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Araştırma
(Research)

Response to Reduced Doses of Mepiquat Chloride on Yield and Quality Characteristics of Cotton (*Gossypium hirsutum* L.) in the Mediterranean Region of Türkiye*

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Abstract

Objective: A field study was undertaken to examine the effect of reduced Mepiquat chloride (MC) dosage applied at different times to enhance the yield and quality attributes of cotton at the Eastern Mediterranean Agricultural Research Institute, Adana, Türkiye, during the 2022 cropping season.

Material and Methods: A split-split plot experiment following a randomized complete block design (RCBD) with three replications was employed.Varieties (Sezener and Selin) were assigned to the main plots, application times (before and after flowering) to the sub-plots, and MC concentrations (0, 40, 40+40 and 80 cc/da) to the sub-sub-plots.

Results: Results shown that Sezener outperformed Selin across metrics: higher fiber yield (490.6 vs 447.5 kg/ha), reflectance (69.8 vs 63.5), and yellowness (11.9 vs 10.8). Under Sezener, the 80 cc/da dosage at 60 days after sowing maximized yield (530.2 kg/ha). Selin showed poorest yield (360.3 kg/ha) and highest trash (2.60%), while Sezener had lowest (0.57%). Mepiquat chloride doses effected quality parameters differently for both varieties. The effect changed within application time. It has been determined that the application of Mepiquat chloride has different effects on the quality parameters in two varieties, and the effect varied according to the time of application. As a matter of fact, in the yellowness parameter, unlike other quality parameters, Selin variety had the lowest, while Sezener had the highest value.

Conclusion: Although most effects were not statistically significant, certain variety-application time interactions revealed practical differences that may inform future studies. Therefore, to maximize monetary returns, further research is needed to enhance yield and quality parameters in the Mediterranean region of Türkiye. In addition, more comprehensive studies should be carried out to understand the change in the effect of Mepiquat chloride application on the basis of varieties.

Keywords: Application time, Cotton, fiber quality, fiber yield, Mepiquat chloride

Akdeniz Bölgesi koşullarında, Azaltılmış Mepikuvat Klorür Dozlarının Pamuk (*Gossypium hirsutum* L.) Verim ve Kalite Özelliklerine Tepkisi

Öz

Amaç: Türkiye'nin Adana ilindeki Doğu Akdeniz Tarımsal Araştırma Enstitüsü'nde pamukta verim ve kalite özelliklerini artırmak amacıyla farklı zamanlarda uygulanan azaltılmış Mepikuvat klorür dozlarının etkisini incelemek için 2022 yılında arazi denemesi kurulmuştur.

Materyal ve Yöntem: Araştırmada material olarak Sezener ve Selin çeşitleri kullanılmıştır. Çeşitler ana parsellere, uygulama zamanları (çiçeklenmeden önce ve çiçeklenmeden sonra) alt parsellere ve Mepikuvat klorür konsantrasyonları (0, 40, 40+40 and 80 cc/da) alt-alt parsellere yerleştirilmiştir. Bu çalışma, tesadüf bloklarında bölünen bölünmüş parseller deneme desenine göre 3 tekerrürlü olarak yürütülmüştür.

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Araştırma Bulguları: Analiz sonuçlarına göre, Sezener yüksek lif verimi (sırasıyla 490.6 vs 447.5 kg/ha), parlaklık (69.8 vs 63.5) ve sarılık (11.9 vs 10.8) bakımından Selin çeşidini geride bırakmıştır. Sezener çeşidinde 80 cc/da uygulamasından en yüksek verim (530.2 kg/ha) verim elde edilmiştir. En düşük verim Selin çeşidinde (360.3 kg/ha) ve en yüksek çeper (%2.60) elde edilirken, Sezener çeşidinde çeper oranı en düşük (%0.57) bulunmuştur. Mepikuvat klorid uygulamasının kalite parametrelerine iki çeşitte farklı etki gösterdiği, ayrıca uygulama zamanına göre etkinin değiştiği belirlenmiştir. Nitekim sarılık parametresinde, diğer kalite parametrelerinin aksine, Selin çeşidi düşük sarılık değerine sahip bulunmuştur.

Sonuç: Mepikuvat klorür uygulamasının pamuk bitkilerinin verim ve kalite parametrelerinde bir miktar değişime sebep olabildiği görülmüştür. İstatistik analizlerin çoğu önemsiz çıksa da, bazı interaksiyonların gelecekteki çalışmalara ışık tutabileceği söylenebilir. Türkiye'nin Akdeniz bölgesinde verim ve kalite parametrelerini artırmak için daha fazla araştırmaya ihtiyaç duyulmaktadır. Ayrıca çeşitler bazında mepikuvat klorid uygulamasının etkisindeki değişikliğin anlaşılması için daha kapsamlı çalışmaların yapılması önerilmektedir.

