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YIELD PERFORMANCE OF RED ONION (*Allium ascalonium. L*) UNDER DIFFERENT IRRIGATION MANAGEMENT IN JAFFNA PENINSULA

Thushyanthy Mikunthan and T. Srivaratharasan

Department of Agricultural Engineering, Faculty of Agriculture,
University of Jaffna, Jaffna, Sri Lanka.

ABSTRACT

Study discusses the yield performance of red onion under sprinkler irrigation with different moisture regime in DL_3 agro climatic zone in calcic red latasols in Jaffna. The objectives of the study to assess yield performance of red onion under different irrigation management. A field trail was designed with five treatments; conventional practice by farmer as control, basin and raised bed planting with 40 cb and 60 cb hydraulic potential with three replicates. The average time period required to bring the field capacity to 10 cb from 40 cb and 60 cb was 45 min and 60 min respectively with 3.5 l /min discharge rate. The efficiency of crop water consumption at 40 cb planted on raised bed was 1.66 kg/m²/mm and at 60 cb planted on raised bed was 1.53 kg/m²/mm. Treatment with 40 cb tension planted on raised bed with sprinkler irrigation recorded the highest yield of 6.04 kg/m² and followed by the treatment with 60 cb tension planted on raised bed (5.59 kg/m²) When compared with control those were more than 30% and 20 %, respectively.

Key words: sprinkler irrigation, red onion, yield performance

1. Introduction

Inadequacy of water is one of the most prominent environmental constraints for agricultural production in dry and intermediate climate zones of Sri Lanka though the majority of soils of these zones are at acceptable fertility levels [1]. Over usage of irrigation water can lead not only to shortage of water but also to the deterioration of crop yields and soil. It is hence vital to ensure that it is applied as effectively as possible in order to reach efficiency. In Jaffna peninsula, groundwater is the only potential water resource except seasonal rainfall. Expansion of cultivable area under irrigation is essential for increased agricultural and horticultural production, which is required to feed the growing population. Over exploitation of groundwater leads sea water intrusion which increases the salinity and polluting the available water source. Hence, the most suitable remedy to this problem is controlled method of irrigation.

Even though sprinkler irrigation is becoming popular in other parts of the country, the knowledge and adaptability of the technology is inadequate among Jaffna Peninsula farmers. Therefore yield study related to sprinkler irrigation in calcic red latasols is important to convince the farmers to adopt this new technology in the field with confidence. Lysimeter studies were carried out at Field Crop Research and Development Institute, Maha Illuppallama, during 1999 to determine the optimum depletion level and to select the best irrigation frequency to big onion (*Allium cepa* L) in rhodustalfs in the dry zone of Sri Lanka and reported that the yield increase in big onion were 59 and 48 percent at 0.2 and 0.4 depletion levels respectively, over the bulb yield of 8.6 t/ha at 0.5 depletion level. And also the response trend of bulb yield for increasing depletion levels and fixed irrigation intervals was negative and linear [2].

A study was conducted to understand the yield performance of red onion under sprinkler irrigation in calcic red latasols and climatic condition of dry zone. A field trial was conducted to assess the performance of the sprinkler irrigation system under different moisture tensions by comparing the yield performance of red onion.

Objective of the study

1. To schedule sprinkler irrigation under different soil moisture tension in red yellow latasols
2. To assess the yield performance of red onion under different irrigation management.

2. Materials and Methods

Study area

A field experiment was carried out at District Agricultural Training Center, Thirunelvely, Jaffna, Sri Lanka to assess the yield performance of red onion under different irrigation management during July to October 2004. The study area belongs to dry zone low country (DL_3) agro climatic region where the soil is calcic red latasols. The average temperature rainfall and evapotranspiration of the study area during the study period were 29°C, 78 mm and 5.02 mm respectively.

The land is having slope of 0-3%. Chilli, red onion and tobacco are the cash crops grown in the study area. Red onion was cultivated previously in two seasons per year using basin irrigation. At present it is cultivated throughout the year irrespective of the seasons due to the high income generation.

