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Effect of Pulse Subsurface Drip Irrıgaton on Yield and Quality Parameters of Sillage Maize (Zea Mays L.)

Yüzeyaltı Damla Sulamada Fasılalı Sulama Uygulamalarının Silajlık Mısırda Verim ve Kalite Parametrelerine Etkisi

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YÜZEYALTI DAMLA SULAMADA FASILALI SULAMA UYGULAMALARININ SİLAJLIK MISIRDA VERİM VE KALİTE PARAMETRELERİNE ETKİSİ

ÖZ:

Ankara koşullarında yürütülen çalışmada, yüzeyaltı damla sulamada fasılalı (kesintili) sulama uygulamalarının silajlık mısırda verim ve kalite parametrelerine etkisi incelenmiştir. Toprakta yarayışlı suyun %30'u tüketildiğinde mevcut nemi tarla kapasitesine getirmek için gerekli sulama suyu F0: tek seferde, F1: bir kesintiyle F2: iki kesintiyle, F3: üç kesintiyle uygulanmıştır. Toprakta nem dağılımını izlemek için toprağın 0.35 m derinliğine gömülü lateral hattındaki damlatıcı noktasından 5-20-35 cm yatay uzaklıkta ve toprağın 0-30, 30-60, 60-90 cm derinliklerinden nötron metre cihazı ile her sulamadan bir gün sonra nem ölçümleri yapılmıştır. İki yıllık ortalamalara göre, su kullanım etkinliği (WUE) ve sulama suyu kullanım etkinliği (IWUE) açısından uygulamalar arasında farklar istatistiksel olarak önemli bulunmuştur ($p<0.05$). Buna göre iki sulama arası kesinti süresi arttıkça WUE ve IWUE de artmıştır. Sulama uygulamalarının silaj (yeşil ot) verimi üzerinde önemli bir etkisi bulunmazken, bazı kalite parametrelerinde (bitki boyu, koçan ağırlığı, gövde ağırlığı, ham kül) istatistiksel farklılıklar bulunmuştur. En yüksek ve en düşük taze silaj verimi, bitki boyu, bitki başına koçan sayısı, gövde ağırlığı, yaprak ağırlığı, kuru madde oranı, ham kül oranı ve ham protein oranı sırasıyla 8768.9-8064.9 kg da-1, 2.44-2.34 m., 1.28-1.13, 0.438-0.374 kg., 0.234-0.212 kg, 41.5%-39.0%, 7.2%-5.2% ve %7.0-6,7 olarak elde edilmiştir. Araştırmada en iyi su dağılımının iki sulama arası süresinin en fazla olduğu F1 uygulamasında sağlandığı belirlenmiş ve bu konu önerilmiştir.

Anahtar Kelimeler: Aralıklı Sulama, Su Kullanım Etkinliği, Basınçlı Sulama, Mısır.

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EFFECT OF PULSE SUBSURFACE DRIP IRRIGATON ON YIELD AND QUALITY PARAMETERS OF SILLAGE MAIZE (ZEA MAYS L.)

ABSTRACT

In the study carried out in Ankara conditions, the effect of pulse (intermittent) irrigation applications in subsurface drip irrigation on yield and quality parameters of silage maize was investigated. When 30% of the available water in the soil was consumed, the irrigation water required to bring the available moisture to the field capacity was applied with F0: one irrigation, F1: one cut F2: two cuts, F3: three cuts. Irrigation time was kept equal to the interruption period in intermittent irrigation. According to the two-year average findings, the differences between the applications in terms of water use efficiency (WUE) and irrigation water use efficiency (IWUE) were found to be statistically significant ($p<0.05$). Accordingly, WUE and IWUE increased as the cut off time between two irrigations increased. While irrigation practices did not have a significant effect on fresh silage yield, statistical differences were found in some quality parameters (plant height, cob weight, stem weight, crude ash). Highest and lowest fresh silage yield, plant height, number of cob per plant, stem weight, leaf weight, dry mater ratio, crude ash ratio and crude protein ratio were obtained as 8768.9-8064.9 kg da-1, 2.44-2.34 m., 1.28-1.13, 0.438-0.374 kg., 0.234-0.212 kg, 41.5%-39.0%, 7.2%-5.2% and 7.0%-6.7%, respectively. In the study, it was determined that the best water distribution was achieved in the F1 treatment, where the interval between irrigations was the longest, and this treatment was suggested.

Keywords: Intermittent Irrigation, Water Use Efficiency, Pressurized Irrigation Corn.

