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The Effects of Different Irrigation Scheduling Approaches on Seed Yield and Water Use Efficiencies of Cotton

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A R T I C L E I N F O

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A B S T R A C T

This study was conducted in the Aegean region conditions of Turkey in 2020. It was carried out on May-505, a local cotton variety. The study examined the variation of seed yield, water use efficiency (WUE), and irrigation water use efficiency (IWUE) of cotton with different irrigation programs and water levels. The field trial, which was designed as two factors and three replications, was designed according to the randomized complete block trial design. Four different irrigation levels (IL) (100%, 67%, 33%, and 0%) and two different irrigation scheduling approaches (gravimetric and pan evaporation) were investigated in the study. Seasonal water use values in treatments varied between 215 (0%) and 746 (100% - Pan evaporation approach) mm during the production period. The average yield values obtained with irrigation levels, which have essential effects on cotton seed yield, are listed as follows; 2057 kg ha^{-1} (IL-0%), 3471 kg ha^{-1} (IL-33%), 3771 kg ha^{-1} (IL-67%), and 5083 kg ha^{-1} (IL-100%). It was determined pan evaporation applications performed higher yields than gravimetric applications. WUE values were between 0.63 – 1.04 kg m^{-3}. The gravimetric method's yield response factor (k_y) was 0.73, and the pan evaporation method's yield response factor (k_y) was 0.89. These results show that cotton is tolerant of water stress. In conclusion, although the pan evaporation approach with 100% treatment is suggested for cotton production in the parts of the Aegean region within the semi-arid climate zone, while water resources are sufficient. When the results are evaluated in terms of seed cotton yield for a deficit irrigation strategy, IL-67% treatment with a gravimetric approach can be used.

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Farklı Sulama Programlama Yaklaşımlarının Pamukta Verim ve Su Kullanım Randımanları Üzerine Etkileri

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Ö Z

Bu çalışma, 2020 yılında Ege Bölgesi'nde May-505 pamuk çeşidi ile gerçekleştirilmiştir. Bu çalışmanın amacı, farklı sulama programları ve farklı su seviyelerinin pamuk kütlü verimi ile su kullanım etkinlikleri (WUE; IWUE) üzerine etkilerini araştırmaktır. İki faktörlü ve üç tekerrürlü olarak kurulan tarla denemesi, tesadüf blokları deneme desenine göre tasarlanmıştır. Çalışmada dört farklı sulama düzeyi (%100, %67, %33 ve %0) ve iki farklı sulama yaklaşımı (Gravimetrik ve kap buharlaşması) incelenmiştir. Her sulama yaklaşımında en yüksek sulama suyu tam sulama (%100 - kap buharlaşması yaklaşımı) konusundan sağlanmıştır. Üretim döneminde parsellerde mevsimsel su kullanım değerleri 215 mm (% 0) ile 746 (% 100) mm arasında değişmiştir. Sulama seviyelerinin (IL) pamuk kütlü verimi üzerinde önemli etkileri olmuştur. Ortalama pamuk kütlü verimi değerleri en düşükten en yükseğe şu şekilde elde edilmiştir; 2.057 kg ha^{-1} (IL-%0), 3.471 kg ha^{-1} (IL-%33), 3.771 kg ha^{-1} (IL-%67) ve 5.083 kg ha^{-1} (IL-%100). Kap buharlaşması uygulamalarının gravimetrik uygulamalara göre daha yüksek verim sağladığı tespit edilmiştir. WUE değerleri de 0,63 ile 1,04 kg m^{-3} arasında değişmiştir. Gravimetrik yöntemin verim tepki etmeni (k_y) 0,73 ve kap buharlaşması yönteminin verim tepki etmeni (k_y) 0,89 olarak bulunmuştur. Sonuç olarak, Ege Bölgesi'nin yarı kurak iklim kuşağı içindeki bölümlerinde, su kaynaklarının yeterli olması koşulunda pamuk üretimi için %100 seviyesinde sulama suyu uygulanan kap buharlaşması yaklaşımı önerilebilir. Kısıtlı su koşullarında ise, %67 seviyesinde sulama suyu uygulanan gravimetrik yaklaşım kullanılabilir.