Measurement of physico chemical properties of soil

Since the average root zone depth of the onion crop is 30 cm [3], six representative soil samples were taken within 0 – 30 cm depth. Bulk density and particle density were measured by standard methods of tube core [4] and Pycnometer [5] method. *In situ* method [6] was used for field capacity measurement. Porosity was calculated using the bulk density and particle density. Permanent wilting point and infiltration of the soil for the study area was taken from the literature [7]. Moreover, the chemical properties of the soil such as available nitrate, P, K and pH were determined using standard procedure [8] using samples taken from each treatment plots.

Discharge rate of sprinkler nozzle

Butterfly type rotating head sprinkler nozzles were used for irrigation. The recommended pressure is 2.5 bar. One side sealed polythene bag was tied in each sprinkler nozzles and was operated for 30 sec. and the collected water was measured by measuring cylinder. Average discharge rate was calculated in l/min.

Field preparation

The land was ploughed using a two wheel tractor and two weeks later the land was harrowed manually. Basal fertilizer was applied at the rate of 65 kg/ha urea.100 kg/ha treble supper phosphate and 50 kg/ha of muriate of potash. First top dressing was done three weeks after planting at the rate of 150 kg/ha ammonium sulphate and 50 kg/ha murrieta of potash. Again second top dressing was done six weeks after planting at the rate of 150 kg/ha ammonium sulphate and murrieta of potash. The size of the each treatment plot was 120 cm x 90 cm. The plot size of the raised bed was 120 cm x 90 cm x 15 cm. The recommendation made by the Department of Agriculture is different. But the selected plot size was the size of conventional farmers use. Irrigation treatment plots were designed at 3 m spacing.

Treatment combinations

The red onion was selected as the test crop because it is one of the most important cash crop being extensively cultivated using large quantity of groundwater in Jaffna peninsula. The research was done with the following five treatments (Table 1) and three replicates. A randomized complete block design was used to different irrigation management. Control was designed as every fourth day irrigation to conventional basin. The soil moisture tension was measured by tensiometer and quick draw soil moisture meter. The tensiometer was permanently installed at the field to measure the soil moisture tension.

Table 1: Combination of treatment

Treatment	Tension (cb)	Planting type	Irrigation type
T_1	40	Basin	Sprinkler
T_2	60	Basin	Sprinkler
T_3	40	Raised bed	Sprinkler
T_4	60	Raised bed	Sprinkler
T_5 (control)	-	Basin	Basin

cb- Centibar

Treatment

Except irrigation depth and irrigation interval all other cultural activities such as pre treatment for seed bulb, planting, weed control, fertilizer application, and chemical application were maintained the same for all treatment plots. Tensiometers were installed in each replicates of sprinkler irrigation at a depth of 60% root zone depth [9] or at 18 cm depth in the centre of the plot. Irrigation was made when the tensiometers were 40 cb or 60 cb

according to the treatment. Irrigation was stopped when the reading of tensiometers were 10 cb (field capacity). The control was irrigated at three days irrigation intervals to represent farmers' practices. For other two treatments, irrigation interval was recorded.

Measurements of water consumption and yield parameters

The application efficiency was estimated using the depth of water stored in the root zone to the depth of water delivered to the field. The efficiency of crop water consumption was calculated by the ratio between bulb yield to estimated crop evapotranspiration. Estimated crop evapotranspiration was calculated by average evaporation of the pan into pan coefficient multiplied by crop coefficient of red onion [3]. The following yield parameters; yield per plot, average bulb bunch yield per plant, average number of single bulb per plant, average single bulb weight, bulb height, bulb diameter, neck thickness, dry matter production, water content and bulb moisture on weight basis were measured and the quality parameter of total soluble solid also tested by a refrectometer. The analysis was done using SAS computer software and mean separation was done by Dunnet test.

Weather data

Rainfall, temperature, pan evaporation and wind speed were collected from Metrological station, Jaffna during the study period.

3. Results and discussion

Variation of weather parameters.

