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Effects of trifloxysulfuron-sodium and fluometuron herbicides on cotton and cocklebur (*Xanthium strumarium* L.)

Trifloxysulfuron-sodium ve fluometuron herbisitlerinin pamuk ve domuz pıtrağı (*Xanthium strumarium* L.) üzerine etkileri

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A B S T R A C T

Cotton is an important industrial crop that is the natural raw material for many sectors such as textile, feed and oil industries. One of the factors affecting the yield and quality of cotton is weeds. Among these weeds, cocklebur (*Xanthium strumarium* L.) appears together with cotton and provides strong competition. In this study, field experiments were conducted at two different locations in 2020 to determine the efficacy of herbicides against cocklebur, which is a problem in cotton production, on yield elements in cotton and in cocklebur. The experiments were laid out according to the randomized block trial system with four replications. Different doses of the herbicides trifloxysulfuron sodium (TFS) (10, 15 and 20 g ha^{-1}) and fluometuron (FLM) (2, 2.5 and 3 l ha^{-1}) were used in the field experiments. As a result of the study, the effects of herbicide applications on cotton and cocklebur were evaluated on the 28th day in both sites. It was found that trifloxysulfuron- sodium was more than 90% effective in controlling cocklebur at different doses while fluometuron was found to be less effective at different doses. Regarding the effects of herbicide applications on cotton, trifloxysulfuron-sodium was found to cause no phytotoxicity at different dosages, while fluometuron showed phytotoxicity at different dosages. The highest cotton and fiber yields were obtained when 15 g ha^{-1} of trifloxysulfuron-sodium was applied. It was found that the effects of the applications on cotton fiber fineness, fiber length, and fiber strength were not significant.

INTRODUCTION

Cotton (*Gossypium hirsutum* L.), native to India, is an industrial plant of the mallow family (Malvaceae). In cotton processing, it is the basic material for ginning industry, for textile industry with its fiber, for oil and feed industry with its seeds and for paper industry with its linter. With these aspects, cotton becomes a strategic product in the world. However, with the growth of population and the increase of living standard, the demand for cotton is increasing day by day. For some countries, cotton has become an important economic product due to the high value it generates (Keskinkılıç 2014).

Cotton was grown on an area of 32.01 million hectares worldwide and about 24.6 million tonnes of the cotton lint were obtained in 2023. In countries that meet approximately 83% of the world's cotton production are China, India, Brazil, USA, Pakistan, Australia and Türkiye respectively. Türkiye ranks seventh in the world in cotton production, fifth in consumption and fourth in imports (Anonymous 2024). In addition, Türkiye produces the most efficient and highest quality cotton among countries that do not grow GM (Genetically Modified) cotton (Anonymous 2017). Cotton production in Türkiye is concentrated in the Aegean, Mediterranean, and Southeast Anatolia regions. Approximately 59% of cotton production in Türkiye occurs in the Southeast Anatolia region, 24% in the Aegean region, and 17% in the Mediterranean region (Anonymous 2023).

There are many factors that limit cotton production, and one of the most important factors is weeds (Arslan and Kitiş 2021). Weeds compete with plants for growth factors such as water, nutrients, and light, and as a result of this competition, they cause a decline in crop productivity and quality (Güncan 2016, Sathishkumar et al. 2021). The cotton crop is very sensitive at early growth stages where weed presence during the first 2 months of growth may reduce yield from 10% to 90% (Tariq et al. 2020). To prevent weed-caused yield loss in cotton, weed control generally needs to be carried out between the 1st and 2nd and 7th and 10th weeks after cotton emergence (Tursun et al. 2016). Moreover, weeds compete with cotton at the early stages, hindering its development and significantly reducing its yield if not controlled. In addition to direct yield losses, weeds such as field bindweed (*Convolvulus arvensis* L.), cocklebur (*Xanthium strumarium* L.), black nightshade (*Solanum nigrum* L.), jimsonweed (*Datura stramonium* L.), and green field foxtail (*Setaria viridis* (L.) P. Beauv.), which occur especially after irrigation in the late periods when the cotton plant opens its boll, adhere to the fibers of the cotton plant, making harvesting difficult and reducing quality (Boz and Doğan 2004, Özkil et al. 2019). Therefore, weed control is absolutely necessary for high quality and efficient cotton production (Güncan 2016). Cocklebur (*X. strumarium*), which causes significant yield losses in cotton production, is reported to be an important weed species to be controlled (Özaslan and Bükün 2013, Süer and Tursun 2024).