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Introduction

The amount and distribution of rainfall in all cotton-producing areas in the Aegean region are one of Turkey's most important agricultural regions are inadequate. Besides, the decrease in groundwater resources and high costs of energy also negatively affect irrigated cotton production. In Turkey's near future, particularly for some products, urgent measures should be taken to avoid water scarcity problems. Limited water resources necessitate efforts to make radical changes in irrigation management and to encourage deficit irrigation practices. Also, it is essential to ensure that producers choose irrigation methods with higher irrigation water efficiency methods (such as drip irrigation, subsurface drip irrigation (SDI), sprinkler irrigation, and low-energy precision applicators (LEPA)) (Simsek et al., 2004). Turkey's seed cotton production meets approximately 44% of the needs of its domestic market. In Turkey, among the first 11 countries made of cotton production globally, in the 2018/2019 season, seed cotton acreage, crop production, and average cotton lint yield were determined 508000 ha, 988000 tonnes, and 1944 kg ha^{-1}, respectively (Anonymous, 2019a). The decrease in groundwater resources due to climate change and the increase in industrial and domestic water consumption have led to a decrease in the amount of water available for agricultural production. Also, the effects of global warming are more and more being felt, and one of the most important of these is drought. Evaporation has a significant role in efficient water use, preparing irrigation programs, and agricultural water management (Yazar et al., 2002a; Panda et al., 2004). Pan evaporation has become a widely preferred method in irrigation planning because it is a method that farmers can easily apply, and pan evaporation has a close correlation with evapotranspiration (Kanber, 1984; Wang et al., 2009). As with many crops, irrigation in cotton is recommended by sprinkler and drip irrigation methods. It can be applied in various topographic and soil conditions and provides frequent and uniform water applications. Compared with furrow and sprinkler irrigation, although irrigated by drip irrigation in cotton yield and with higher water use efficiency values, surface irrigation is still preferred in Turkey (Çetin and Bilgel, 2002; Dagdelen et al., 2006). Mateos et al. (1991) reported that the drip irrigation method could be preferred because water use efficiency is 30% higher than the furrow irrigation method in limited water resource conditions.

Yazar et al. (2002b), in a study conducted in Turkey Southeastern Anatolia Region conditions, investigated the effects of different irrigation methods, levels, and intervals on yield of cotton. The researchers obtained the highest average cotton yield as 5850 kg ha^{-1} from full irrigation (100%) on land irrigated with drip irrigation at 6-day intervals. In a study evaluating seed cotton yield with different irrigation intervals in drip irrigation under Cukurova conditions, the maximum seed cotton yield was 4220 kg ha^{-1}, and seasonal water consumption was 511 mm in the parcel irrigated at five days intervals (Ertek and Kanber, 2001). Since the importance of using irrigation water effectively increases daily, it is necessary to prefer methods that will increase water use efficiency, such as drip and sprinkler irrigation (Sezen et al., 2004). Many studies have been obtained in favor of the drip irrigation method due to the high cotton yield and high WUE values (Mateos et al., 1991; Ertek and Kanber, 2001; Cetin and Bilgel, 2002; Yazar et al., 2002b; Karam et al., 2006; Ibragimov et al., 2007). Basal et al. (2009) investigated the effects of different water doses on water use efficiency, yield, yield components, and fiber quality in drip irrigation. They found that water use efficiency increased from 0.62 to 0.75 kg m^{-3} when the water rates decreased from 100% to 75%. It was also found that raw cotton yield, the number of bolls, and the weight of cotton per boll fell in parallel with the irrigation level reduction. Dağdelen et al. (2009) investigated the effects of different water levels on water use efficiency and fiber quality parameters under drip irrigation methods in the Aegean region in 2004-2005. The authors reported that the water use efficiency varied between 0.76 and 0.98 kg m^{-3}. The average cotton yield was between 2550 and 5760 kg ha$^{-1,}$ and the average seasonal plant water consumption was between 256 and 753 mm. In a study conducted on cotton under Syrian conditions to determine the effect of different irrigation rates on cotton yield, water use efficiency, and fiber quality, researchers found the average cotton yield between 2909 and 5090 kg ha^{-1}, and the plant water consumption ranged from 408 to 773 mm (Hussein et al., 2011). Also, the highest WUE value, 0.71 kg m^{-3}, was obtained from the irrigation application of 80% of the soil water depletion. Erten and Dagdelen (2020) conducted a study to determine the effects of 0%, 25%, 50%, 75%, and 100% irrigation levels with gravimetric approach on cotton yield using drip irrigation under Aydın-Turkey conditions. The researchers found average WUE and IWUE values varied between 0.747-1.120 and 0.972-2.503 kg m$^{-3,}$ respectively.