INTRODUCTION

Irrigation water is one of the most important needs for sustainable, high and quality production in agriculture. The decrease in irrigation water potential as a result of agricultural drought and the increase in water demand due to the increasing population necessitates the efficient use of water resources. Approximately 77% of the water resources used in agriculture in Türkiye. However, with the population growth and the increase in irrigated areas in agriculture, water demand is increasing among sectors. This situation makes water saving important in agriculture (Çakmak and Gökalp, 2011)

Various irrigation methods have been tried from past to present for optimum water use in agriculture. The main purpose of irrigation is to provide the highest efficiency with optimum irrigation without creating water stress in the plant root area. For this reason, ways to reduce water losses such as deep infiltration, runoff, evaporation are sought in irrigation studies. Subsurface drip irrigation is one of the methods developed for the most efficient use of water. Determining the water behaves in vertical and horizontal direction in the soil profile are issues that need to be known in order to meet the optimum plant water requirements.

Subsurface drip irrigation provides a better efficiency in irrigation compared to surface drip irrigation as it reduces evaporation from the soil surface. In addition, since the laterals are located in the plant root zone, the plants benefit better from water and fertilizers. On the other hand, some studies have reported that subsurface drip irrigation has a lower wetting area than surface drip irrigation (Camp et al., 2000; Lamm, 2002). This situation may lead to limited development especially on the root system of frequently planted plants and decrease in yield and quality. In order to eliminate this problem, it was thought that the water should be cut and given intermittently (Mohammed and Abed, 2020; Vyrlas and Sakellariou-Makrantonaki, 2005; Bakeer et al., 2009). In the pulse irrigation method, the irrigation water is not given at once, but by dividing into certain amounts and time intervals. Vyrlas and Sakellariou-Makrantonaki (2005), reported that intermittent drip irrigation increases sugar beet yield and sugar content and Bakeer et al. (2009), reported that intermittent drip irrigation increases yield and water use efficiency of potato.

Corn, which is used as fresh for human and animal nutrition, has had a very wide usage area with the developing industry. It is used primarily in canned food, snacks, oil, fuel, flour and derivatives (Özata et al., 2016). 75% of producted corn in Türkiye used for forage industry, 20% for food industry and 5% for oil production and for seed (Anonymous, 2020a).

In the study, the possibility of providing a better water use efficiency in the soil by continuous and intermittent irrigation was investigated. Accordingly, the effect on yield and quality parameters of silage maize was investigated by providing a better water distribution in the soil without the plant experiencing water stress.

2. MATERIAL AND METHODS

2.1. Site Description

This study was carried out between 2019-2020 years in General Directorate of Agricultural Research and Policies, Soil Fertilizer and Water Resources Research Center Institute Sarayköy Research and Application Station in the Kahramankazan district of Ankara Province of Türkiye (Figure 1). The experimental area is located between +40°04'30.7" N latitude and +32°36'24.0" E longitude.

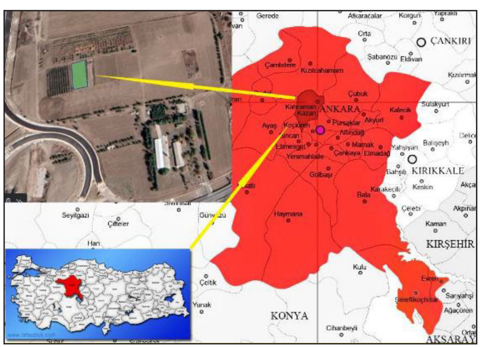

Figure 1. Trial location

In the province of Ankara, precipitation usually occurs during the winter months, falling as snow and slush. The most rainfall occurs in May and December. The period when it is covered with snow varies between 20-30 days. The average annual precipitation amount is 387 mm, the months of July and August are the hottest and driest months. The highest temperature measured in the region is 41 °C, the lowest temperature is -24.9 °C and the annual average temperature is 11.9 °C.

Soil samples were taken at depths of 0-0.3 m, 0.3-0.6 m and 0.6-0.9 m before the experiment to determine the properties of the soil.

2.2. Experimental Design and Cultural Practices

The field experiment was conducted using a random blocks design with four irrigation treatments and three replications. The plot size was determined as 3.5 m x 6 m (WxL). Silage corn variety ADA 9516 developed by Sakarya Corn Research Institute was used in the study. In order to prevent side effects that may occur through infiltration after irrigation, 2.0 m of non-irrigated area was left between the parcels and 3.0 m between the blocks.

The experimental area was prepared for planting in spring by plowing with a plow and a rake, after deep plowing in autumn. Silage maize seeds were sown with the seed drill at 0.70 m between row and 0.15 m above row. In the first year of the trial, the silage corn was planted on May 2, 2019 and the harvest was on September 11, 2019. In the second year of the experiment, the sowing was done on April 30, 2020, while the harvest was done on September 7, 2020.

Fertilization was done according to soil analysis in both years of the research. In the first year of the experiment, 25 kg da^{-1} Diammonium Phosphate (DAP) fertilizer was applied with the planting. On 1 July 2019, 25 kg da^{-1} Ammonium Sulphate (AS) fertilizer was applied by fertigation method. In the second year of the study, 25 kg da-1 DAP fertilizer was applied with planting, while 10 kg da-1 AS fertilizer was applied with the irrigation system on 20 July 2020.