Cocklebur begins to emerge from the early stages of cotton and may reappear throughout the season after irrigation. Therefore, it is considered one of the most competitive weeds in cotton. It is stated that the presence of one cocklebur in a 9 m cotton row causes a yield loss of about 9% (Coble and Byrd 1992). In the critical period between the 2nd and 10th week after cotton emergence, it causes yield losses of 6-27%. Cocklebur also reduces cotton plant height and boll weight (Byrd and Coble 1991).

It is known that in Türkiye, weeds are hoed by hand or tractor and controlled by chemical means (Pala and Mennan 2018). However, mechanical control with hand or tractor hoe causes difficulties in weed control because of high costs and difficulties in providing labor, so growers prefer chemical control. In chemical control of cotton, herbicides are usually applied pre-emergence or post-emergence. Post-emergence herbicides are generally used to control grass weeds. Herbicides containing the active ingredient trifloxysulfuron sodium are available for broadleaf weed control, but this herbicide is not preferred by growers because it causes phytotoxicity in cotton, and mechanical control is reported to be used because there are not many other herbicide options (Basal et al. 2019). Since there is no hoeing in the late stages of cotton, the need for chemical control of cocklebur is also important (Pala and Mennan 2018).

Cocklebur is reported to be one of the densest and most widespread important weed species in the Southeastern Anatolia region of Türkiye, where cotton production is intensive (Arslan 2018, Özaslan and Bükün 2013, Süer and Tursun 2024). In this study, we aimed to investigate the effect of effective herbicide application against cocklebur on cotton yield and quality.

MATERIALS AND METHODS

Site description and experimental setup

Studies were conducted to evaluate the efficacy of herbicides containing 500 g L^{-1} fluometuron (FLM) and 75% trifloxysulfuron-sodium (TFS) active ingredients against cocklebur, which is a problem in cotton, on yield elements and cocklebur in cotton. In this regard, field experiments were conducted at two different locations during the 2020 cotton production season. The field experiments were established in the experimental field of GAP International Agricultural Research and Training Center Directorate (GAPUTAEM) (37°.56' N, 40°.15' E) on April 22, 2020 and in Elidolu village of Yenişehir, Diyarbakır, Türkiye (37°.58' N, 40°.13' E) on May 5, 2020. Soil samples (0-30 cm) were collected at the beginning of both experiments to determine various physical and chemical properties of the soil. While the soil structure of the experiment laid out in GAPUTAEM is loamy, that of Elidolu is clay loam. It was observed that the organic matter and salt content in the two trial areas where the study was carried out was low, the lime content was at a moderate level, the amount of P_2O_5 was low, the amount of K_2O was sufficient and the pH was alkaline. According to the soil analysis results, it was found that the amount of

Table 1. Soil characteristics of the experimental fields (0–30 cm soil depth)

	GAPUTAEM		Elidolu	
Soil characteristics	**Values**	**Properties**	**Values**	**Properties**
Texture (%)	72.5	Clayey	68.05	Clay-loam
Total salt (%)	0.023	Without salt	0.92	Without salt
pH	8.15	Alkaline	8.2	Alkaline
Lime-$CaCO_3$ (%)	7.31	Medium chalky	11.95	Medium chalky
P_2O_5 (mg kg^{-1})	1.49	Slightly	1.77	Little
K_2O (mg kg^{-1})	94.38	Sufficient	95.60	Sufficient
Organic matter (%)	0.96	Slightly	0.25	Slightly

organic matter in the soil in the GAPUTAEM trial area was higher than in the trial area in Elidolu (Table 1).

