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Irrigation scheduling of onion in Tekirdað province of Turkey

A. Halim Orta and Mehmet Ener*

* *Department of Farm Structure and Irrigation, Faculty of Tekirdag Agriculture, University of Trakya, 59030 Tekirdað, Turkey, E-mail: horta@tu.tzf.edu.tr*

Abstract

The study was conducted to analyze the response of onion (*Allium cepa* L.) to different irrigation schedules in the research field of Tekirdað Agricultural Faculty, University of Trakya, Turkey, during 1997 and 1998. Onion crop was subjected to four irrigation treatments according to available soil water depletion fractions of 0.30, 0.50, 0.70 and no irrigation. Irrigation thresholds (amount of soil water at 0.40m depth) were used as criteria to initiate drip irrigations. For each differential water treatment, the parameters of bulb morphology (diameter and height), solids soluble in bulbs, bulb weight, and total yield were analyzed. As a result, it was found that 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 (in 14 applications) and 227.2 mm (in 13 applications) 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. In the Province of Tekirdað in Thrace, annual bulb production is about 92,000 tons from 5,000 ha (Anonymous, 1997). Yarim Imralli is the most commonly used regional cultivar in Tekirdað. The season lasts from the middle of April to the beginning of August. Onion is cultivated under both irrigation and no irrigation conditions in the region. Portable sprinkler irrigation is the irrigation system used mostly to grow onion in the region. 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 (Nassar and Waly, 1977, Hedge, 1986 and 1988; Chung, 1989, Ýmtiyaz and Singh, 1990, Patil, 1993, Abu-Awwad, 1994, Koriem *et al.*, 1994, Thabet *et al.*, 1994, Olalla *et al.*, 1994, Shock *et al.*, 1998 and 2000). In general, 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 allowable depletion levels of available soil moisture as irrigation threshold on morphological parameters, soluble solids and yield of onions in the Province of Tekirdað in Turkey.

Materials and methods

Trials were conducted in 1997 and 1998 at the research field of Agricultural Faculty of Tekirdað, University of Trakya, Turkey, at 40° 59′ N latitude, 27° 29′ W longitude and 4 m altitute. The annual average temperature was 13.7°C with annual total precipitation 579.7 mm. Some climatic parameters during the study are shown in Table 1.

Table 1. Some meteorological data for the experimental years

Year	Month	Average Temp erature (°C)	Average RH (%)	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	33.9
	July	23.9	73.7	3	9.6	46.8
	Aug.[1]	23.4	77.7	3	9.6	5.8
1998	Apr.[2]	13.9	73.4	2.6	6.1	39.9
	May	16.6	78	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

The soil in the research field was deep, heavy textured and well drained. Some physical characteristics of soil are presented in Table 2. Basic intake rate was measured 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 block design with three replications. The treatments consisted of three allowable depletion levels of available soil moisture as irrigation thresholds and a treatment with no irrigation, which were as follows:

$I_{0.30}$: Irrigation when 30% of available soil moisture was consumed

$I_{0.50}$: Irrigation when 50% of available soil moisture was consumed

$I_{0.70}$: Irrigation when 70% of available soil moisture was consumed

NI: No irrigation

Table 2. Physical characteristics of soils in the experimental site

Depth (cm)	Texture	Bulk density (g/cm^3)	Field capacity (mm)	Wilting point (mm)	Available water holding capacity (mm)
0-20	Coarse	1.56	90.5	58.2	32.3
20-40	Coarse	1.57	86.5	57.8	28.7
40-60	Coarse	1.57	82	61.1	20.9

Soil water level was monitored in each plot by neutron probe (CPN, 503 DR Hydroprobe) 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 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 0.60m 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 w*et al*l area. Soil water level was measured at 9.00 AM daily and, if necessary, the plots were irrigated individually. Evapotranspiration for ten-days periods was calculated according to the method of water balance in 0.40 m soil depth. Fertilization was 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 ten days. In the laboratory, the onions were topped and the roots were removed, bulb weight, height and diameter were measured. Soluble solids 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 number of irrigations and the amount of irrigation water applied for the highest irrigation threshold were maximum in both years. According to the data for the numbers of irrigation (Table 3), for every increase in irrigation threshold there was an additional numbers of irrigation required. The total amounts of irrigation water in all treatments in second year were lower than those of in 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).

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

Year	Growing season	Treatment	Number of applied irrigation	Irrigation water	Rainfall (mm)	Seasonal evapo transpi- ration-
1997	1.5-3.8	$I_{0.30}$	14	339.4	92.2	435.5
		$I_{0.50}$	10	323.2		438.1
		$I_{0.70}$	7	306.8		394.2
		NI	-	-		177
1998	15.4-28.7	$I_{0.30}$	13	227.3	184.1	404.2
		$I_{0.50}$	7	220.6		428.6
		$I_{0.70}$	4	167.7		412.6
		NI	-	-		265.6

Mean comparison of total yield, bulb weight, height, diameter, percentage soluble solids and their classifications according to Duncan's Multiple Range Test are 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 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. Percentage soluble solids of the bulbs was 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 had minimum 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, it can be said that in the province of Tekirdað in Turkey, irrigation had a large effect on increasing of the total onion yield without decreasing soluble solid in bulbs. Irrigation also influenced morphological characteristics of bulbs. Onion yield and bulb size increased with increasing irrigation threshold. These results suggest that in order to achieve the required objectives in the region, onion should be irrigated when 30% of available soil moisture is consumed. Other researches carried at in different places have shown similar results (Doorenbos and Kassam, 1979, Shock *et al.,* 1998, Hedge, 1986).

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

Year	Treatment	Yield	Bulb weight (t/ha)	Bulb height (g)	Bulb diameter (mm)	Soluble Solids in bulb (%)
1997	$I_{0.30}$	43.07a	99.8a	62.3a	56.3a	11.3
	$I_{0.50}$	37.53ab	87.0ab	60.6a	52.8a	11.5
	$I_{0.70}$	35.81b	83.0b	59.9a	52.5a	11.2
	NI	17.40c	40.3c	47.9b	38.7b	10.8
1998	$I_{0.30}$	20.64a	47.9a	40.4	42.9	12.5
	$I_{0.50}$	18.70ab	43.6ab	39.7	43.5	12.6
	$I_{0.70}$	17.29b	40.1b	41.2	43.8	12.7
	NI	13.87c	32.2c	37.3	38.5	13.6

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