Anahtar Kelimeler: Mepikuvat Klorür; uygulama zamanı; pamuk; lif verimi; lif kalitesi

Introduciton

Turkey, officially the Republic of Türkiye (Turkish: Türkiye Cumhuriyeti), is a country which borders West Asia to the Anatolian Peninsula and Southeast Europe to the Balkan Peninsula (Dewdney et al. 2024). It is an industrialized country, and a key partner for the European Commission (EC, 2020; NIC, 2020). Turkey`s economy is currently ranked 17th largest by nominal gross domestic product (GDP) and 11th largest by purchasing power parity (PPP) per capita in the world (WEO, 2023). The rapid economic growth of Turkey is highly linked with transportation, mining, agriculture and manufacturing, principally food-processing, metallurgy, chemicals, bulding-materials and textile (Dewdney et al. 2024). The textile industry plays a significant role for the national economy through export earnings and labor-intensive workforce (Sezener, 2021; Tokel et al. 2021). Cotton is a key crop in Turkey, where textile industries rely on fiber (Tokel et al. 2022). The crop is mainly produced in three regions, namely, Southeastern Anatolia, the Mediterranean region (including the province of Antalya), and Aegean Region (ICAC, 2022). In the 2020/21 cropping season, Türkiye was ranked as the seventh (7th) world's largest cotton producer with approximately 631,000 tons of fiber (Statista, 2022).

Globally, in recent years, cotton (*Gossypium hirsutum* L.) production has encountered to face challenges, such as Covid-19 epidemic, greenhouse gas emissions, drought, low profit, pests, diseases, salinity, heat and temperature (USDA, 2022; Devlet 2021; Sezener, 2021; Tokel et al. 2021). Out of these factors, effects of drought pose serious risks, causing a dramatic decline in plant biomass, planting areas, yield and yield components, fiber development and fiber quality (Çelik, 2023; Kılınçoğlu et al. 2021).Drought actually surpasses the world cotton fiber requirements as yield losses per 1°C increase in temperature approximately 10 - 17% but in areas of heavy water scarcity, losses reached 50 - 70% in some years (Wang et al. 2024; Jia et al. 2024; Zafar et al. 2023; Rehman et al. 2022). Liu et al. (2023) estimated a loss with a value of 30 billion USD, adversely affecting over 250 million farmers across the globe. Cotton farming areas of Turkey have tried and adopted several measures to control drought stress. The potential approaches developed include using drought-tolerant cotton varieties (Çelik, 2023; Sezener et al. 2015), irrigation (Ozudogru, 2021) and use of synthetic growth regulators (Çınar and Ünay, 2021). However, despite these achievements, the yield of strategic crops anticipated with drought is projected to decrease in several important crops such as wheat, barley, corn, cotton (Sen et al. 2012; Çelik, 2023).

Plant growth regulators (PGR) affects *Gossypium* spp., by reducing boll rot and increasing boll retention (Kemerait, 2021; Kulvir et al. 2015), reducing excessively the vegetative growth (Çınar and Ünay, 2021), managing canopy architecture (Echer and Rosolem, 2012), and improve lint yield and fiber quality (Çınar and Ünay, 2021; Collins et al. 2017; Rosolem et al. 2013).Mepiquat chloride (MC) is the most extensively used plant growth regulator for controlling overgrowth of cotton across areas of Turkey(Çınar and Ünay, 2021; Çopur et al. 2010). It works by inhibiting the synthesis of gibberellin into endogenous hormone, and hence improve morphology by reducing intermodal distance, stem height, number of nodes and height to node ratio

(Chia, 2018; Collins et al. 2017; Sawan, 2017). Furthermore, MC increases light interception by the lower leaves, flower and fruit retention, and finally source to sink ratio (Priyadrashini et al. 2023). Effectiveness of MC depends with several factors, typically; variety, management, environmental factors, application method, time and doses (Priyadrashini et al. 2023; Murtza et al. 2022; Samples et al. 2015). These studies have concentrated on the alterationsof application time and high doses of MCfor an enhancement of cotton phenology, yield and lint quality. Hence there is a need to investigate the response of reduced rates of MC at different times of cotton grown in Adana, Turkey.Therefore, this study aims to evaluate the effects of reduced doses of Mepiquat Chloride applied at different growth stages on the yield and fiber quality of two cotton varieties under Mediterranean climate conditions.

Materials and Methods

Description of the Experimental Area

The field-based research was conducted at the Eastern Mediterranean Agricultural Research Institute, during the 2022/23 cotton cropping season. The Institute is located at the 17th kilometer of Karatas Road of Dogankent, Yuregir, Adana / Turkey with the GPS coordinates of 36° 51' 23.2" N and 35° 20' 48.3" E. Adana is found in the East Mediterranean zone, characterized byhot and dry summer, and mild and rainy winters. The zone also has categorized by erratic and bimodal rainy that 78% of the annual mean rainfall extends from November/March and 22% falls between April/October. For instance, data from the meteorology stations for a period of 46 years (1973–2019) show a mean rainfall of 616.7 mm per annum (Boydak et al. 2019; Barut et al. 2017).

Soil Properties of the Study Area

The soil morphology of research area belongs to the calcareous black soilswith low salt content, low organic matter, low P content, high potassium (K) content and low Zn concentration. The color of the topsoil varied from black to dark gray with a texture ranged from clay-to-clay loam. At an experimental site, the soil pH (H_2O) ranges from slightly to moderately alkaline, with values falling between 7.85 and 7.87, influenced notably by the carbonate content and base saturation (Husein et al. 2024; Barut et al. 2017). The soil pH value of the study site was suitable for most crops including cotton (Ikram et al. 2022).