Local practices for cotton cultivation were used in preparing the soil for the experiments. The soil was plowed with a chisel, then with a disk harrow, and finally with a harrow to obtain a smooth seedbed. The cotton variety 'Stoneville 468' was sown with a four-row planter with a row spacing of 70 cm, and 8 cm between plant rows. Considering the results of soil analysis, 160 kg ha^{-1} of pure nitrogen (N) and 80 kg ha^{-1} of phosphorus (P) were applied, with half of the nitrogen and all of the phosphorus as 20-20 (N:P) blend fertilizer before sowing. The other half was administered before the first irrigation (approximately 40-45 days after sowing). Fields were irrigated as needed. The experiments in both field experiments were designed as a completely randomized block experiment with four replications. Each experimental plot was 24 m^2 (3 m x 8 m) and had four rows of cotton. To determine the effect (%) of herbicides on cocklebur, two randomly selected gravel plots (1 m^2) were established in each plot. According to the cotton cultivation technique, practices such as hoeing (hand and tractor hoe) and irrigation were uniformly applied in all plots. Cotton pest control was carried out according to the cotton cultivation technique.

Herbicide applications

Herbicide applications were made at GAPUTAEM on June 11, 2020, and at Elidolu on June 19, 2020. Different doses of the herbicides trifloxysulfuron-sodium (75%) and fluometuron (500 g l^{-1}) were applied when cocklebur had two to six leaves and at the six to eight leaf stage of cotton. In addition, the season-long weedy and weed-free control treatments were established in order to compare the efficacy of herbicide doses on cocklebur (Table 2). In weed-free control applications, weeds were periodically hoed with a hand hoe starting from cotton emergence.

Table 2. Herbicides and doses used in the experiment

Treatments	Application Time	Properties
75% Trifloxysulfuron-sodium	Post emergence	10 g ha^{-1}
75% Trifloxysulfuron-sodium	Post emergence	15 g ha^{-1}
75% Trifloxysulfuron-sodium	Post emergence	20 g ha^{-1}
500 g l^{-1} Fluometuron	Post emergence	2 l ha^{-1}
500 g l^{-1} Fluometuron	Post emergence	2.5 l ha^{-1}
500 g l^{-1} Fluometuron	Post emergence	3 l ha^{-1}

Herbicide was applied with a gasoline backpack sprayer (Oleo-Mac Sp 126 brand) with 6 fan beams (Teejet brand) boom type, 2 m working width, and 3 atmospheres of pressure. 300 l ha^{-1} of water was used for spraying.

Effect of herbicide applications on cotton and cocklebur

The rate of phytotoxicity (%) caused by the application of different doses to cotton was evaluated using the 0-100 scale, by selecting ten cotton plants randomly from the plots, on the 7th, 14th, 21st, and 28th day after herbicide treatment (DAHT).

In determining the effect (%) of herbicide applications on cocklebur, the effect of cocklebur on a fixed area of 1 m^2 and the cocklebur on which the herbicide application was made were compared with the visual effects on days 7, 14, 21, and 28 DAHT. Herbicide effects (%) were determined visually according to the 0-100 scale (Uygur 1991). In these ratings, 0 = completely healthy, while 100 = dead plant.

Determination of the effects of herbicide applications on the dry weight (g m^{-2}) of cocklebur

Cocklebur plants on the solid plots established in the experimental plots were harvested from the ground 28 DAHT and their dry weight was determined after they were dried in an oven at 105 °C for 24 h (Süer et al. 2024).

Effect of herbicide applications on cotton yield, ginning efficiency and fiber yield

Cotton unseed in the middle two rows of each plot in the applications studied in the experiment was harvested by hand, and cotton yield (kg ha^{-1}), ginning efficiency (GE: %), and cotton fiber yield (CFY: kg ha^{-1}) were calculated.

GE :[Fiber cotton (g)/(Cottonseed (g) + Cotton fiber (g))] x100

Cotton fiber yield (kg ha^{-1}): (Cotton unseed yield x Ginning efficiency) /100

Determination of the effect of herbicide applications on fiber quality characteristics of cotton

Cotton quality analyses were carried out at the GAP International Agricultural Research and Education Center Directorate Cotton Fiber Testing and Analysis Laboratory in Diyarbakır, Türkiye. Analyses were carried out with the HVI 1000 instrument. The effects of different herbicide doses on fiber quality characteristics such as fiber fineness, fiber length, and fiber strength in cotton were determined.