The scarce of water is a critical problem in cotton production. Besides different drip irrigation levels, proper management, such as irrigation approaches should be studied by researchers. Therefore, limited irrigation water resources require significant changes in irrigation management or require water conservation practices. This study aimed to determine the effects of different irrigation scheduling approaches and irrigation levels on water use efficiency and seed cotton yield in cotton irrigated by drip irrigation method and select the most suitable irrigation program in cotton in semi-arid climatic conditions.

Materials and Methods

This research was carried out at Aydın Adnan Menderes University Agricultural Research Station in the 2020 production season. The research area is at 37^0 51 ' N latitude, 27°51' E longitude, 56 m altitude, and is in the semi-arid climate zone. In the Lower Büyük Menderes Basin, where the research station is located, the Mediterranean climate prevails with hot and dry summers and cold and rainy winters. According to the long-term climate data, the total amount of precipitation in the basin is 657 mm year^{-1}. Climate data obtained during the production season (May - September / 2020) are given in Table 1 (Anonymous, 2019b).

Table 1. Climatic variables for experimental site

1970-2019				
Month	Temperature (ºC)	Relative Humidity (%)	Rainfall (mm)	Evaporation (mm)
May	21	56.9	35.6	161.3
June	26	49.2	16.6	222.1
July	28.6	48.6	7.5	257.5
August	27.6	52.9	5.3	231.6
September	23.3	55.9	15.1	161.9
2020				
Month	Temperature (ºC)	Relative Humidity (%)	Rainfall (mm)	Evaporation (mm)
May	22.1	54.9	33.3	175.2
June	25.2	54.4	20.3	200.2
July	29.9	47.8	0	272.6
August	29.2	46.9	0	247.1
September	26.9	54.7	0	182.8

Table 2. Some physical characteristics of experimental site soils

Soil depth (cm)	Soil texture	Bulk density (g cm^{-3})	Field capacity (%)*	Wilting point (%)*	Available water holding capacity (mm)
0-30	Sandy-Loam	1.35	23.1	10.1	52.6
30-60	Sandy-Loam	1.45	22.9	9.4	58.8
60-90	Sandy-Loam	1.52	18.4	7.3	50.6
90-120	Sandy-Loam	1.50	20.3	7.2	59.0
0-120					221.0

*on a dry weight basis

Table 3. Irrigation treatments examined in the research

Irrigation application methods	Irrigation Levels (%)	Abbreviations
Gravimetric	100	C_1
	67	C_2
	33	C_3
	0	C_4
Pan evaporation	100	D_1
	67	D_2
	33	D_3
	0	D_4

When the climate data of long years in Table 1 are examined, it is seen that the average temperature was 25.3°C and the average relative humidity was 52.7%. In addition, the total precipitation and evaporation amounts were measured as 80.10 mm and 1034.40 mm, respectively. In the trial year, the average temperature was 26.7°C and the average relative humidity was 51.7%. Also, the total precipitation and evaporation amounts were measured as 53.60 mm and 1077.90 mm, respectively.

The soil series in the research area was Büyük Menderes Basin developed on alluvial materials (Aksoy et al., 1998). The experimental site's soil is classified as Entisols and Fluvisols-Regosols silty-clay-loam with relatively high water holding capacity. The soil texture, bulk density, field capacity, wilting point, and available water holding capacity values of each 30 cm layer of 0 - 120 cm soil depth in the experimental area are given in Table 2.

Before starting the field experiment, 50 kg da^{-1} compound fertilizer (containing 15% pure N, 15% P, and 15% K) was applied to the planting area. The planting process was carried out on May 13, 2020, at 0.70 x 0.20 m intervals, and the May-505 cotton variety was used. The required remaining portion of nitrogen was given by 40 kg da^{-1} before first irrigation.

The study, prepared as a randomized complete block design with three replications and two factors; four different irrigation levels (100, 67, 33, and 0%) and two different irrigation program techniques (gravimetric and pan evaporation) were investigated. There is 3 m space between each of the trial plots, and four cotton rows with 0.7 m intervals and 5 m lengths have been created within the plot. In the pan evaporation method, irrigation water was applied to D_1 (control), D_2, D_3, and D_4 treatments, respectively 100%, 67%, 33%, and 0% of the 7-day cumulative pan evaporation amounts measured from the class-A pan. In gravimetric method, irrigation water was applied when 50% of available water in the root zone (0 – 90 cm) is consumed. Irrigation amount to C_1 (control), C_2, C_3 and C_4 treatments, were 100%, 67%, 33% and 0% of consumption, respectively. (Table 3).