Experimental Design, Treatments and Crop management

A split-split plot experiment fitted to randomized complete block design (RCBD) was laid down with two cotton varieties: Sezener and Selin as the main plots. Two application times [i.e., at squaring (60 DAS) and at boll development (78 DAS)] as the subplots. Four different concentrations of MC (control, 40, 40+40 and 80 cc/da), served as sub-sub plots. The treatments were randomly allocated to a plot 3m by 3m and replicated thrice. Adjacent replications were separated by a 2 m alley, main plots were separated by 1.5m alley, the sub plots were separated by 1m apart and the sub-sub plots were separated by a 0.5 m alley. Plant spacing of 0.7 m between rows and 0.2 m within rows with two plants per hole was used. Throughout the growing season, recommended agronomic practices were applied that included weeding, irrigation and insecticide application.

Data sampling

Yield and quality characters

Fiber yield

Seed cotton was picked from thirty matured plants in the two central rows of each plot, then ginned and weighed in gram. Fiber yield, calculated using the following formula

[10000 m^2× fiber weight (g)] / [(0.2 m × 0.7 m) × 30 plants]. (i)

The latter was converted to kg per hectare.

Fiber quality

The ginned cotton from each plot was sent to the quality analysis department of the Eastern Mediterranean Agricultural Research Institute for high-volume instrument (HVI-900, USTER, USA) analysis of fiber properties, typically, reflectance, yellowness and trash area (%). Methods used in this study adopted from Illarionova et al. (2019).

Statistical analysis

Data collected were subjected to analysis of variance (ANOVA) appropriate to the experimental design used. Data analysis was led using mixed model of SPSS software (SPSS statistics 17.0) in order to eliminate multicollinearity between the parameters. Treatment means were compared using Tukey's multiple range tests at $P \leq 0.05$ (Gomez and Gomez, 1984). The assumptions of normality and homogeneity of variance were tested using the Shapiro–Wilk and Levene's tests, respectively.

Results

The results linking to analysis of variance of yield and fiber quality attributes were presented in Table 1.

Table 1. The statistical significance levels of the Variance of Analysis pertaining to the impacts of Mepiquat Chloride on fiber parameters of cotton

		Fiber yield and quality characters			
Source of Variation	**df**	**Fiber yield (kg/ha)**	**Reflectance (Rd)**	**Yellowness (+b)**	**Trash Area (%)**
Main plots					
Variety	1	22244.366ns	36.277ns	2.950ns	3.000ns
Sub plots					
App. T	1	13715.470ns	0.285ns	0.255ns	0.010ns
Sub-sub plots					
Conc	3	2600.541ns	36.017ns	0.426ns	1.790ns
Interactions					
Conc X App. T	3	12792.331ns	1.122ns	0.295ns	0.193ns
Conc X Var	3	3715.758ns	5.649ns	1.560ns	0.449ns
Var X App. T	1	30.258ns	23.102ns	4.260*	1.015ns
Var X App. T X Conc	3	12659.726ns	2.092ns	1.277ns	0.896ns

Values represent mean square (MS) and the significance levels *and ns represent p ≤ .05, and p > .05, respectively. Conc = Concentration, App. T = Application Time, Var = Variety, ns = not statistically significant, SD = standard deviation, df = Degrees of freedom.

The interaction between varieties and application time of Mepiquat Chloride showed a significant (P≤0.05) effect on yellowness (+b).

Fiber yield

The fiber yield did not demonstrate a significant difference (p > 0.05) with application timing; so far, the highest quantity (485.62 kg/ha) was observed with the application of Mepiquat Chloride at 60 DAS (Table 1 and Table 2). The fiber yield of Sezener variety was higher (490.58 kg/ha) than in variety Selin (447.52 kg/ha). The 80 cc/da treatment recorded the highest fiber yield (530.16 kg/ha) under Sezener when Mepiquat Chloride was applied at 60 DAS (Table 2). With the application of 40 + 40 cc/da, the Selin variety underperformed and gave a lowest fiber yield (360.32 kg/ha) when Mepiquat Chloride was applied at 78 DAS (Table 2).

Table 2. Impact of different doses and timing of Mepiquat Chloride application on fiber yield of cotton

Treatments		**Fiber yield (kg/ha)**				
Variety	**Application Time**	**Control**	**40 cc/da**	**40 +40 cc/da**	**80 cc/da**	
Selin	60 DAS	497.62 ± 19.82	492.06 ± 33.68	486.51 ± 26.53	376.98 ± 86.78	447.52 ± 21.44
	78 DAS	415.87 ± 54.37	426.98 ± 102.74	360.32 ± 59.80	523.81 ± 50.30	
Sezener	60 DAS	496.03 ± 10.50	500.00 ± 21.82	505.56 ± 8.40	530.16 ± 22.01	490.58 ± 9.56
	78 DAS	511.90 ± 33.36	403.17 ± 26.81	476.19 ± 7.66	501.59 ± 14.31	
	60 DAS			485.62 ± 14.08		
	78 DAS			452.48 ± 19.21		
	Grand Mean			469.048		
	SE			83.341		
	CV (%)			17.768		

Values represent mean ± SD. DAS = Days After Sowing, SE = Standard Error, CV = coefficient of variation, SD = standard deviation, cc = cubic centimeters, da = Dekar.

Fiber quality

Fiber reflectance

The results revealed that there were no significant (p > 0.05) differences between application time for fiber reflectance (Rd), but the highest value (66.90) was identified when Mepiquat Chloride was applied before flowering (60 DAS) (Table 1 and Table 3). The variety Sezener recorded with highest reflectance value (67.70) at all doses (Table 3). Additionally, the findings discovered the highest reflectance (69.83) under the Sezenervariety and the lowest (63.50) under the Selin variety, both observed with control (0 cc/da) at 60 DAS (Table 3).