In both years of the study, hoeing was done when the corn plants had 2-3 leaves. In the second year of the study, weed spraying was carried out in May.

2.3. Irrigation

Subsurface drip irrigation system was used in the experiment. Irrigation water was provided from the well in the research area. Irrigation system consisted of pump, hydrocyclone, injection pump, screen filter, manometers, pressure regulator, main valve, control valves of each parcel, water meters, manifold pipelines, lateral pipelines with in-line drippers.

In the irrigation system, lateral pipes with 20 mm diameter and a dripper spacing of 0.33 m were used. The laterals were placed at a depth of 0.35 m from the soil surface (Bilgen and Kodal 2019) and placed one lateral per plant row (Lamm, 1997; Lamm, 2003).

Irrigation subjects in the research were formed as follows.

F0- giving the irrigation water at one time (without interruption),

F1- giving the irrigation water in two stages (one cut),

F2- giving the irrigation water in three stages (two cuts),

F3- giving the irrigation water in four stages (three cuts)

In the study carried out, when 30 ± 5% of the extent water capacity at 0-0.6 m soil depth was consumed (Ry), the available soil water was completed to the field capacity (Bilgen and Kodal 2019). Irrigation was started when the plants had 5-6 leaves and ended when the corn kernels were observed to mature (Demir et al., 2018).

In determining the soil moisture content, 0-30 cm of the soil was measured by gravimetric method and 30-60, 60-90 cm was measured by neutron meters. Before starting irrigation, the calibration equation was obtained by plotting the neutron meter values read from the same depths with the values obtained by gravimetric method. Calibration equations obtained for each depth are used in converting neutronmeter readings into true moisture values. The principles stated in (Tüzün, 2006) were taken into consideration for the neutronmeter calibration performed in the experimental area.

Equation 1 has been used in calculating the amount of irrigation water (volumetric) applied to the parcels.

$$\theta_h = a + b(SO) \qquad (1)$$

$$SO = \frac{S}{SS} \qquad (2)$$

Where, θh, soil volumetric water content (%); a, calibration curve constant; b, slope of the calibration line; SO, count rate; S, neutron meter count-reading value; SS is the standard count value.

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Conversion of the obtained volumetric water content to mm for each soil depth (0-3,0.3-0.6,0.6-0.9) m;

$$\mathbf{AM} = \theta_h . \gamma t . \frac{D}{10} \qquad (3)$$

In equality; AM: available moisture (mm); ɣt: volume weight of soil (g cm-3); D: depth of soil to be wetted (mm).

The amount of irrigation water to be applied:

$$\mathbf{I} = \frac{FC-AM}{100} . \gamma t . D \qquad (4)$$

Where, I: net amount of irrigation water (mm); FC: field capacity (%); AM: available moisture (%); ɣt: soil bulk density (g cm-3); D: depth of soil to be wetted (mm).

Equations suggested by Howell et al. (1990) were used in determining water use efficiency (WUE) and irrigation water use efficiency (IWUE).

$$\mathbf{WUE} = \frac{Y}{ETc} \qquad (5)$$

$$\mathbf{IWUE} \ \frac{Y}{I} \qquad (6)$$

Where, Y: yield (kg da-1); ETc: crop water consumption (mm)

The daily actual evapotranspiration amounts for the silage maize plant during the growing season were calculated with the following equation according to the water budget method. (Jensen vd., 1990).

$$ETc = I + P + C_r - D_w - R_f \pm \Delta S \qquad (7)$$

where;

ETc: Crop water consumption (mm),

I: The amount of water given by irrigation (mm), P: amount of precipitation (mm),

$C_{r:}$ Capillary amount (mm),

Dw: Amount of penetration , (mm)

R_f: Runoff amount (mm),

ΔS: Moisture change amount in the soil (mm).

Since there is no ground water problem in the experimental area, capillary rise (Cr) was not taken into account.

2.4. Plant observations and measurements

In the study, in order to determine the effects of intermittent irrigation applications on the silage maize, the parameters of fresh silage yield, dry matter ratio, plant height, number of cob, first cob height, cob weight, stem weight, leaf weight, crude ash ratio and crude protein ratio were measured. Plant observations in the research were made according to the Technical Instruction for Measuring Corn Agricultural Values (MAV) Trials of the Seed Registration and Certification Center (Anonymous, 2020b). Crude ash and Crude protein analyzes were carried out according to the standards specified in the AOAC (1995). Accordingly, in order to eliminate the edge effect in the plots, a row of plants on all sides has been omitted. Measurements were made by randomly sampling 20 plants from the remaining plants..

2.5. Statistical analysis

Data obtained from the study were analyzed for variance using SPSS v25 computer package program. The significance levels were determined by performing the Duncan test for the treatments in which the differences were found to be statistically significant ($P < 0.05$) (Biswas et al., 2015).

