OnLine Journal of Biological Sciences 1 (8): 735-736, 2001

A Study on Irrigation Scheduling of Onion (*Allium cepa* L.) in Turkey

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Abstract: This study was conducted to analyze the response of onion (*Allium cepa* L.) to different irrigation scheduling and subjected to four irrigation treatments during the years of 1997 and 1998 according to available soil water depletion fractions of 0.30, 0.50, 0.70 and no irrigation. The yield and yield components except solids soluble in bulbs were affected by irrigation and soil water depletion fractions. The highest yield was obtained from the plots in which irrigation water was applied at soil water fraction level of 0.30. Maintenance of soil moisture depletion level at 0.30 required 339.4 mm and 227.2 mm of irrigation water in 1997 and 1998, respectively. The seasonal evapotranspiration of onion was 420.0 mm in 1997 and 351.2 mm in 1998.

Key words: Onion, evapotranspiration, irrigation scheduling, yield components

Introduction

The onion (*Allium cepa* L.) is one of the chief horticultural crops of Turkey. Present production in Turkey is about 2.1 million tons of bulb from 105 000 ha. "Yarim Imralli" is the most commonly used regional cultivars in Tekirdağ. The season lasts from the mid of April to the beginning of August. Onion is cultivated under both irrigation and no irrigation conditions. The irrigation systems used mostly to grow onion is portable sprinkler irrigation. Seasonal evapotranspiration for optimum yield from 350 mm to 450 mm, depends on the environmental conditions of each year. Bulb yields range from 10 t ha^{-1} to 40 t ha^{-1} under no irrigation and irrigation conditions, respectively. Many studies have been reported on the irrigation of onions (Koriem *et al*., 1994; Thabet *et al*., 1994; Olalla *et al*., 1994; Shock *et al*., 1998 and 2000). These studies give clear proof that the bulb and dry matter production are highly dependent on appropriate water supply. For optimum yield, it is necessary to prevent the crop from experiencing water deficit, especially during the bulbing stage. During the early vegetative growth period the crop appears to be less sensitive to water deficit; excessive irrigation during this period can lead to a delayed start of bulbing and a reduced bulb development (Doorenbos and Kassam, 1979).

The objective of this study was to evaluate the effects of irrigation and several depletion levels of available soil moisture as irrigation threshold on morphological parameters, solids soluble and yield of onions in the Province of Tekirdağ in Turkey.

Materials and Methods

Trials were conducted in 1997 and 1998 at the research field of Agricultural Faculty of Tekirdağ, University of Trakya, Turkey, at 40° 59′ N latitude, 27° 29′ W longitude and 4 m altitute. The annual average temperature is 13.7 °C and annual average total precipitation is 579.7 mm. Some climatic parameters during the study are shown in Table 1. The soils in the research field are generally deep, heavy textured and well drained. Some physical characteristics of soil are presented in Table 2. Basic intake rate was measured by double ring infiltrometer and found as 12 $mm.h^{-1}$.

Shallots of the onion (Yarim Imralli) were planted on 1 May 1997 and 15 April 1998, and the onions were undercut on 3 August 1997 and 28 July 1998. Plots, 12 m^2, were twenty rows wide with row spacing of 0.15 m and 4 m long. Population density was 45 plants m^{-2}.

The experiment was arranged in a Randomized Complete Block Design (RCBD). The treatments consisted of three allowable depletion levels of available soil moisture as irrigation thresholds which were $I_{0.30}$, $I_{0.50}$ and $I_{0.70}$ irrigation when 30, 50 and 70 % respectively of available soil moisture was consumed and a treatment with no irrigation.

Soil water level was monitored in each plot by neutron probe in 20-40 cm and 40-60 cm soil layers during the whole growing season. Soil moisture content of 20 cm was measured by gravimetric method (James, 1993) since it was not possible to monitor by neutron probe. The amount of soil moisture in 0.40 m depth was used to initiate irrigation; the values within 0.60 m depth were used to obtain the evapotranspiration of the crop.

The plots were irrigated by drip irrigation. Pressure compensating drippers were used to supply uniform water distribution. Dripper discharge rate was 4 L h^{-1} above 10 m operating pressure. Dripper and lateral spacings were chosen as 0.50 m according to soil characteristics to be able to wet all area. Soil water level was measured at 9.00 a. m. daily and if necessary, the plots were irrigated individually. Evapotranspiration for 10 days periods were calculated according to the method of water balance in 0.40 m soil depth (Heerman, 1985). Doses of fertilization were done according to the results of fertility analysis of soils. Irrigation was stopped about 15 days before harvest.

The onions were undercut with a rod weeder and left in the field for field curing for about 10 days. In the laboratory, the onions were topped and the roots were removed, bulb weight, height and diameter of all onions harvested were measured. Solids soluble in bulbs were measured by Refractometer Method (Helrich, 1990). Onion grade data were statistically analyzed by analysis of variance (MSTAT 3.0, Michigan State University, Michigan).