Statistical analysis

In the field experiments, data were evaluated using the IBM SPSS 25 statistical package program in studies to determine the effects of herbicide applications on cocklebur dry weight (g m^{-2}), cotton yield (kg ha^{-1}), ginning yield (%), fiber yield (kg ha^{-1}), and fiber quality traits. Data obtained from the studies were subjected to GLM model One Way (ANOVA) variance analysis, and the difference between the applications was determined by Duncan's multiple comparison test according to the significance level of P≤0.05.

RESULTS AND DISCUSSION

Herbicide applications on cotton and cocklebur

In both field experiments conducted in GAPUTAEM and Elidolu villages, it was found that different dose applications of the herbicide containing the active ingredient trifloxysulfuron-sodium (TFS) did not cause phytotoxicity in cotton after the first count on day 7 (Table 3). Similar to our results, Özkil and Üremiş (2021) reported in their study on the control of *Ipomoea triloba* in Mediterranean cotton fields that the application of TFS caused a temporary reduction in growth in cotton, but the symptoms disappeared

Table 3. Phytotoxicity rate (%) caused by herbicides on cotton

GAPUTEAM				
Treatments	**7th day**	**14th day**	**21th day**	**28th day**
TFS (10 g ha^{-1})	0.5±0.5c	0.0±0.0c	0.0±0.0b	0.0±0.0c
TFS (15 g ha^{-1})	4.2±0.4c	2.0±0.8c	0.0±0.0b	0.0±0.0c
TFS (20 g ha^{-1})	5.2±0.4c	3.5±0.6c	0.0±0.0b	0.0±0.0c
FLM (2 l ha^{-1})	18.2±2.8b	14.5±1.7b	6.5±2.8a	1.7±0.8b
FLM (2.5 l ha^{-1})	23.7±3.1a	22.5±2.1a	9.7±3.0a	4.5±0.2a
FLM (3 l ha^{-1})	26.5±1.1a	23.7±1.7a	9.7±4.2a	5.0±0.8a
Elidolu				
Treatments	**7th day**	**14th day**	**21th day**	**28th day**
TFS (10 g ha^{-1})	0.0±0.0b	0.0±0.0b	0.0±0.0c	0.0±0.0d
TFS (15 g ha^{-1})	0.0±0.0b	0.0±0.0b	0.0±0.0c	0.0±0.0d
TFS (20 g ha^{-1})	0.5±0.5b	0.0±0.0b	0.0±0.0c	0.0±0.0d
FLM (2 l ha^{-1})	10.0±0.0a	8.0±1.4a	4.2±1.2b	3.0±0.8c
FLM (2.5 l ha^{-1})	10.5±0.8a	7.7±1.0a	7.0±0.7a	6.5±0.2b
FLM (3 l ha^{-1})	11.0±1.0a	7.7±1.2a	9.2±1.2a	10.7±0.8a

[*] TFS: 75% trifloxysulfuron-sodium, FLM: 500 g l^{-1} fluometuron. Each column was evaluated within itself, and the values marked with the same letter are statistically the same (P > 0.05)

with time. Richardson et al. (2007a) found that 7 days after post-emergence application of 3.8 g ha^{-1} and 15 g ha^{-1} of the active herbicide TFS to weeds in cotton, phytotoxicity ranged from 19-22%, but at 28 days after application, this rate decreased to 5%-12%. In our study, it was found that no phytotoxicity was observed in cotton plant after 28 days when the herbicide containing the active ingredient TFS was applied at a dose of 15 g ha^{-1}. This difference may be due to the experiments being conducted under different ecological conditions.

It was found that phytotoxicity was observed at all doses of the herbicide containing the active ingredient fluometuron (FLM) at different doses, but decreased after 28 days of application. Similar to our study, Chachalis and Galanis (2007) found that phytotoxicity rate in cotton was less than 4% after 3 weeks when different doses of acetochlor (1.68, 2.10, 2.52 and 2.94 kg ha^{-1}) were applied in combination with FLM dose (1.75 kg ha^{-1}) against weeds in cotton.