Table 3. Impact of different doses and timing of Mepiquat Chloride of fiber reflectance of cotton

Treatments				Reflectance (Rd)		
Variety	**Application Time**	**Control**	**40 cc/da**	**40 +40 cc/da**	**80 cc/da**	
Selin	60 DAS	63.50 ± 3.40	67.73 ± 0.93	66.50 ± 2.18	63.63 ± 4.63	65.96 ± 0.85
	78 DAS	66.40 ± 1.04	68.83 ± 1.15	67.30 ± 1.87	63.77 ± 2.58	
Sezener	60 DAS	69.83 ± 1.16	69.13 ± 2.02	68.60 ± 1.85	66.30 ± 2.00	67.70 ± 0.55
	78 DAS	67.50 ± 1.27	68.73 ± 0.88	67.23 ± 1.15	64.23 ± 0.03	
	60 DAS			66.90 ± 0.88		
	78 DAS			66.75 ± 0.56		
	Grand Mean			66.827		
	SE			3.575		
	CV (%)			5.349		

Values represent mean ± SD. DAS = Days After Sowing, SE = Standard Error, CV = coefficient of variation, SD = standard deviation, cc = cubic centimeters, da = Dekar.

Fiber yellowness

Our investigation unveiled that Mepiquat Chloride application significantly ($P \leq 0.05$) impacted fiber yellowness, with both the application time and variety playing a crucial role (Table 1). Specifically, the Sezener variety exhibited a higher fiber yellowness (11.91) compared to the Selin variety (10.82) when Mepiquat Chloride was applied at 60 DAS (Table 4). Additionally, the highest fiber yellowness (12.37) was recorded in the Sezener variety, while the lowest (10.20) was observed in the Selin variety, both under the 40 + 40 cc/da Mepiquat Chloride application at 60 DAS (Table 4). The interaction showed that the yellowness (+b) value (11.91) was highest in the Sezener variety when Mepiquat Chloride (MC) was applied at pre-flowering (60 DAS), and lowest (10.82) in the Selin variety at the same stage (Fig. 1).

Table 4. Impact of different doses and timing of Mepiquat Chloride application on fiber yellowness of cotton

Treatments				Yellowness (+b)		
Variety	**Application Time**	**Control**	**40 cc/da**	**40 +40 cc/da**	**80 cc/da**	**Var x App. T**
Selin	60 DAS	10.77 ± 0.48	11.00 ± 0.31	10.20 ± 0.60	11.30 ± 0.35	10.82 ± 0.23b
	78 DAS	11.77 ± 0.50	10.47 ± 0.32	11.07 ± 0.60	11.77 ± 0.33	11.27 ± 0.25ab
Sezener	60 DAS	11.23 ± 0.23	11.70 ± 0.36	12.37 ± 0.33	12.33 ± 0.57	11.91 ± 0.22a
	78 DAS	10.73 ± 0.58	11.90 ± 0.42	11.20 ± 0.76	10.83 ± 0.23	11.17 ± 0.27ab
	60 DAS	11.36 ± 0.19				
	78 DAS	11.22 ± 0.18				
	Grand Mean	11.290				
	SE	0.905				
	CV (%)	8.015				

Values represent mean ± SD, and values followed by different letters within each column are statistically different at $P \leq 0.05$. Var = Variety, App. T = Application Time, DAS = Days After Sowing, SE = Standard Error, CV = coefficient of variation, SD = standard deviation, cc = cubic centimeters, da = Dekar.

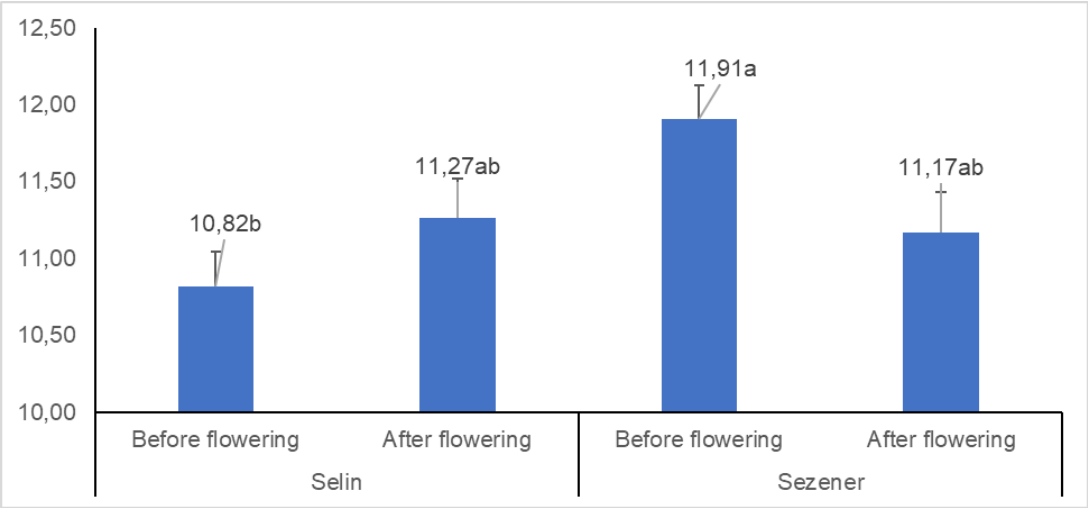

Figure 1. Variety x PGR application time interactions

Trash

The waste in the fiber did not display a significant difference ($p > 0.05$); nevertheless, the smallest quantity (1.24%) was detected with the application of Mepiquat Chloride at 60 DAS (Table 1 and table 5). The trash content in the Selin variety peaked at 1.51%, compared to 1.01% in the Sezener variety (Table 5). Moreover, the results revealed the highest trash content of 2.60% in the Selin variety with application of Mepiquat Chloride at 40 + 40 cc/da at 60 DAS, whereas the lowest trash value (0.57%) was observed in the 40 cc/da treatment under the Sezener variety at 78 DAS (Table 5).