3. RESULTS AND DISCUSSION

3.1. Climate and Soil Data

The climate data were obtained from the climate station located in the experimental area. Climate data for the year and months in which the research was conducted are given in Table 1. The long-term climate data of the experimental area were obtained from the General Directorate of Meteorology (Anonymous, 2020c). In the first year of the experiment, the rains were observed in May-June-July, while in the second year of the study, only in May and June.

Table 1. Meteorological data for the field of the trial

Year	*Months*	*Temperature Values (°C)*			*Total Precipitation*	*Average Relative Humidity*
		Avr.	*Max.*	*Min.*	*(mm)*	*(%)*
2019	*May*	*16.1*	*24.4*	*8.2*	*23.2*	*68.5*
	June	*20.6*	*29.8*	*13.2*	*52.6*	*68.3*
	July	*21.8*	*30.2*	*13.0*	*18.8*	*52.7*
	August	*23.2*	*31.8*	*14.9*	*2.0*	*46.8*
	September (11 days)	*21.7*	*30.1*	*13.4*	*0.4*	*45.7*
	Seasonal	***20.7***	***29.3***	***12.5***	***97.0***	***56.4***
2020	*May*	*15.1*	*23.9*	*6.5*	*34.6*	*60.6*
	June	*19.4*	*27.7*	*11.3*	*24.4*	*61.1*
	July	*24.7*	*33.7*	*15.1*	*0.8*	*46.3*
	August	*23.7*	*33.1*	*14.0*	*0.0*	*40.0*
	September (7 days)	*24.0*	*39.3*	*12.2*	*0.0*	*39.1*
	Seasonal	***21.4***	***31.5***	***11.8***	***59.8***	***49.4***
Long years average (1927-2020)	*May*	*16.0*	*22.4*	*9.7*	*52.0*	*50.0*
	June	*20.0*	*26.7*	*12.9*	*35.3*	*46.0*
	July	*23.4*	*30.3*	*15.8*	*14.2*	*38.0*
	August	*23.4*	*30.4*	*16.0*	*12.5*	*38.0*
	September	*18.9*	*26.1*	*11.8*	*18.1*	*41.0*
	Seasonal	***20.3***	***27.2***	***13.2***	***132.1***	***42.6***

(Anonymous, 2020c)

According to long-term average climate data, there was 26% less rainfall in the first year of the study and about 55% less rainfall in the second year. While 97.0 mm of precipitation occurred in the first year of the trial, 58.4 mm of precipitation occurred in 2020. There was no rainfall above the effective rain in either year of the study. On the other hand, the temperature and relative humidity values were above the long-term averages.

Soil analysis were carried out to determine the available water capacity in the soil and to arrange the appropriate drip irrigation system. According to the analysis results, some properties of the soil in the trial area are given in Table 2.

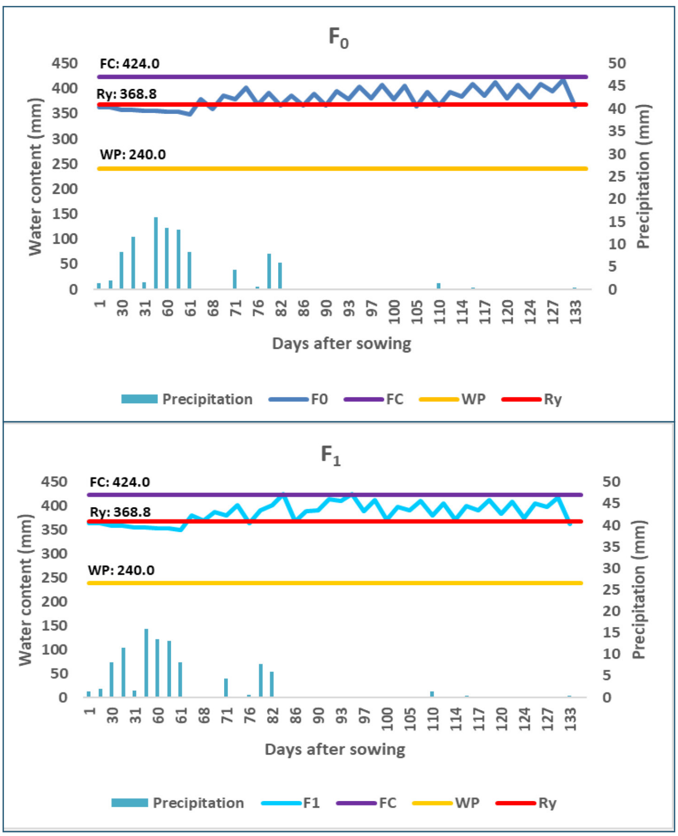
Table 2. Some physical properties of the trial field soil