It was determined that the effect of TFS herbicide on cocklebur was more than 90% in 28 days in both experimental areas (GAPUTAEM and Elidolu) (Table 4). The study found that the difference between the effects of different TFS doses on cocklebur was insignificant. In studies similar to our results, Richardson et al. (2007a) found that the effects of pre-emergence and post-emergence herbicides applied for weed control in cotton ranged from 96% to 98% of the same herbicide on cocklebur in cotton. In another study, Rezakhanlou et al. (2014) found that the highest efficacy of the applied TFS herbicide in controlling cocklebur in cotton was at doses of 16 and 19 g ha^{-1} and the difference between the two doses was insignificant.

The efficacy of FLM herbicide proved to be quite low compared to TFS. The highest efficacy of FLM on cocklebur was determined after 28 days with 55.5% and 46.0%, respectively. Kaloumenos et al. (2005) evaluated the effects of pre-sowing, pre-emergence, and post-emergence herbicide applications on cotton and weeds in cotton fields in Greece and reported that fluometuron failed to control cocklebur, as occurred in our experiments.

Herbicide applications on the dry weight (g m^{-2}) of cocklebur

The highest dry weight value for herbicide applications was obtained from weedy control plots in GAPUTAEM and Elidolu with 607.0 g m^{-2} and 262.7 g m^{-2}, respectively. The lowest dry weight value was obtained at TFS doses of 10 and 15 g ha^{-1} in both experimental plots. In both field experiments, it was found that herbicide applications of TFS and FLM resulted in a significant decrease in dry weight compared to weedy control plots (Table 5).

In the experiments at both sites (GAPUTAEM and Elidolu), it was determined that the application of 10 and 15 g ha^{-1} of the herbicide TFS had an effect of over 90% on the dry weight of cocklebur, compared to weedy control plots. Rezakhanlou et al. (2014) found that the application of TFS at a dose of 15 g ha^{-1} had an effect of over 90% compared to the weedy control in controlling cocklebur. In addition,

Table 4. Effect of different dosage applications of trifloxysulfuron-sodium (TFS) and fluometuron (FLM) on cocklebur (%)

GAPUTEAM				
Treatments	**7th day**	**14th day**	**21th day**	**28th day**
TFS (10 g ha^{-1})	74.5±6.4a	89.5±2.2a	91.5±1.5a	90.2±4.1a
TFS (15 g ha^{-1})	73.2±4.4a	87.0±1.7a	90.2±1.7a	90.0±0.9a
TFS (20 g ha^{-1})	78.2±2.9a	87.0±1.2a	90.2±1.2a	92.0±1.2a
FLM (2 l ha^{-1})	36.2±5.2b	39.5±4.8b	33.5±3.7c	22.7±5.2c
FLM (2.5 l ha^{-1})	39.0±5.4b	53.2±3.6b	64.0±8.8b	55.5±1.5b
FLM (3 l ha^{-1})	45.7±12.0b	52.0±8.8b	51.7±8.4b	48.7±9.2b
Elidolu				
Treatments	**7th day**	**14th day**	**21th day**	**28th day**
TFS (10 g ha^{-1})	82.7±4.7a	90.7±4.3a	92.0±1.7a	93.0±1.2a
TFS (15 g ha^{-1})	89.7±1.3a	91.0±1.1a	92.5±0.8a	93.5±1.5a
TFS (20 g ha^{-1})	89.7±1.0a	91.2±1.4a	94.2±0.7a	94.2±0.7a
FLM (2 l ha^{-1})	30.7±1.1c	27.5±2.6c	22.7±3.4c	26.2±5.5c
FLM (2.5 l ha^{-1})	29.7±1.8c	31.0±3.2c	27.5±2.7c	30.0±4.0c
FLM (3 l ha^{-1})	42.0±5.6b	41.7±3.8b	42.5±5.4b	46.0±7.6b

[*] TFS: 75% trifloxysulfuron-sodium, FLM: 500 g l^{-1} fluometuron. Each column was evaluated within itself, and the values marked with the same letter are statistically the same ($P > 0.05$)