The average maximum temperature was 31.8 °C with the deviation of ± 1.72 °C during July – October 2004. The highest temperature was recorded as 35 °C and the lowest temperature was 27.6 °C. The environment was relatively hot and the sprinkler irrigation might have cool the plant to enhance the crop growth.

Figure 1 shows the amount of rainfall and pan evaporation during the study period. Out of 64 days, 14 days experienced rainfall that amounted to 171.5 mm. Ten days received less than 10 mm rainfall and in these days the readings of tensiometers were found unchanged even after receipt of rainfall. Only the last two irrigation treatments were disturbed by unusual early start of *Maha* rainfall. The water distribution is favorable up to wind speed of 10 km/h with distribution uniformity of 84.5 % [10]. Only 75% of uniformity could be achieved with an average wind speed of approximately 16 km/h [11]. In this study, the average wind speed was recorded as 10.71 km/h with a deviation of ± 1.5 km/h. In most of the days, the wind speed was less than 10 km/h and this did not influence the distribution uniformity of the sprinkler used in this study. The average pan evapotranspiration was 4.92 mm.

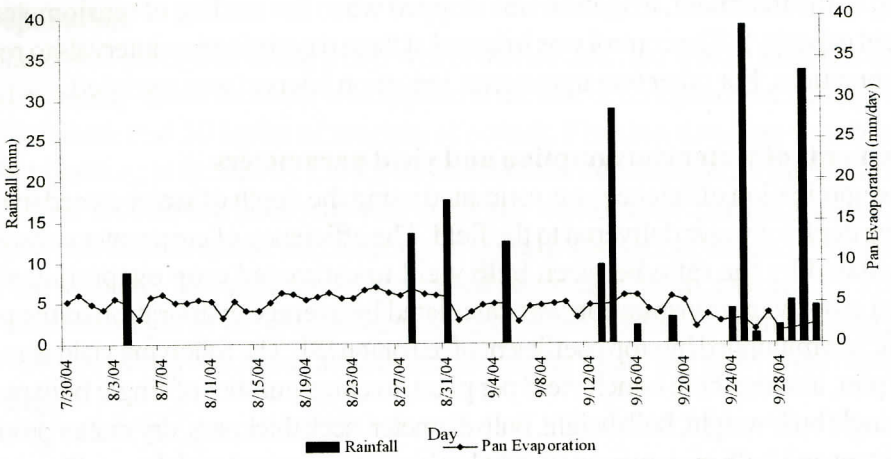

Figure 1: The Rain fall and pan evaporation variations

Physio Chemical properties of soil

Since no significant difference among the six random samples, the values were averaged for field capacity (18.20 % as gravimetric basis), bulk density (1.704 g/cm^3) and particle density (2.56 g/cm^3), permanent wilting point (11 %), porosity (33.43 %), Infiltration rate of the soil (430 mm/hour) and available water (122.68 mm of water/ m depth). Available N, P and K were not significant different in all treatment plots.

Irrigation scheduling.

Water discharge from the six nozzles was not significantly different. Hence the average discharge rate of the sprinkler nozzles was taken and it is 3.5 l/min. Soon after planting, the first three irrigations were done on one day irrigation interval for good crop establishment. After that the determined treatments were continued. There was 28 mm of torrential rainfall in the study area on 49th day, which disturbed the irrigation trail. Usually farmers stop their irrigation after 55th day of planting in order to dry the field for harvesting.

The measured average time period required to bring the tensiometers from 60 cb to 10 cb was one hour; means averagely one hour was required to supply the water requirement to the root zone and averagely 45 min was required for 40 cb. Total water applied in a single irrigation was 23.3 mm and 17.5 mm at 60 cb and 40 cb respectively. The application rate was less than the soil infiltration rate of 430 mm/hour. The sprinkler covered an area of

9 m^2. The average observed irrigation intervals were two days and one day for 60 cb and 40 cb respectively. Table 2 shows the irrigation management parameters for two different soil moisture tensions.