Depth (m)	Sand (%)	Loam (%)	Clay (%)	Texture	Soil Bulk Densty (g cm^{-3})	Field Capacity		Wilting Point		Available Water Content
						%	mm	%	mm	mm
0.0-0.3	16.90	31.20	51.90	C	1.18	40.0	142	22.3	79	63
0.3-0.6	12.80	32.00	55.20	C	1.15	40.3	138	23.7	81	57
0.6-0.9	11.70	34.30	54.00	C	1.19	42.2	150	24.0	87	63

The soil texture is clay (C). As seen in Table 2, the bulk density of the soil at a depth of 0-0.6 m varies between 1.15-1.19 g cm$^{-3,}$ the moisture content of the soil at field capacity varies between 40.0-42.2% and the wilting point between 22.3-24.0%. The available water capacity of the soil is 120 mm / 0.6 m.

3.2. Irrigation, Yield and Water Use Efficiencies

The graph of water change in the soil for both years of the study according to irrigation treatments is given in Figure 2 and Figure 3



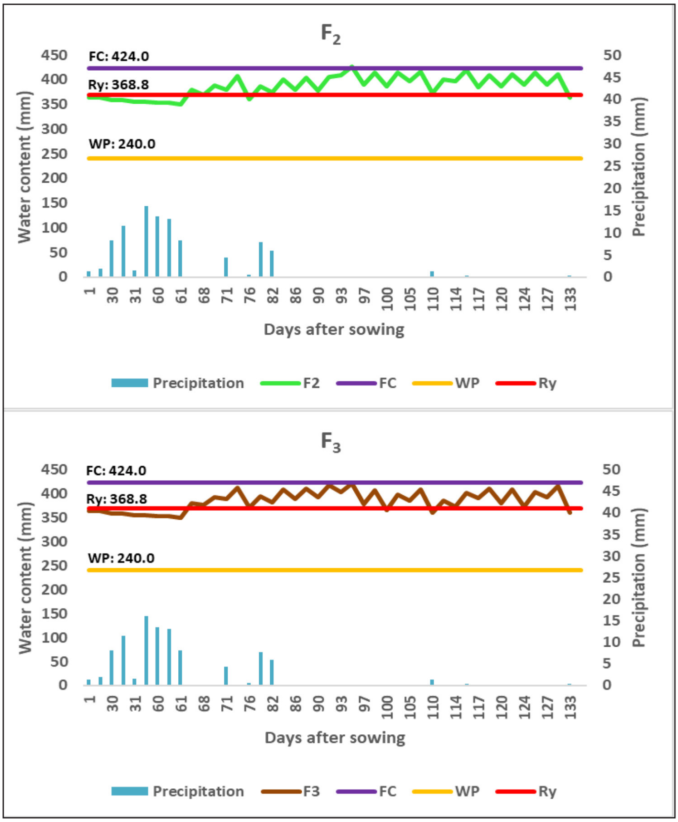
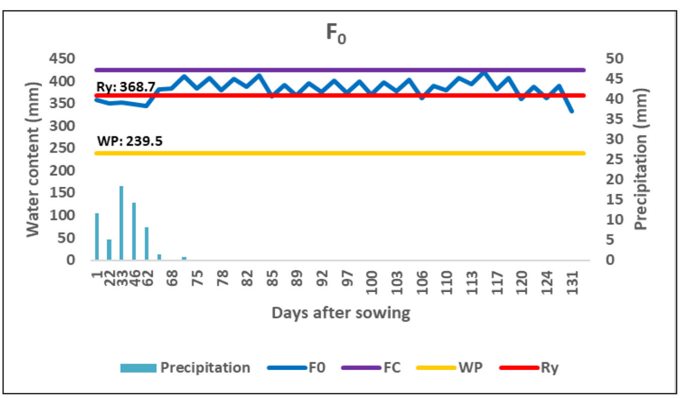


Figure 2. Water change in the soil according to irrigation issues in 2019 Where; FC is field capacity, WP is wilting point; Ry is amount of water allowed to be consumed