Table 5. Herbicide applications on the dry weight (g m^{-2}) of cocklebur

	GAPUTAEM		Elidolu	
Treatments	**Dry weight (g m^{-2})**	**Impact rate (%)**	**Dry weight (g m^{-2})**	**Impact rate (%)**
TFS (10 g ha^{-1})	56.2±11.5c	90.7	15.7±6.3c	94.0
TFS (15 g ha^{-1})	78.0±20.2bc	87.1	17.7±2.6bc	93.2
TFS (20 g ha^{-1})	77.5±14.4bc	87.2	32.2±7.4b	87.7
FLM (2 l ha^{-1})	136.0±16.9b	77.5	30.0±9.2bc	88.5
FLM (2.5 l ha^{-1})	81.0±14.4bc	86.6	30.7±9.3bc	88.3
FLM (3 l ha^{-1})	66.0±22.6bc	89.1	31.7±3.3b	87.9
Weedy control	607.0±105.0a	-	262.7±36.8a	-

[*] TFS: 75% trifloxysulfuron-sodium, FLM: 500 g l-1 fluometuron. Each column was evaluated within itself, and the values marked with the same letter are statistically the same (P > 0.05)

in the study of Özkil and Üremiş (2021) using different herbicides to control *Ipomoea triloba* in cotton, it was found that the application of TFS at a dose of 15 g ha^{-1} (two applications 2 weeks apart) had an effect on dry weight of *I. triloba* between 92% and 97%. There are similarities between the results obtained and our study.

Herbicide applications on cotton yield, ginning efficiency and fiber yield

In the experiments, the highest seed cotton yield was obtained from season long weed-free control plots in GAPUTAEM and Elidolu with 5022 kg ha^{-1} and 3015 kg ha^{-1}, respectively. In TFS herbicide, the highest yield was obtained with a dose of 15 g ha^{-1} (Table 6). When the yields from the two experiments were compared, it was found that the cotton yield of GAPUTAEM was higher than that of Elidolu. This is thought to be due to the soil structure, organic matter content, and slope of the land where the experiments were conducted.

In experiments, the highest cotton and fiber yields were obtained after weed-free control plots with the 15 g ha^{-1} dose of TFS. Yield at the 20 g ha^{-1} dose is believed to be lower than at the 15 g ha^{-1} dose, possibly due to the herbicide causing phototoxicity in cotton (Table 6). Similar to our results, Rezakhanlou et al. (2014) reported that TFS at a dose of 16 g ha^{-1} gave the highest yield in cotton and that performance at a dose of 19 g ha^{-1} was lower than at a dose of 16 g ha^{-1}, which may be due to phytotoxicity in cotton. The application of FLM herbicides was found to be 3 l ha^{-1} after the yield of the weed-free plot. Similar results were obtained for fiber yield (Table 6). For herbicide application against weeds in cotton, Şahin et al. (2020) reported that the highest cotton yield in cotton was obtained from weed-free control plots and this application followed the application of cycloxydim+triloxsulfuron sodium. In our study, it was found that 2 l ha^{-1} and 3 l ha^{-1} FLM produced higher cotton seed and fiber yield compared to weedy control. Similar to our results, Chachalis and Galanis (2007) found in their study that mixing acetochlor with FLM provided benefits in cotton fiber yield.

Herbicide applications on fiber quality characteristics of cotton

In both field experiments, it was found that the difference between the effects of the treatments on cotton fiber fineness, fiber length, and fiber strength was not statistically significant. The best results in terms of cotton fiber fineness were obtained in GAPUTAEM with the 15 g ha^{-1} application dose of TFS and in the weed-free control plot in Elidolu. The highest fiber length was obtained with a TFS dose of 20 g ha^{-1} in GAPUTAEM and in the weed-free control plot in Elidolu (Table 7).

Table 7.