Equation (1 and 2) was used to calculate the irrigation water amount for two approaches;

$$V = P \times A \times E_{pan} \times WL \quad (1)$$

$$I = (FC-AW)/100 \times \gamma_t \times D$$

$$V = I \times A \times WL \quad (2)$$

Where V is the volume of irrigation water (L), P percentage of wetted area (taken as 100 % for row crops), A is plot area (m^2), E_{pan} is the amount of cumulative evaporation during a seven-day irrigation interval (mm), WL represents irrigation levels (0.33, 0.67 and 1.00), FC field capacity (mm), AW available water in the soil within 90 cm depth before irrigation applications (mm), γ_t bulk density (g cm^{-3}) and D effective root zone (mm). Class A pan, used to measure the evaporation, was placed next to the plots in the meteorology. The irrigation water required for the plots was obtained from the underground water source (deep well) in the experiment area, and the drip irrigation method was applied. Right next to the deep well, there is a control unit consisting of control valves, a screen filter with a capacity of 10 L s^{-1}, manometers mounted at the inlet and outlet of each unit. 63 mm outer diameter PVC latch manifold pipes were used to transmit the water taken from the control unit to the parcels, and in the parcel, 16 mm diameter PE lateral pipes were placed along the plant rows. In the parcel, irrigation lines with 10 m operating pressure, 4 L h^{-1} discharge rate, 0.2 m dripper range, and 0.7 m lateral range were used to convey water in the parcel. Soil water balance equation (3) was used to determine crop water consumption of the treatments as follows (Heerman, 1985);

$$ET = R + I - D \pm \Delta W \quad (3)$$

Where; ET is the crop water use (mm), *R* is the effective rainfall (mm), *I* is the irrigation amount (mm), *D* is the quantity of percolation (mm), and ΔW is the conversion of soil water storage in the measured soil depth.

The WUE values used in the study were obtained by dividing the yield values (kg ha^{-1}) by the water use efficiency (mm), and the IWUE values were obtained by dividing the yield values (kg ha^{-1}) by the amount of irrigation water applied (mm) (Howell et al., 1990). Then, the Stewart model (Doorenbos and Kassam, 1986) was used to determine the relationship between water and yield for each irrigation program (Equation 4):

$$1-(Ya/Ym)=k_y(1-ETa/ETm) \quad (4)$$

Where; *ETa* is the actual seasonal crop water use-value (mm), *ETm* is the maximum seasonal crop water use-value (mm), *Ya* is the corresponding actual yield (kg ha^{-1}), and *Ym* is the corresponding maximum yield (kg ha^{-1}).

The yield values used in the above equations were obtained by weighing the cotton harvested by hand from each parcel on October 16, 2020. Then, these yield values were subjected to variance analysis, and the differences between irrigation practices were determined. Besides, irrigation practices were compared and ranked using the least significant differences test (LSD). The significance level for the differences here was taken as $P < 0.05$. The TARIST program was used to make these calculations (Acikgoz et al., 1994).

Results and Discussions

The total amount of irrigation water given to the treatments, seasonal crop water consumption, WUE, and IWUE values for the production period are shown in Table 4. Irrigations were conducted seven times between July 9 and August 26, 2020. The total amount of irrigation water supplied to the treatments was between 177-550 mm.