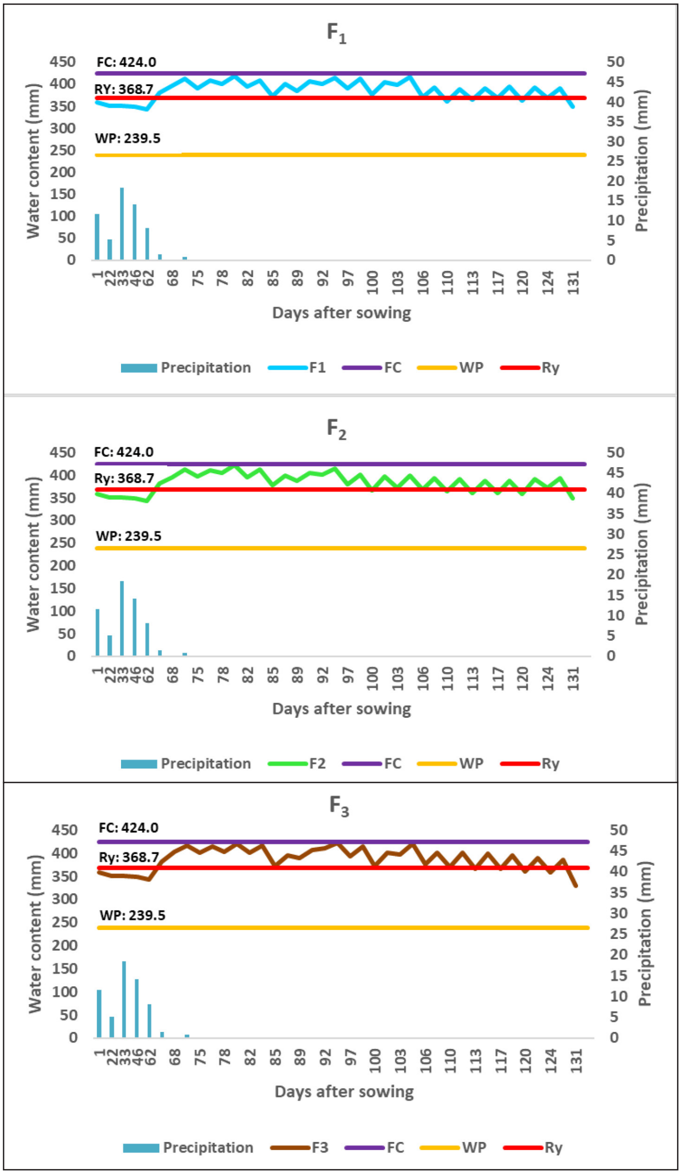


Figure 3. Water change in the soil according to irrigation issues in 2020 Where; FC is field capacity, WP is wilting point; Ry is amount of water allowed to be consumed

In the study carried out, when 30±5% of available soil water content in 0-60 cm soil depth is consumed, irrigation water was applied until it was brought to field capacity (Bilgen and Kodal 2019). Irrigation was started when the plants had 5-6 leaves and when it was seen that the grains passed from the milk stage to the cheese stage, the irrigation was terminated (Demir et al., 2018). In both years of the study, 16 irrigations were carried out. In the first year of the study, 436.4 mm irrigation water was applied for F_0 where irrigation water was applied at once, 399.5 mm for F_1, where water was applied in one interval, 415.7 mm for F_2 where water was applied in two intervals, and 425.5 mm for F_3 where water was applied in three intervals. Plant water consumption (ET) amounts were also obtained as 546 mm, 540 mm, 536 mm and 541 mm for F_0, F_1, F_2 and F_3 treatments, respectively. In the second year of the study, 456.5, 390, 396.0 and 403.7 mm irrigation water was applied on F0, F1, F2 and F3, respectively. Plant water consumption amounts were obtained as 546 mm, 459 mm, 462 mm and 481 mm for F_0, F_1, F_2 and F_3 treatments, respectively. When the soil moisture graphs in Figure 2 and Figure 3 are examined, it is seen that the available water content in the soil does not fall below the Ry level during the irrigation period. Accordingly, water stress on the plant was not allowed in all irrigation treatments.

Irrigation water amount in corn, which is a plant with high water demand, may vary from region to region depending on irrigation method and climate conditions. In similar studies, it is seen that regional differences affect the amount of irrigation water applied. Karaşahin (2014) compared different irrigation methods and plant density in the corn plant in his study. Accordingly, irrigation water was applied between 402-498 mm in the first year and 480-590 mm in the second year in subsurface drip irrigation. In the study conducted in Eskişehir conditions, the irrigation amount was found between 333-618 mm (Uygan, 2017). In a study conducted in China, the amount of irrigation water was reported to be between 224 and 346 mm (Zhou et al., 2018). Couto et al. (2013) reported that they applied irrigation water between 497-570 mm in their study. When the research findings were compared, the results were similar to Karaşahin (2014) and Uygan (2017), but differed from other studies. It can be said that climatic conditions, differences in irrigation method and plant variety affect the amount of irrigation water applied.

Table 3. WUE and IWUE values

Irrigation Treatments	2019		2020		2019-2020	
	WUE ^{NA}	IWUE^{NA}	WUE**	IWUE**	WUE*	IWUE**
F_0	14.9	18.7	14.6 c	17.3 c	14.8 c	18.5 c
F_1	16.8	21.5	19.5 a	22.9 a	18.2 a	21.9 a
F_2	16.1	20.8	19.0 a	22.2 a	17.5 ab	20.9 ab
F_3	15.6	19.8	17.3 b	20.6 b	16.4 b	19.6 bc

When Table 3 is examined, the differences in the level of treatments in the two-year average WUE and IWUE values were found to be statistically significant. Accordingly, F_1 and F_2 treatments came to the fore in the two-year average WUE and IWUE values. While the highest average WUE value was obtained in F_1 with 18.2 kg m^{-3}, the lowest WUE value was obtained in F0 with 14. kg m^{-3}. In irrigation water use efficiency, the highest IWUE was obtained with 21.9 kg m^{-3} in F1 and the lowest IWUE with 18.5 kg m^{-3} in F0.