Table 5. Impact of different doses and timing of Mepiquat Chloride application on trash in the fiberof cotton

Treatments		**Trash Area (%)**				
Variety	**Application Time**	**Control**	**40 cc/da**	**40 +40 cc/da**	**80 cc/da**	
Selin	60 DAS	1.30 ± 0.18	0.58 ± 0.08	2.60 ± 1.19	2.06 ± 1.32	1.51 ± 0.24
	78 DAS	1.58 ± 0.46	0.93 ± 0.22	1.59 ± 0.71	1.40 ± 0.26	
Sezener	60 DAS	0.73 ± 0.26	0.92 ± 0.35	0.93 ± 0.41	0.80 ± 0.06	1.01 ± 0.13
	78 DAS	1.05 ± 0.54	0.57 ± 0.21	1.34 ± 0.30	1.71 ± 0.62	
	60 DAS			1.24 ± 0.24		
	78 DAS			1.27 ± 0.15		
	Grand Mean			1.260		
	SE			0.978		
	CV (%)			77.895		

Values represent mean ± SD. DAS = Days After Sowing, SE = Standard Error, CV = coefficient of variation, SD = standard deviation, cc = cubic centimeters, da = Dekar.

Discussion

The application of Mepiquat chloride at various stages did not show a significant impact on fiber yield. This might be attributed by effectiveness of Mepiquat chloride on cultural practices and environmental conditions and geographical factors as reported by Samples et al. (2015). Spraying of higher dose (80 cc/da) of MC at 60 DAS resulted in highest fiber yield. The highest fiber yield with high dose of Mepiquat chloride might be attributed to increased inhibition of gibberellin synthesis, highest number of branches, leaf area index, number of leaves, surface leaf area, number of bolls at reproductive and harvest. The similar results of increasing yield with higher dose were reported by earlier researchers (Priyadarshini et al. 2023; Priyanka et al. 2021; Patel et al. 2021; Singh et al. 2017; Khetre et al. 2018).

The decline in fiber yield (360.32 kg/ha) with 40 + 40 cc/da at 78 DAS could be attributed to reduced chlorophyll synthesis in plants for carbon assimilation, carbohydrate synthesis, protein and sugar formation. This finding aligns with previous studies (Sravanthi et al. 2022; Singh et al. 2017; Çopur et al. 2010) that highlighted the effect of early leaf defoliation from late application of Mepiquat chloride, leading to adversely effects on all agronomic characters of the plant.

In our study, each variety exhibited slightly different significant responses to the application of Mepiquat chloride on fiber yield. The differences could be ascribed to heterogeneity in plants chlorophyll synthesis for carbon assimilation, carbohydrate synthesis, protein and sugar formation. The genotypic discrepancy in response to Mepiquat chloride application had been documented by prior researchers (Sravanthi et al. 2022; Vistro et al. 2017; Singh et al. 2017; Verhalen et al. 2003).

Fiber color is among the vital criterion for classifying cotton into different grades based on Nickerson and Hunter. The level of Reflectance (Rd) and the degree of yellowness (+b are the two parameters quantifying color grade of cotton samples in the High-Volume Instrument (HVI) classing system (Anon, 2014). Reflectance indicates the brightness or whiteness of the cotton fibers and yellowness reflects the degree of color pigmentation. Color brightness values range from +40 (matt/darker) to +85 (lighter/brighter) and for yellowness, the values span from +4 (white/low +b) to +18 (yellower/high +b) (Watts et al. 2014). Results from our study revealed that Rd values were within the higher range (bright) with the control in the Sezener variety while Rd were in the low range (dark) with control in the Selin variety. Yellowness was higher for 40 + 40 cc/da at 60 DAS in the Sezener variety than 40 + 40 cc/da at 60 DAS in the Selin variety (Table 5); nevertheless, all values still aligned in the yellow range. Working with cotton, Priyanka et al. (2022) reported similar results, emphasizing that the application of plant growth regulators does not have any significant effect on quality parameters.

When averaged across varieties and application timing, the interaction shown significant effects on

yellowness (+b) (Table 1). Applying Mepiquat chloride at 60 DAS decreased fiber yellowness in Selin but significantly increased it in Sezener, indicating a variety-specific response to timing of application. This differential effect advocates varietal biochemical or structural mechanisms influencing pigment accumulation in fibers. Despite significant effects, differences in yellowness (+b) among varieties and timing were minimal; ranging from light yellow to yellow (data not provided). Overall, the Mepiquat chloride (MC) doses, timing and varieties had slight effect on cotton fiber color. Similar results regarding the application of MC at different times to cotton varieties on fiber quality attributes were reported by Murtza et al. (2022), Çınar and Ünay, (2021), and Khanzada and Khanzada (2019). Other scientists have associated fiber color with environmental growth conditions, specifically, soil type, rainfall, frost, grass, cotton leaf, extreme relative humidity, insects and fungi activity, as well as management practices such as storage conditions and planting dates (Yaşar and Karademir 2021; Kassambara et al. 2019; Bradow and Davidonis, 2000; Allen et al. 1995).