Seasonal plant water use values varied in connection with the irrigation water applied to the parcels and moisture at planting and harvest. Simultaneously, although it has a significant effect on plant water consumption, there was no rain in the growing season's experimental area. In parallel with the increase in irrigation levels in each application, water use values have also increased. Seasonal water use varied from 746 mm D_1 treatment (pan evaporation) to 215 mm in D_4 treatment (rain-fed) plots in the production period and 719 mm in C_1 (gravimetric) treatment to 215 mm in C_4 treatment (rain-fed) plots. This was followed by D_2 and C_2 treatments, 572 and 553 mm in the growing season, respectively (Table 4). The highest seasonal water use values were obtained from treatments D_1 and C_1 control treatments (100%) as 746 mm and 719 mm, respectively. Similar to our findings, the seasonal water use value of 800 mm was obtained by Erten and Dagdelen (2020) under Aydın Plain conditions. Sezgin et al. (2001) and Dağdelen et al. (2006) obtained 899 and 855 – 882 mm of seasonal water consumption with furrow irrigation in the same region. Also, in similar studies with drip irrigation Dağdelen et al. (2009), Basal et al. (2009), Akcay and Dağdelen (2017) and Tunalı et al. (2020) obtained 265 – 753, 268 – 754, 331 – 774, and 305 – 723 mm, respectively. Seasonal water consumption values obtained in studies conducted in different regions using the drip irrigation method are as follows: it was between 287 – 584 mm in Adana conditions (Unlu et al., 2011), between 410 – 725 mm in High Texas Plains in (Colaizzi et al., 2005), and around 738 mm in the conditions of the Bekaa Valley in Lebanon (Karam et al., 2006). When the results of the mentioned studies are examined, it can be said that they are in harmony with this study's results.

Table 4. Seed cotton yield and water use efficiency values as influenced by irrigation application methods and irrigation levels

Irrigation application methods	Irrigation Levels	Seed cotton yield (kg ha^{-1})	Irrigation water applied (mm)	Water use (mm)	Water use efficiency (WUE) (kg m^{-3})	Irrigation water use efficiency (IWUE) (kg m^{-3})
Gravimetric	C1-100%	4995	536	719	0.695	0.932
	C2-67%	3943	359	553	0.713	1.098
	C3-33%	3657	177	383	0.954	2.066
	C4-0%	2257	-	215	1.049	-
Pan evaporation	D1-100%	5171	550	746	0.693	0.940
	D2-67%	3600	368	572	0.630	0.977
	D3-33%	3286	181	392	0.838	1.810
	D4-0%	1857	-	215	0.864	-

Table 5. Variance analysis of seed cotton yield influenced by different treatments and irrigation levels

		Seed cotton yield (kg ha^{-1})
Treatment (T)	Gravimetric	3713
	Pan	3478
$LSD_{\%5}$		
Irrigation Level (IL)	% 100	5083^{a}
	% 67	3771^{b}
	% 33	3471^{b}
	% 0	2057^{c}
$LSD_{\%5}$		72.527
	T	ns
	IL	**
	T × IL	ns

*P<0.05; **P<0.01; ns: not significant, In a column values with a common letter does not significantly differ from one another using $LSD_{\%5}$

Table 6. The comparison of WUE and IWUE values for different research

Sources	Irrigation system	WUE (kg m^{-3})	IWUE (kg m^{-3})
Our research	Drip	0.69-1.04	0.93-2.06
Ertek and Kanber (2001)	Drip	0.58-0.62	0.75-0.94
Yazar et al. (2002a)	Drip	0.50-0.74	0.60-0.81
Yazar et al. (2002b)	Lepa	0.55-0.67	0.58-0.77
Karam et al. (2006)	Drip	0.80-1.30	-
Ibragimov et al. (2007)	Drip	0.63-0.88	0.82-1.12
Dagdelen et al. (2009)	Drip	0.77-0.96	0.82-1.44
Basal et al. (2009)	Drip	0.62-0.85	0.66-1.57
Akcay and Dagdelen (2017)	Drip	0.83-1.26	1.05-1.96
Dagdelen et al. (2019)	Drip	0.73-1.13	0.91-2.23
Erten and Dagdelen (2020)	Drip	0.74-1.12	0.97-2.50
Tunali et al. (2020)	Drip	0.83- 1.19	1.03- 1.93

The response of seed cotton yield for different irrigation treatments is given in Table 5. When the results obtained were analyzed, it was shown that irrigation levels significantly affected cotton yield. No interaction was observed between irrigation practices (T) and irrigation levels (IL) for the parameters examined. Seed cotton yield had no significantly affected on irrigation applications (T). The gravimetric application resulted in higher efficiency than pan evaporation applications. It has been observed that cotton yield increases with irrigation water levels. When the irrigation levels (IL) were examined, three groups were formed during the year. The first group consisted of the 100% treatments where no water restriction had been applied in the whole growing season, treatments in which water had been applied at the 67 % level were second. Treatments that had received water at the 33 % level formed the last group. As the irrigation level increased, the cotton yield increased. Average yield values according to irrigation levels are as follows: in IL-100 5083 kg ha^{-1}, in IL-67 3771 kg ha^{-1}, in IL-33 3471 kg ha^{-1} and IL-0 (based on rainfall) 2057 kg ha^{-1}. When the yield reduction ratio values between the irrigation levels are examined in the study, it was determined that there is a 59.6% difference in yield between the lowest and highest efficiency values. When the irrigation level decreased from 100% to 67%, there was a 33% reduction in the water level; cotton yield decreased by 31.7%. Similar results have been reported in many previous studies.