In similar studies, WUE values were determined by Gezer (2012), Dağdelen et al. (2010) and Kiziloglu et al. (2009) as 14.52 kg m^{-3}, 11.97-10.22 kg m^{-3} and 14.76-15.04 kg m^{-3} respectively. Gezer (2012), Şimşek et al., (2011), Dağdelen et al., (2010), Arıtürk (2008) reported the IWUE value as 17.93-23.0 kg m^{-3}, 6.49-8.44 kg m^{-3}, 10.57-12.24 kg m^{-3} and 19.56-21.92 kg m^{-3}, respectively. The WUE and IWUE values obtained in the study were similar to Dağdelen et al. (2010), Arıtürk, (2008) and Kiziloglu et al. (2009) while the values were higher than other studies. The plant variety used in the research, the differences in the irrigation method and the climate difference can be the reason for the differences in the findings.

3.3. Plant Measurements

The yield and variance values of some plant parameters obtained in the study are given in Table 4.

Table 4. Some measurement values of corn plant

Year	Treatments	Fresh Silage Yield (kg da^{-1})	Dry Matter Ratio (%)	Plant Height (m)	Number of Cob (per plant)	First Cob Height (m)	Cob Weight (kg)	Stem Weight (kg)	Leaf Weight (kg)	Crude Ash Ratio (%)	Crude Protein Ratio (%)
2019	F_0	8151.5	40.5	2.34 b	1.10	1.13	0.256 b	0.387 b	0.213	5.1 b	6.7
	F_1	8589.7	40.8	2.42 ab	1.37	1.17	0.266 ab	0.446 a	0.224	7.2 a	7.0
	F_2	8631.0	36.9	2.72 a	1.27	1.05	0.273 a	0.457 a	0.218	7.6 a	6.6
	F_3	8415.0	41.1	2.39 ab	1.33	1.12	0.260 b	0.431 ab	0.237	7.2 a	6.5
2020	F_0	7978.3 b	41.9	2.34 b	1.17	1.07	0.267 ab	0.360 b	0.211	5.4 c	6.7
	F_1	8948.2 a	41.5	2.45 a	1.20	1.06	0.274 a	0.429 a	0.236	7.3 a	6.5
	F_2	8776.4 a	41.1	2.39 ab	1.13	1.05	0.269 a	0.418 a	0.235	6.5 ab	7.1
	F_3	8314.9 ab	41.9	2.31 b	1.13	0.95	0.259 b	0.384 ab	0.230	5.7 bc	7.5
2019-2020 Average	F_0	8064.9	41.2	2.34 b	1.13	1.10	0.261 b	0.374 c	0.212	5.2 c	6.7
	F_1	8768.9	41.2	2.43 a	1.28	1.11	0.270 a	0.437 a	0.231	7.2 a	6.8
	F_2	8703.7	39.0	2.44 a	1.20	1.05	0.271 a	0.438 a	0.227	7.0 ab	6.8
	F_3	8365.0	41.5	2.35 b	1.23	1.03	0.259 b	0.407 b	0.234	6.4 b	7.0

In the variance analysis of the two-year average fresh silage yield values, the yield differences compared to the subjects were found to be statistically insignificant. The highest two-year average yield value was obtained in F_1 with 8768.9 kg da^{-1}. Silage corn is a plant with high yield loss when water is restricted (Çamoğlu vd., 2011; Moussa vd., 2008; Song vd., 2019). In similar studies conducted, Akdeniz et al. (2004), Yıldız et al. (2017), Karaşahin (2014) and Demir et al. (2020) reported the highest yield values as 7608.5 kg/da, 13477 kg da-1, 900 kg da^{-1}, 10420 kg da^{-1}, respectively. The findings obtained in the study were generally similar to the other results except Yıldız et al. (2017).

The plant dry matter ratio may vary depending on the plant variety, stress conditions and growing conditions. When the analysis of variance on dry matter ratios were examined, no statistically significant difference was found between irrigation subjects. The highest and lowest dry matter yield values of 41.5% and 39.0% were obtained from F_3 and F_2 subjects, respectively. While the findings of the study were similar to Mok et al. (2014), Marsalis et al. (2010) and Eralp (2007), were found to higher than Akdeniz et al (2004), Güney et al. (2010) Çarpıcı et al. (2017).