The quality characteristics of cotton fibers are important in the textile industry. Cotton fibers with the highest fiber strength are preferred in the yarn industry. As a result of the study, it was found that the application of TFS and FLM herbicides had no effect on the quality characteristics of cotton fibers. In parallel with our results, some studies reported that TFS applications have no effect on cotton fiber quality characteristics compared to other applications (Richardson et al. 2003, Richardson et al. 2004, Richardson et al. 2007a, 2007b). In contrast to our study, Şahin et al. (2020) found that cotton fiber quality characteristics were affected by herbicide applications, with the best results obtained from weed-free control plots, and this result was followed by cycloxydim+triloxsulfuron sodium and clethodim+triloxsulfuron sodium applications. The differences between the results we obtained in this study were due to the different ecological conditions of the experimental plots and the differences in the cotton varieties used in the experiments.

Table 6. Herbicide applications on cotton yield, ginning efficiency (GE) and fiber yield (FY)

GAPUTEAM			
Treatments	**Yield (kg ha^{-1})**	**GE (%)**	**FY (kg ha^{-1})**
TFS (10 g ha^{-1})	3930±42.2b	44.0±0.5a	1727±17.9bc
TFS (15 g ha^{-1})	4875±32.1a	44.8±0.4a	2185±14.5ab
TFS (20 g ha^{-1})	3907±12.1b	44.7±0.4a	1748±7.1bc
FLM (2 l ha^{-1})	3017±13.7c	44.7±0.8a	1346±4.9c
FLM (2.5 l ha^{-1})	3870±16.5b	44.3±0.5a	1711±6.4c
FLM (3 l ha^{-1})	4040±37.3b	45.1±0.3a	1822±15.9cb
Weedy control	3187±19.5bc	43.9±0.3a	1622±24.5c
Weed-free control	5022±28.1a	44.4±0.3a	2231±13.2a
Elidolu			
Treatments	**Yield (kg ha^{-1})**	**GE (%)**	**FY (kg ha^{-1})**
TFS (10 g ha^{-1})	2617±8.9bc	44.6±0.4a	1164±7.5ab
TFS (15 g ha^{-1})	2885±11.6ab	44.4±0.5a	1276±4.4ab
TFS (20 g ha^{-1})	2712±14.1abc	44.4±0.2a	1207±5.6ab
FLM (2 l ha^{-1})	2475±18.4c	43.8±0.5a	1086±4.2b
FLM (2.5 l ha^{-1})	2437±9.4c	45.0±0.4a	1130±3.7b
FLM (3 l ha^{-1})	2537±3.5bc	44.5±0.8a	1121±6.0b
Weedy control	1790±6.7d	44.1±0.7a	791±3.7c
Weed-free control	3015±9.2a	44.1±0.2a	1331±10.3a

[*] TFS: 75% trifloxysulfuron-sodium, FLM: 500 g l-1 fluometuron. Each column was evaluated within itself, and the values marked with the same letter are statistically the same (P > 0.05)

Table 7. Herbicide applications on fiber quality characteristics of cotton

	GAPUTAEM			Elidolu		
Treatments	**Fiber fineness (mic)**	**Fiber length (mm)**	**Fiber Strength (g/tex)**	**Fiber fineness (mic)**	**Fiber length (mm)**	**Fiber Strength (g/tex)**
TFS (10 g ha^{-1})	4.7±0.0a	29.9±0.2a	35.0±0.8a	4.9±0.1a	28.7±0.7a	33.9±0.6a
TFS (15 g ha^{-1})	5.0±0.1a	28.7±0.5a	33.7±0.5a	4.9±0.0a	29.0±0.4a	34.2±0.7a
TFS (20 g ha^{-1})	4.7±0.1a	30.3±0.6a	33.4±0.5a	4.8±0.0a	28.5±0.4a	33.8±0.6a
FLM (2 l ha^{-1})	4.7±0.0a	29.5±0.1a	34.9±0.4a	4.7±0.0a	28.8±0.2a	33.4±0.2a
FLM (2.5 l ha^{-1})	4.7±0.0a	29.3±0.6a	35.6±1.0a	4.9±0.0a	28.9±0.2a	34.7±0.4a
FLM (3 l ha^{-1})	4.7±0.0a	30.0±0.3a	34.9±1.0a	4.7±0.1a	28.6±0.8a	32.9±1.5a
Weedy control	4.6±0.2a	29.8±0.2a	33.3±0.5a	4.9±0.0a	28.9±0.3a	34.5±0.9a
Weed-free control	4.9±0.1a	30.0±0.4a	35.2±1.0a	5.0±0.0a	29.4±0.3a	35.0±0.5a

