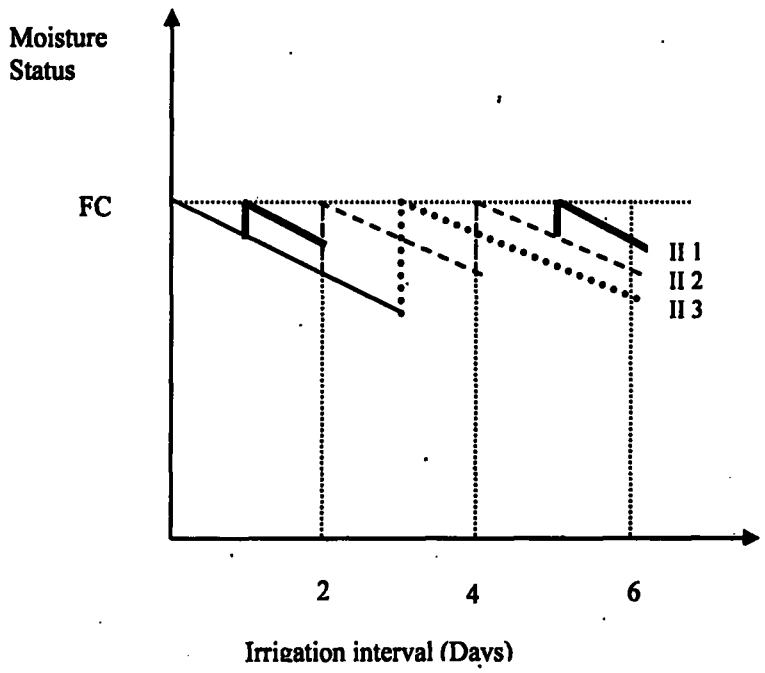

Figure 2. Illustration of irrigation schedule under sprinkler irrigation.

Bulb yield and water use efficiency

Table 1. Water use efficiency in flood irrigation.

Water Depletion Level (Prior to Irrigation)	*Yield (t/ha)*	*Water Used (cm)*	*Water Use Efficiency (kg/ha – cm)*
0.40 – 0.45	13.98[a]	63	220[a]
0.50 – 0.60	12.60[b]	63	200[b]
0.55 - 0.65	11.10[c]	63	170[c]

Means with the same letter are not significantly different at P = 0.05

The allowable depletion, agreed by most of the researchers, is 0.5 (Sivanayagam, 1973). But farmers do not have a technique to find the moisture depletion level to decide the next irrigation. In reality, the next irrigation is decided through their experience. The farmers in Group I applied water at lower depletion levels and reduced the water stress to the plant resulting in higher yields compared to other groups. The farmers' point of view is that the availability of water, labor and pumping cost are the major factors that determine the irrigation interval.

The water use efficiency for sprinkler irrigation system is shown in Table 2. Higher water use efficiency was observed in sprinkler irrigation compared to flood irrigation. The highest yield of about 20 t/ha was obtained with the water use efficiency of 510 kg/ha-cm at daily irrigation. Although the yields varied there was no significant difference in water use efficiency between irrigation intervals 2 and 3 days. Optimum soil moisture regime, increment of effective area for planting and efficient use of fertilization as explained in the subsequent section contributed significantly to yield increase under sprinkler irrigation system.

Table 2. Water use efficiency in sprinkler irrigation.

Water Depletion Level (Prior to Irrigation)	*Yield (t/ha)*	*Water Used (cm)*	*Water Use Efficiency (kg/ha – cm)*
0.15 – 0.25	20.17[a]	38.8	510[a]
0.25 – 0.35	18.69[b]	38.8	480[b]
0.40 - 0.45	14.91[c]	32.7	450[b]

Means with the same letter are not significantly different at P = 0.05

Farmers who practiced micro-sprinklers had shorter irrigation intervals as shown in Table. 2. The water depletion levels were less than 0.5. It was reported that the field capacity and permanent wilting point of Rhodustalfs soil are 26 % and 16 % respectively, on volumetric basis (Joushua, 1985). The application rates practiced in sprinkler irrigation are within the retention capacity of the soil.

Effective land area for planting

Effective land area for planting had increased by about 10 % in sprinkler irrigation compared to flood irrigation (Table 3). Sprinkler irrigation system does not require bunds for retaining water, as required in flood irrigation.

Table 3. Effective land area for planting.

Irrigation system	*Land preparation*	*Effective land area/ha*
Flood irrigation	with bunds	8578 m^2
Sprinkler irrigation	without bunds	9625 m^2

Labor usage

Labor usage in irrigation and fertilizer application in both irrigation systems were assessed. As shown in Table 4, flood irrigation requires higher amount of labor compared to sprinkler irrigation. Labor savings on irrigation and fertilization were about 66 and 36 %, respectively in sprinkler irrigation compared to flood irrigation.

Table 4. Average labor usage (man-days/ha) per crop season.

Irrigation system	*Irrigation*	*Fertilizer application*
Flood irrigation	75	55 (manual application)
Sprinkler irrigation	25	35 (through fertigation unit)

Financial analysis

Farmers using sprinkler irrigation reduced the cost of production by about Rs. 13,056 per ha compared to flood irrigation (Table 5). Farmers were able to obtain an additional income of Rs 98,445 per ha as a result of increased productivity and reduced cost of production under sprinkler irrigation. It was estimated that the unit cost of production declined from Rs 12.97 per kg to Rs. 9.63 per kg as a results of sprinkler irrigation.

Table 5. Cost and return of red onion production.

Item	*Flood irrigation Rs/ha*	*Sprinkler irrigation Rs/ha*
Cost of production		
Machinery & input cost	105326.38	109897.73
Labor cost	67705.40	56833.00
Capital cost	8318.13	27675.20
Total cost	181349.90	194405.93
Average yield, Producer Price and Returns		
Average yield (kg/ha)	13983.66	20178.16
Producer price (Rs/kg)	18.00	18.00
Gross return (Rs/ha)	251705.88	363206.88
Net return (Rs/ha)	70355.98	168800.95
Unit cost of production (Rs/kg)	12.97	9.63

CONCLUSIONS

In sprinkler irrigation, a higher yield of 20 t/ha was obtained with the water use efficiency of 510 kg/ha-cm at daily irrigation with 0.2 water depletion level. However, there was no significant difference in water use efficiency between irrigation interval at 2 and 3 days. The maximum water use efficiency in flood irrigation was 220 kg/ha-cm, which is 48 % of that obtained in sprinkler irrigation at the same depletion level. Optimum soil moisture regime, increment of effective area for planting and efficient use of fertilization contributed significantly to the yield increase in sprinkler irrigation system. Economic analysis revealed that use of sprinkler irrigation reduced labor requirement by about 55 man days and increased net return by around Rs. 98,445 per hectare compared to flood irrigation. The unit cost of production was Rs 9.63 per kg and Rs 12.97 per kg under sprinkler irrigation and flood irrigation, respectively. The unit cost of production of red onion was relatively low under sprinkler irrigation due to increased productivity.

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