Average plant height values were found significant at 1% error level among subjects. Accordingly, the highest and lowest plant height values were obtained from F2 and F0 subjects with 2.44 and 2.34 m, respectively. While the plant height values obtained in the study show similarities with Bouazzama et al. (2012), Kiziloglu et al. (2009), Güney et al. (2010), Demir et al. (2020), Akdeniz et al. (2004) and Şimşek et al. (2011), found higher than Mok et al. (2014).

In the analysis of variance regarding the number of cobs, no statistically significant difference was found between irrigation subjects. In terms of quality, the number of cobs in maize is usually desired to be one per plant. In the study, the values of the number of cobs per plant were similar to the values reported by Bulut et al. (2008), Öztürk et al. (2008), Yozgatlı et al. (2019) and Yılmaz et al. (2020), but lower than Bulut (2016) and Olgun (2011).

First cob height in silage maize may vary depending on the type of corn used, stress conditions during vegetation period and climatic characteristics. In the analysis of variance related to the first cob height, the difference between irrigation subjects was not found to be statistically significant. While the first cob height values obtained in the study were within the range of values found by Afzal et al. (2009), Yozgatlı et al. (2019 and Güneş (2017), found lower than Demir et al. (2020), Yılmaz et al. (2020), Yıldız et al. (2017).

Differences between subjects were found to be significant at 1% error level in the variance analysis related to the cob weight. According to the two-year average values, the highest and lowest cob weight values were obtained from subjects F_2 and F_3 as 0.271 and 0.260 kg, respectively. Obtained cob weight values in the study were higher than the findings of Mok et al. (2014) and Sampathkumar et al. (2013), while lower than Yılmaz et al. (2020), Olgun (2011) and Ergül (2008).

According to the two-year averages, the highest stem weight was obtained with 0.437 and 0.438 kg from F_1 and F_2 subjects, respectively. The stem weight values obtained were found higher than the values reported by Moralar (2011) but lower than Yılmaz et al. (2020), Yıldız et al. (2017) and Han (2016).

In the first year of the study, the highest and lowest leaf weight was obtained with 0.237 and 0213 kg, respectively, in F_3 and F_0 subjects, while in the second year of the study, the highest and lowest leaf weight values were obtained from F_1 and F_0 subjects with 0.237 and 0.211 kg, respectively. In the analysis of variance regarding leaf weight, the difference between irrigation subjects was not found to be statistically significant. The leaf weight values obtained were higher than the findings of Sade et al. (2002), Sarıyerli (2017) and Moralar (2011), lower than Han (2016), Yıldız et al. (2017) and Güneş (2004) and leaf weight values were similar to Ergül (2008), Yılmaz et al. (2020), Güneş, (2004).

According to the two-year averages, the highest crude ash ratio was obtained in F1 with 7.2% and the lowest crude ash ratio was obtained in F_0 with 5.2%. Two-year average crude ash ratios were found significant at 1% error level among subjects. While the crude ash ratio values obtained in the study were higher than Demir et al. (2020) and Hasan et al. (2018), the crude ash ratio was found similar to Erdal et al. (2009), Çarpıcı (2009) and Korkmaz (2019).

The highest average crude protein ratio was obtained in F_1 with 7.0% in the first year of the study, while the highest crude protein was obtained in F3 with 7.0% in the second year. There was no statistical difference between subjects and years in variance analysis. While the crude protein values obtained in the study were lower than the findings of Yozgatlı et al. (2019, Erdal et al. (2009) and Sade et al. (2002), similar values were obtained with the findings of Griffiths et al. (2004), Mok et al (2014), Demir et al (2020).

4. CONCLUSION

In the study carried out, irrigation issues were brought to the field capacity when the available moisture in the soil is consumed by 30 ± 5%. Controlled intermittent and non-intermittent irrigation practices, in which soil moisture was monitored, did not create water stress in the silage corn plant. Therefore, intermittent and continuous irrigation practices did not make a statistical difference on yield values of maize silage plants. On the other hand, statistical differences were found in some quality parameters such as crude ash, stem weight, cob weight, and plant height. In the parameters with statistical differences, it is seen that F_1 and F_2 issues are mostly in the foreground. This situation showed that pulse irrigation practices provide better moisture distribution in the soil and positively affect some quality parameters in the plant. Giving water at once in agricultural irrigation limits the time required for the best distribution of water in the soil. This can be seen among the causes of deep infiltration or surface runoff, especially in long-term farmer irrigations. In intermittent subsurface drip irrigation, the treatments where the water cut-off time is relatively long (F_1 and F_2) came to the fore. It is considered useful to study different soil structures and water deficiency to determine the effect of pulse subsurface drip irrigation on plant yield and quality parameters.

Conflict of Interest

The authors declare that there is no conflict of interest.

Ethics

This study does not require ethics committee approval.

Author Contribution Rates

Design of Study: RG (%50), AE (%50),

Data Acquisition: RG (%100),

Data Analysis: RG (%85), AE (%15),

Writing up: RG (%85), AE (%15),

Submission and Revision: RG (%100),

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