Results and Discussion

The total numbers of irrigation, the total amount of irrigation water, the rainfall and seasonal evapotranspiration for each treatment are given in Table 3. The numbers of irrigation, for every increase in irrigation threshold was an additional numbers of irrigation required. The total amounts of irrigation water in all treatments in second year were lower than those of first year because of greater rainfall in second year. There was no significant difference between seasonal evapotranspiration values of irrigated treatments, but evapotranspiration values at NI treatment were lower than those of other treatments in both years because of water deficit in root zone (Table 3).

Onion total yield, bulb weight, height, diameter, percentage

Table 1: Some meteorological dat for the experimental years

Years	Month	Average Temperature (°C)	Average relative humidity (%)	Average wind speed (m/s)	Average sunshine duration (h)	Total rainfall (mm)
1997	May	17.3	73.3	3.3	7.9	5.7
	June	21.4	79.7	2.6	9.0	33.9
	July	23.9	73.7	3.0	9.6	46.8
	August[1]	23.4	77.7	3.0	9.6	5.8
1998	April[2]	13.9	73.4	2.6	6.1	39.9
	May	16.6	78.0	2.8	5.2	62.4
	June	22.3	73.4	2.6	9.7	23.6
	July	24.2	71.6	3.2	10.4	58.2

[1] values are for the first 10 days of month [2] values are for the last 20 days of month

Table 2: Some physical characteristics of soils in the experimental site (C; Clay)

Depth (cm)	Texture	Bulk density (g/cm^3)	Field capacity (mm)	Wilting point (mm)	Available water holding capacity (mm)
0-20	C	1.56	90.5	58.2	32.3
20-40	C	1.57	86.5	57.8	28.7
40-60	C	1.57	82.0	61.1	20.9

Table 3: Total number of irrigations, the total amount of irrigation water, the rainfall and seasonal evapotranspiration

Years	Growing season	Treatments	Number of Irrigation	Irrigation water applied (mm)	Rainfall (mm)	Seasonal evapotranspiration (mm)
1997	1.5-3.8	$I_{0.30}$	14	339.4		435.5
		$I_{0.50}$	10	323.2	92.2	438.1
		$I_{0.70}$	7	306.8		394.2
		NI	-	-		177.0
1998	15.4-28.7	$I_{0.30}$	13	227.3		404.2
		$I_{0.50}$	7	220.6	184.1	428.6
		$I_{0.70}$	4	167.7		412.6
		NI	-	-		265.6

Table 4: Onion yield, bulb weight, height, diameter and percentage soluble solids of the bulb

Years	Treatments	Yields (t ha^{-1})	Bulb weight (g)	Bulb height (mm)	Bulb diameter (mm)	Soluble solids in bulb (%)
1997	I0.30	43.07a	99.8a	62.3a	56.3a	11.3NS
	I0.50	37.53ab	87.0ab	60.6a	52.8a	11.5NS
	I0.70	35.81b	83.0b	59.9a	52.5a	11.2NS
	NS	17.40c	40.3c	47.9b	38.7b	10.8NS
1998	I0.30	20.64a	47.9a	40.4NS	42.9NS	12.5NS
	I0.50	18.70ab	43.6ab	39.7NS	43.5NS	12.6NS
	I0.70	17.29b	40.1b	41.2NS	43.8NS	12.7NS
	NS	13.87c	32.2c	37.3NS	38.5NS	13.6NS

$P < 0.05$ NS; non significant

soluble solids and their classifications according to Duncan's New Multiple Range Test (DMR) were given in Table 4. Onion yield and grade were far lower in 1998 than in 1997 because of different previous crop and climatic conditions. Total yields in 1998 were about half those of 1997. Total onion yield and bulb weight at treatments varied significantly in both years. Bulb height and diameter were found significantly different in 1997, but there were no significant differences in 1998. Soluble solids (%) of the bulbs were not affected by treatments statistically in two years.

Onion yield increased with increasing irrigation threshold in each year. The highest yield was obtained with the highest threshold tested. NI treatment minimized the total onion yield in both years. Yield of NI treatment was lower 60% in 1997 and 33% in 1998 than those of $I_{0.30}$ treatment.

As a result, irrigation had a large effect on increasing of the total onion yield without decreasing solid soluble in bulbs. Irrigation also influenced morphological characteristics of bulbs. Onion yield and bulb sizes increased with increasing irrigation threshold. These results suggest that onion has to be irrigated and irrigation water should be applied when 30% of available soil moisture was consumed in order to achieve the required objectives in the region. Other researches carried out in different places have reported similar results (Doorenbos and Kassam, 1979; Shock *et al.*, 1998 and Hedge, 1986).

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