Trash refers to the amount of non-lint materials in cotton, such as leaves, barks, burs, and other impurities like dust and soil derived from the cotton fiber. Trash quantity is analyzed from scanning the surface of the cotton sample with a digital camera, followed by calculation of the trash count and the area it covers (Anon, 2014). Trash content within cotton lint is graded between 0 and 1.6% to avoid fabric defects, number of dockage and breakage in the yarn (Watts et al. 2014). In our findings, the highest trash area was recorded for the treatment of 40 + 40 cc/da at 60 days after sowing (DAS) in the Selin variety, compared to the treatment of 40 cc/da at 60 DAS in the same variety (Table 6). This indicates that spraying of MC at different intervals led to lint with lowest grades of cleanliness (dirty); while a single application yielded lint of higher cleanliness grades. Trash levels in cotton, when averaged across application times and within different varieties, did not show significant effect, as all the measured values remained within a dockage free. This might be due to trash content is a function of harvesting technique, microbial and insect activities, storage conditions, and weather parameters (temperature, rain and humidity) (Bennett et al. 2010). However, the Selin Variety exhibited a greater presence of non-lint material compared to the Sezener variety, this might be attributed to its higher above-ground biomass content than the latter variety.

Conclusions

The results indicated that application of reduced doses of MC at different times lowered the yield and quality-related components. Mepiquat Chloride application at a higher dose (80 cc/da) revealed greater performance compared to lower doses. Besides, the early application of MC as 40 cc/da at squaring (60 DAS), predominantly enhanced the cleanliness of cotton fiber compared to the alternating of 40 +40 cc/da at various stage. Furthermore, yellowness (+b) for all Mc doses and their application time aligns within the yellow range for cotton fibers, signifying that these differences are unlikely to influence net returns. Considering the financial perspective, relying solely on MC application may end up with economic losses. This study was conducted in a single location and year; thus, the results should be validated under diverse agroecological zones to enhance yield and quality parameters, ultimately maximizing monetary returns.

Conflict of Interest

The authors declare that for this manuscript, they possess no existing financial or familiar personal conflict of interest.

Author Contributions Statement

M.M.: Conceptualization, methodology, validation, formal analysis, investigation, data curation, writing—original draft, writing—review and editing, visualization, project administration.

O.K.: Conceptualization, data curation, formal analysis, investigation, methodology, project administration, supervision, validation, visualization, resources, writing—review and editing, funding acquisition.

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References

Allen, S. J., Auer, P. D. & Pailthorpe, M. T. (1995). Microbial damage to cotton. *Textile Research Journal*, 65, 379–385. doi:10.1177/004051759506500702.

Anonymous, (2014). Uster HVI 1000 Application Handbook, USTER Technologies AG, Switzerland. 2(1), 4-29.

Barut, H., Şimşek, T., Irmak, S., Sevilmiş, U. & Aykanat, S. (2017). The Effect of Different Zinc Application Methods on Yield and Grain Zinc Concentration of Bread Wheat Varieties. *Turkish Journal of Agriculture - Food Science and Technology*, 5(8), 898-907.

Bennett, B.K., Misra, S.K. & Richardson, J. (2010). A determination of cotton market price and premiums required to justify more lint cleaning in the gin plant. *Journal of Cotton Science*, 14, 199-204.

Boydak, Ç., Kara, O., Arslan, R., Çil, A. N., Çil, A., Barut, H. & Irmak, S. (2019). Effects of Different Zinc and Iron Doses on Yield and Some Yield Components of NC-7 Peanut (*Arachis hypogaea* L.). *Ziraat Fakültesi Dergisi*, 14(2), 134-142.

Bradow, J. M. & Davidonis G. H. (2000). Quantitation of fiber quality and the cotton production-processing interface: A physiologist's perspective. *Journal of Cotton Science*, 4, 34-64.

Çelik, S. (2023). Assessing Drought Tolerance in a Large Number of Upland Cotton Plants (Gossypium hirsutum L.) under Different Irrigation Regimes at the Seedling Stage. Life, 1-18.

Chia, L. (2018). What are the differences between Mepiquat Chloride and Chlormequat Chloride. Plant Hormones. https://www.plantgrowthhormones.com/info/. [Accessed on March 8, 2024].

Çinar, V. M. & Ünay, A. (2021). Response to Early Treatment of Chlormequat Chloride in Cotton (Gossypium hirsutum L.). Adü Ziraat Dergisi, 18(1), 127-131.

Collins, G. D., Edmisten, K. L., Wells, R. & Whitaker, J. R. (2017). The effects of mepiquat chloride applied to cotton at early bloom and physiological cutout. *Journal of Cotton Science*, 21(3), 183-189.

Çopur, O., Demirel, U. & Karakuş, M. (2010). Effects of several Plant Growth Regulators on the Yield and Fiber Quality of Cotton (*Gossypium hirsutum* L.). *Notulae Botanicae Horti Agrobotanici Cluj-Napoca*, 38(3), 104-110.

Devlet, A. (2021). Modern agriculture and challenges. *Frontiers in Life Sciences and Related Technologies*, 2(1), 21-29.