[*] TFS: 75% trifloxysulfuron-sodium, FLM: 500 g l-1 fluometuron. Each column was evaluated within itself, and the values marked with the same letter are statistically the same (P > 0.05)

In both experiments, it was determined that trifloxysulfuron-sodium at 10, 15 and 20 g ha^{-1} did not cause any phytotoxicity on cotton and the effect on cocklebur was over 90%. In the field experiments conducted the highest cotton yields, fiber yields, and ginning efficiencies were obtained at an application dose of 15 g ha^{-1} of TFS herbicide. In both field experiments, it was found that the cotton plant became phytotoxic with the application of different doses of the herbicide containing the active ingredient FLM.

Despite the use of pre-sowing and pre-emergence herbicides and cultural and mechanical control of cocklebur in cotton growing areas, adequate control is not possible. Therefore, post-emergence herbicide applications should be combined with these control methods. In post-emergence applications, the active ingredients used to control broadleaf weeds such as cocklebur are limited. In addition, weeds reemerge after irrigation with seed banks present in the soil, making them difficult to control. Therefore, field preparation, irrigation, tillage, hoeing, and chemical control must be timely and appropriate. As a result of the study, it was found that TFS herbicide cocklebur controlled and no phytotoxicity was observed on cotton plant. Therefore, it is important to consider the active ingredient and application dose in the fight against cocklebur. In this way, unnecessary and excessive use of herbicides in cotton growing areas will be prevented and growers will be able to obtain both high quality and productive cotton.

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Author’s Contributions

Authors declare the contribution of the authors is equal.

Statement of Conflict of Interest

The author declared no conflict of interest.

ÖZET

Pamuk işlenmesi bakımından tekstil, yem ve yağ sanayisi gibi birçok sektörün doğal hammaddesi olan önemli bir endüstri bitkisidir. Pamukta verim ve kaliteyi etkileyen faktörlerden biri de yabancı otlardır. Bu yabancı otlardan domuz pıtrağı (*Xanthium strumarium* L.) pamuk ile beraber çıkış yaparak yüksek bir rekabet oluşturur. Bu çalışmada, pamuk üretiminde sorun olan domuz pıtrağına karşı kullanılan herbisitlerin pamukta verim unsurları ve domuz pıtrağına olan etkinliğini belirlemek amacıyla 2020 yılında iki ayrı lokasyonda tarla denemeleri kurulmuştur. Denemeler, tesadüf blokları deneme desenine göre 4 tekerrürlü olacak şekilde yapılmıştır. Tarla denemelerinde trifloxysulfuron-sodium (TFS) (10, 15 ve 20 g ha^{-1}) ve fluometuron (FLM) herbisitlerin (2, 2,5 ve 3 l ha^{-1}) farklı dozları uygulanmıştır. Çalışma sonucunda herbisit uygulamalarının pamuk ve domuz pıtrağına olan etkileri her iki lokasyonda 28. günde değerlendirilmiştir. Trifloxysulfuron-sodium farklı doz uygulamalarında domuz pıtrağı kontrolünde %90'nın üzerinde etkili olduğu, fluometuronun ise farklı doz uygulamalarında etkinliğinin düşük olduğu belirlenmiştir. Herbisit uygulamalarının pamuktaki etkilerine bakıldığında, trifloxysulfuron-sodium’un farklı doz uygulamalarında herhangi bir fitotoksisiteye neden olmadığı, fluometuronun’un ise farklı doz uygulamalarında fitotoksisite gösterdiği görülmüştür. En yüksek pamuk ve lif verimi 15 g ha^{-1} trifloxysulfuron-sodium uygulamasından elde edilmiştir. Uygulamaların pamuk lif inceliği, lif uzunluğu ve lif mukavemeti üzerindeki etkilerinin önemli olmadığı belirlenmiştir.

Anahtar kelimeler: domuz pıtrağı, fitotoksisite, pamuk verimi, lif verimi, lif kalitesi, Türkiye

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