Table 2: Parameters of irrigation management

Parameter	Treatment	
	60 cb	40 cb
Time required to bring to 10 cb	One hour	45 min
Irrigation Interval	Two days	One day

The yield and yield components except soluble solids at bulbs were affected by irrigation and soil water depletion fractions at 0.30, 0.50, 0.70 and no irrigation in Turkey for *Alliuum cepa* L.and the highest yield was obtained from the plots in which irrigation was applied at soil water fraction level of 0.30 [12]. Tension at 20 cb and 30 cb were skipped since maintaining tensiometers at this level is not possible (very close irrigation intervals).

Farmers, in general, require 2 to 2½ hours to irrigate 0.101 ha (0.25 ac) field of onion by surface irrigation. The time required to such irrigation is significantly reduced from 2 to 2½ hours to one hour to 45 min with the usage of sprinkler.

Response of irrigation treatment on yield performance

Onion planted in raised bed with 40 cb showed the highest efficiency of 1.66 kg/m^2/ mm and at 60 cb planted on raised bed was 1.53 kg/m^2 /mm. The mean bulb yield ranged from 4.64 to 6.04 kg/m^2. Details of the mean bulb yield for each treatment are given in Table 3.

Table 3: Mean yield, mean bulb bunch weight, mean bulb weight, mean bulb diameter and mean bulb neck thickness in red onion

Treatment	Mean yield (kg/m^2)	Mean bulb bunch weight(g)	Mean bulb weight (g)	Mean bulb Diameter (cm)	Mean bulb Neck thickness (cm)
T_1 – Sprinkler 40cb, Basin	5.02[b]	43.925[c]	9.685[b]	2.697[b]	0.527[b]
T_2 – Sprinkler 60cb, Basin	5.21[b]	41.266[c]	7.902[d]	2.434[d]	0.482[c]
T_3 – Sprinkler 40cb, Raised bed	6.04[a]	52.052[a]	10.788[a]	2.973[a]	0.558[a]
T_4 – Sprinkler 60cb, Raised bed	5.59[b]	49.455[b]	9.579[c]	2.685[c]	0.496[c]
T_5 – control	4.64[b]	39.934[c]	7.010[d]	2.381[d]	0.490[c]
CV	10.01	6.878	7.248	3.763	2.244

Highest yield was recorded where irrigation water was applied at 40 cb tension, planted in raised bed (T3) and was followed by 60 cb tension, planted in raised bed (T4). The yield increase in sprinkler irrigation compare to the control is 30.2% and 20.5% in 40 cb with sprinklers and planted in raised bed and sprinkler irrigation at 60 cb with sprinklers and planted in raised bed respectively. Frequent irrigation (One day irrigation interval) can help bulbs to grow to the full capacity while two days irrigation interval probably increases the physiological stress, which eventually reduces the bulb growth. Also fine soil structure with good aeration of raised bed influences the formation of bulb while basin soils are compacted and slightly water logged which reduces the yield. Raised bed would have provided aeration during the heavy rainfall events and contributed to better yield.

The bulb diameter and bulb neck thickness in 40 cb tension planted in raised bed also varied significantly than other treatments (Table 3). The highest mean bulb diameter and neck thickness was recorded in 40 cb planted on raised bed with sprinkler irrigation. Other yield parameters; mean number of bulbs per plant, mean dry matter yield, mean water content, moisture retention on weight basis, mean bulb length and total solids were varied but not significantly varied among the treatments.

4. CONCLUSION

Scheduling of irrigation with 60 cb tension was achieved with 23.3 mm depth of irrigation water for one hour duration and two days irrigation interval where as in tension at 40 cb, irrigation was completed with 17.5 mm depth of irrigation water for with 45 min duration with one day irrigation interval. However considering the yield parameters, crop water consumption and irrigation duration, irrigation at 40 cb planted on raised bed was selected as best irrigation management for red calcic latasols with sprinkler irrigation. It is essential to seek ways of achieving the most efficient and equitable use of groundwater resources in Jaffna Peninsula with making their use sustainability

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