Dewdney, J.C., Yapp, M. E., Sardarian, R. & Tompkinson, G., (2024). Turkey. https://www.britannica.com/place/Turkey. [Accessed on March 1,2024].

Echer, F. R. & Rosolem, C. A. (2012). Plant Growth Regulator Losses in Cotton as Affected by Adjuvants and Rain. *Ciência Rural*, 42(12), 2138-2144.

European Commission, (2020). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Commission Staff Working Document. Turkey 2020 Report, Brussels Erişim adresi https://neighbourhood-enlargement.ec.europa.eu/system/files/2020-10/turkey_report_2020.pdf

Gomez, K. A. & Gomez, A. A. (1984). Statistical procedure for agricultural research. 2nd edition, John Wiley and Sons Co, New York. 680pp.

Husein, H. H., Bäumler, R., Lucke, B. & Sahwan, W. (2024). Black Soils in the Eastern Mediterranean: Genesis and Properties. Geographies, 4, 168–181.

ICAC, (International Cotton Advisory Committee (2022). Cotton This Month. Erişim adresi https://www.icac.org/Content/PublicationsPdf%20Files/c2e2b3f4_f2c3_48b7_834b_eb5e3e071695/CTM_2022_02_01.pdf.pdf

Ikram, M., Rehamn, H. U., Soysal, S., Aamir, M., Islam, M. S., Kumari, A. & Sabagh, A. E. (2022). Impact of climate change on cotton growth and yield. In: Cotton production under abiotic stress. Emine Karademir, Cetin Karademir (eds), iksad publishing house. 5 – 21.

Illarionova, K., Grigoryev, S. & Asfondiarova, I. (2019). HVI in implementation of internet technologies for providing quality of textile articles. IOP Conf. Series:

Materials Science and Engineering. 497. doi:10.1088/1757-899X/497/1/012110.

Jia, Y., Yang, B., Han, Y., Wang, G., Su, T., Li, X., Lei, Y., Zhi, X., Xiong, S., Xin, M., Li, Y. & Feng, L. (2024). Enhanced Cotton Yield and Fiber Quality by Optimizing Irrigation Amount and Frequency in Arid Areas of Northwest China. *Agronomy*, 1-15.

Kassambara, E. M., Sissoko, S., Diawara, M. O., Teme, N. & Yattara, A. A. (2019). Planting Date Effect on Yield and Fiber Properties in Some Cultivars and Promising Crosses of Cotton (*Gossypium hirsutum* L.) in Mali. *Journal of Bioanalysis & Biostatistics*, 2(1), 1-7.

Kemerait, B. (2021). Cotton disease and nematode management: 2021 updates. In P. Roberts & C. Hand (Eds.), 2021 Georgia Cotton Production Guide (Publication No. 124-1, pp. 110–132). University of Georgia Cooperative Extension. Erişim adresi: https://extension.uga.edu/publications/detail.html?number=AP124-1

Khanzada, B. & Khanzada, K.K. (2019). Effect of plant growth regulators on the lint quality of cotton parameters. *International Journal of Zoology Studies*, 4, 24–26.

Khetre, O. S., Shinde, V. S., Asewar, B. V. & Mirza, I. A. B. (2018). Response of growth and yield of Bt cotton to planting densities as influenced by growth regulators. *International Journal of Chemical Studies*, 6(4), 485- 488.

Kılınçoğlu, N., Cevheri, C. İ., Cevheri, C. & Yüsra, N. H. Y. (2021). Effects of exogenous glycine betaine application on some physiological and biochemical properties of cotton (*G. hirsutum* L.) plants grown in different drought levels. *International Journal of Agriculture, Environment and Food Sciences*, 5(4), 689-700.

Kulvir, S., Pankaj, R. & Singh, K. (2015). Dose and time dependent efficacy alteration of different defoliants on seed cotton yield. *Journal of Environmental Biology*, 36, 891-895.

Liu, J., Wang, C., Li, H., Gao, Y., Yang, Y. & Lu, Y. (2023). Bottom-Up Effects of Drought-Stressed Cotton Plants on Performance and Feeding Behavior of *Aphis gossypii*. *Plants*, 1-16.

Murtza, K., Ishfaq, M., Akbar, N., Hussain, S., Anjum, S. A., Bukhari, N. A., AlGarawi, A. M. & Hatamleh, A. A. (2022). Effect of Mepiquat Chloride on Phenology, Yield and Quality of Cotton as a Function of Application Time Using Different Sowing Techniques. *Agronomy*, 1-12.

NIC (2020). Appendix B: International Organizations and Groups". The World Factbook. Central Intelligence Agency. Archived from the original on 9 April 2008. [Accessed on March 4, 2024].

Ozudogru, T. (2021). Cotton Production Economy in the World and Türkiye. *Textile and Engineer*, 28, 122, 149-161.

Patel, B. R., Chaudhary, P. P., Chaudhary, M. M. & Reddy, T. V. (2021). Effect of mepiquat chloride on yield attributes, yield and economics of Bt cotton under high density planting system. *Pharma Innovation International Journal*, 10(12), 1503-1507.

Priyadarshini, M., Kumar, G. S., Nagabhushanam, U. & Reddy, K. P. C. (2023). Effect of Different Doses and Scheduling Time of Plant Growth Regulators and Defoliants on Growth and Yield of Cotton (*Gossypium hirsutum* L.) under High Density Planting System. *International Journal of Environment and Climate Change*, 13(10), 2252-2260.