Dagdelen et al. (2005) obtained the highest cotton efficiency with the drip irrigation method in Aydın Region from full irrigation (100%). They irrigated at eight-day intervals in the class A pan evaporation method. On the other hand, Yazar et al. (2002b) obtained the highest seed cotton yield (5870 kg ha^{-1}) in the Harran Plain from full irrigation (100%), which they irrigated with the drip irrigation method with a six-day irrigation interval. Dagdelen et al. (2009) studied the drip irrigation method in western Turkey, found the average cotton yield 5760 kg ha^{-1}. In another study conducted under Aydın Plain conditions, the treatment with the highest average cotton yield was obtained from S1 (Carisma – V1) treatment with 6300 kg ha^{-1}, and it was determined that the yield of Carisma-V1 variety was higher than the other varieties used in the study (Candia - V2 and Gloria - V3) (Dagdelen et al., 2019). Similar results were obtained by Erten and Dagdelen (2020) as 5985 kg ha^{-1} at the same conditions. Tunali et al. (2020) examined the effects of different water levels and seed coating techniques on water use efficiency and cotton yield. Among the yield values obtained in the study, the highest cotton yield was obtained from delinted cotton seed with 6223 kg ha^{-1} and an irrigation level of 100% (D_1). It is seen that the above studies and the results obtained from this study are compatible. In evaluations conducted previously, it has been found that irrigation levels significantly affect seed cotton yield. It has been concluded that the most proper irrigation program suggested for achieving the highest cotton yield would be using the pan evaporation applications under sufficient water conditions in which the crop water requirements were fully met by IL-100% treatment (D_1).

Regression analysis was performed to evaluate the yield values obtained in cotton. According to the regression analysis results, a meaningful second-order polynomial relation was found between seasonal water use and cotton yield (Figure 1). Yazar et al. (2002a), Dagdelen et al. (2009), Erten and Dagdelen (2020), Unlu et al. (2011) examined the polynomial relationship with yield and water use in cotton irrigated by drip irrigation.

The ky factor, which shows the relationship between Relative ET and Relative yield, was determined according to Stewart et al. (1977). The yield response factor (k_y) was determined to be 0.73 in gravimetric applications and 0.89 in pan evaporation applications (Figure 2). The average k_y for the whole growing season was found to be 0.84 by Doorenbos and Kassam (1986), 0.89 by Yazar et al. (2002b), 0.78 by Dagdelen et al. (2009), and 0.73 to 0.82 by Tunalı et al. (2020) in Aydın conditions.

Table 4 shows the WUE and IWUE values obtained from the research during the growing season. WUE and IWUE values decreased when the irrigation amount increased. In the study, due to the water stored in the soil, the IWUE values were higher than the WUE values (0.69 kg m^{-3} (D_2 - pan evaporation for IL-67%) to 1.04 kg m^{-3} (C_4 - gravimetric for IL-0%)). Treatment IL-33% from all applications (C_3 and D_3) used to water more efficiently. Thus, when water was restricted under these conditions, a reduction of 26.7% and 36.4% were seen in seed cotton yield. Table 6 shows a comparison of the WUE and IWUE values obtained from our study and the water efficiency values reported by other researchers. The table shows that both WUE and IWUE values were similar to the findings of other researchers.