Priyanka, K., Rekha, M. S., Lakshman, K. & Rao, C. S. (2021). Influence of plant growth regulators in cotton under HDPS. *The Pharma Innovation Journal*, 10(7), 329-331.

Priyanka, K., Rekha, M. S., Lakshman, K. & Rao, C. S. (2022). Effect of plant growth regulators on growth and yield of HDPS cotton. *Journal of Cotton Research and Development*, 36(1), 65-70.

Rehman, T., Tabassum, B., Yousaf, S., Sarwar, G. & Qaisar, U. (2022). Consequences of Drought Stress Encountered During Seedling Stage on Physiology and Yield of Cultivated Cotton. *Frontier Plant Science*, 13, 1-11.

Rosolem, C. A., Oosterhuis, D. M. & Souza, F. S. D. (2013). Cotton response to mepiquat chloride and temperature. *Scientia Agricola*, 70, 82-87.

Samples, C., Dodds, D. M., Catchot, A., Golden, B., Gore, J. & Varco, J. (2015). Determining optimum plant growth regulator application rates in response to fruiting structure and flower bud removal. *Journal of Cotton Science*, 19(3), 359–367.

Sawan, Z. M. (2017). Plant Density; Plant Growth Retardants: Its Direct and Residual Effects on Cotton Yield and Fiber Properties. *International Journal of Environmental Sciences & Natural Resources*, 5(3), 555 - 663.

Sen, B., Topcu, S., Türkeş, M., Sen, B. & Warner, J. F. (2012). Projecting climate change, drought conditions and crop productivity in Turkey. *Climate Research*, 52(175), 175-191.

Sezener, V., Basal, H., Peynircioglu, C., Gurbuz, T. & Kizilkaya, K. (2015). Screening of cotton cultivars for drought tolerance under field conditions. *Turkish Journal of Field Crops*, 20(2), 223-232.

Sezener, V. (2021). Cotton at a glance in Türkiye. In book: Cotton production under abiotic stress. Emine Karademir, Cetin Karademir (eds), iksad publishing house. 129 – 160.

Singh, K., Singh, H.P., Rathore, P., Singh, K. & Mishra, S. K. (2017). Manipulations of source sink relationships through mepiquat chloride for enhancing cotton productivity and monetary returns in north western India. *Journal of Cotton Research and Development*, 31(1), 62-68.

Sravanthi, S., Rekha, M. S., Venkateswarlu, B., Rao, C. S. & Jayalalitha, K. (2022). Effect of defoliants on percent defoliation and yield of American cotton (*Gossypium hirsutum*). *Research on Crops*, 23(2), 458-465.

Statista, (2022). Cotton Production by Country 2022 - World Population Review. Erişim adresi: https://worldpopulationreview.com/country-rankings/cotton-production-by-country.

Tokel, D., Dogan, I., Hocaoglu-Ozyigit, A. & Ozyigit, I. I. (2022). Cotton Agriculture in Turkey and Worldwide Economic Impacts of Turkish Cotton. *Journal of Natural Fibers*, 1-22.

Tokel, D., Genc, B. N. & Ozyigit, I. I. (2021). Economic impacts of Bt (*Bacillus thuringiensis*) cotton. *Journal of Natural Fibers*, 1–18.

USDA, (United States Department of Agriculture). (2022). Agricultural Outlook Forum. (In) The World and United States Cotton Outlook. James J; Stephen; Leslie M and Graham Soley (eds). Erişim adresi: https://www.usda.gov/oce/ag-outlook-forum.

Verhalen, L. M., Greenhagen, B. E. & Thacker, R. W. (2003). Lint Yield, Lint Percentage, and Fiber Quality Response in Bollgard, Roundup Ready, and Bollgard/Roundup Ready Cotton. The Journal of Cotton Science, 7, 23–38.

Vistro, R., Chachar, Q. I., Chachar, S. D., Chachar, N. A., Laghari, A., Vistro, S. & Kumbhar, I. (2017). Impact of Plant Growth Regulators on the Growth and Yield of Cotton. *International Journal of Agricultural Technology*, 13(3), 353-362.

Wang, L., Lin, M., Han, Z., Han, L., He, L. & Sun, W. (2024). Simulating the Effects of Drought Stress Timing and the Amount Irrigation on Cotton Yield Using the CSM-CROPGRO-Cotton Model. *Agronomy*, 1-21.

Watts, D.B., Runion, G.B., Nannenga, K.W.S. & Torbert, H.A. (2014). Enhanced-Efficiency Fertilizer Effects on Cotton Yield and Quality in the Coastal Plains. *Agronomy Journal*, 106(2), 745-752.

World Economic Outlook (WEO) Database (2023). GDP (current US$). Erişim adresi: data.worldbank.org & IMF.org

Yasar, S. & Karademir, E. (2021). Determination of the factors limiting cotton fiber quality in Turkey. *Journal of Applied Life Sciences and Environment*, 185, 85-99.

Zafara, S., Afzala, H., Ijaz, A., Mahmood, A., Ayub, A., Nayab, A., Hussaine, S., UL-Hussan, M., Sabir, M. A., Zulfiqar, U., Zulfiqar, F. & Moosaj, A. (2023). Cotton and drought stress: An updated overview for improving stress tolerance. *South African Journal of Botany*, 161, 258-268.