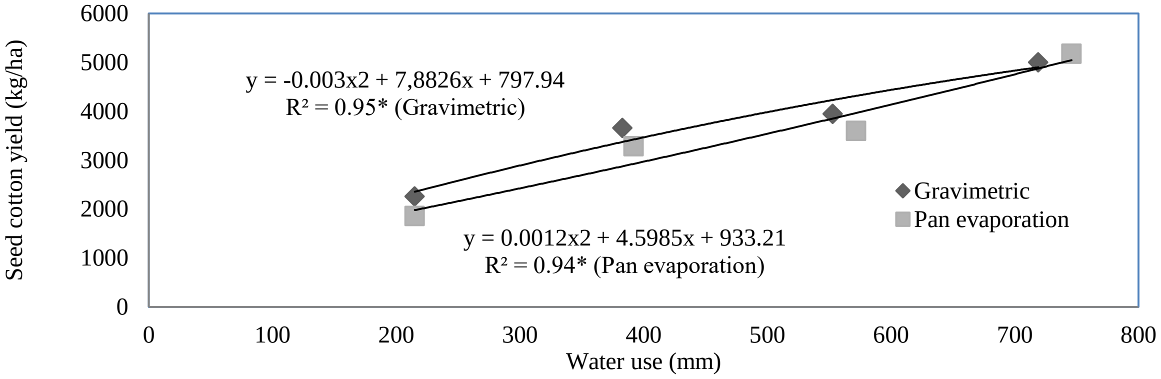

Figure 1. The relationship between water use and seed cotton yield

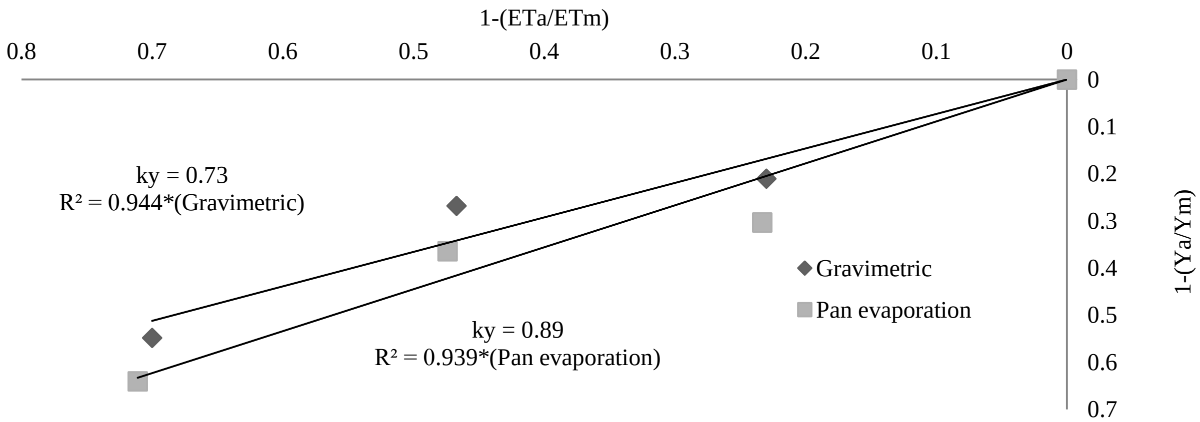

Figure 2. Yield response factor, k_y, of cotton seed irrigation approaches

Conclusion

When the results obtained from the study are examined, it has been revealed that both the amount of irrigation water and water application approaches and the use of water are vital in obtaining a higher yield in cotton. It was observed that irrigation levels (IL) significantly affected cotton yield at the P <0.01 level. The highest seed cotton yield was obtained from IL-100% treatment as averaging 5083 kg ha^{-1}, followed by IL-67% treatment as averaging 3771 kg ha^{-1}. Irrigation applications had no significant effect on seed cotton yield. Moreover, pan evaporation applications with IL-100% treatment (D_1) performed higher yields than gravimetric applications with IL-100% treatment (C_1). It has been found that the increase in irrigation interval leads to a decrease in WUE and IWUE values. Likewise, the highest values of WUE and IWUE were observed at the lowest irrigation levels in different irrigation applications. However, the lowest cotton yield values occurred in irrigation applications with the lowest irrigation level. Therefore, it reveals that it would be inconvenient to use low irrigation levels in Aydın Plain conditions, especially for cotton irrigated with drip irrigation. The study also concluded that there is a significant relationship between seasonal water consumption and seed cotton yield. Overall, this research indicated that pan evaporation applications with IL-100% treatment ((D_1) could be used for cotton grown in the Aegean region, similar to Turkey's area, under no water shortage. Besides, it can be said that IL-67% can be used in cotton irrigated by the gravimetric method in semi-arid climates with water constraints. Here, a 33% reduction (IL-67%) of water delivered to the soil by drip irrigation corresponded to a 26.7% yield reduction during the growing season.

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