Selcuk Journal of Agriculture and Food Sciences

http://sjafs.selcuk.edu.tr/sjafs/index

Research Article

SJAFS
(2022) 36 (Special Issue), 13-22
e-ISSN: 2458-8377
DOI:10.15316/SJAFS.2022.071

The Effect of Some Pre-Emergence Herbicides on Weeds and Corn Yield

Merve KOÇ[1], Murat KARACA[2*]

[1]Pankobirlik Sugar Beet Cooperative, Konya, Türkiye
[2] Selçuk University, Faculty of Agriculture, Department of Plant Protection, Konya, Türkiye

ARTICLE INFO

Article history:
Received date: 25.11.2022
Accepted date: 09.12.2022

Keywords:
Corn
Weed
Herbicide
Application time

ABSTRACT

In this study, two herbicides (Isoxaflutole 225 g/l + Thiencarbazone-Methyl 90 g/l + Cyrosulfamide 150 g/l and Dimethenamid-P 280 g/l + Terbuthylazine 250 g/l), which are commonly used pre-emergence period against weeds that cause problems in corn planting areas were investigated. The experiments were carried out under field conditions in order to investigate the effect of registered dose of the herbicides to the weeds and corn yield components at the Konya province in 2018 – 2019 years. Herbicides Isoxaflutole 90 g/l + Thiencarbazone methyl 150 g/l + Cyprosulfamide and 280 g/l Dimethenamide-p + 250 g/l Terbuthylazine were tested in the pre-emergence period of the corn plant at doses of 35 ml/da and 300 ml/da, respectively. As a result of the experiments, Isoxaflutole 90 g/l + Thiencarbazone methyl 150 g/l + Cyprosulfamide were determined as the most effective herbicide to control weeds and increase corn yield components when it was applied during pre-emergence period. The effectiveness of herbicides was determined according to the biomass of weeds and their number in m^2. In addition, in both years, *A. retroflexus* was determined as the most intense species with 16.83 plants/m^2 and 32.97 plants/m^2 ratios respectively, in the experimental areas. Considering the corn stem diameter, cob length, corn stem length, corn stem dry and fresh weight, dry and fresh cob weight, thousand-grain weight and yield per decare in both years, it was determined that the active substances used increased in yield 2 to 3 times compared to the weed control plots.

1. Introduction

Corn is a C4 plant that makes the best use of solar energy and produces the driest matter per unit area. Corn production in Türkiye is increasing rapidly every year. The underlying reason for this is to make agricultural lands irrigable through various projects. Corn, which has an important role in Türkiye's agriculture, is used in many areas. These are human food, animal feed, biofuel industry, starch-based sugar industry, vegetable oil industry and bioethanol industry (Özcan, 2009; Anonymous, 2012).

Corn ranks third among cereals in the world following wheat and paddy in terms of cultivation area, but ranks first in production and yield. According to 2019 FAO data, 1,090 million tons of corn yield was obtained from 188,6 million hectares of cultivation area in the world (Anonymous, 2019c). In Türkiye, 6.5 million tons grain produced in an area of 6.9 million decares in 2020 (Anonymous, 2022).

Konya province was the first rank in terms of grain corn production in Türkiye with 1.1 million tons in 100K ha. Silage corn cultivation area was 30,774 ha and total production was 1.8 million tons. (TUİK, 2019).

Various problems are encountered during the cultivation of corn, which is of great importance in terms of agriculture. One of them is weeds that may result in yield and quality looses. The growing period of the corn with 3-10 leaves after emergence was considered the critical period against weeds (Doğan et al., 2004a). Although weed control has been partly carried out in corn production in the world, yield loss due to weeds was around 10.5% on average, while this rate was 20-30% in Türkiye (Güncan and Karaca, 2018). A study conducted by Oerke et al. in 19 different geographical regions has indicated that the yield loss might reach up to 40.3% when weed control practices were not performed (Oerke et al., 1999; Oerke, 2006). These losses depend on many factors such as species, density, distribution of weeds, soil structure, soil moisture, soil temperature and amount of organic matter in the soil. Weed control in corn may carry out both mechanically and chemically as

* Corresponding author email: *mkaraca@selcuk.edu.tr*
This study is a part of first authors MSc thesis

well as cultural measures. Although the last two methods gave good results in weed control even if they increased production costs. (Doğan et al., 2004b).

Skrzypczak and Pudelko (1993), in their study on corn cultivation areas, showed that the herbicides with Atrazine, Linuron, Atrazine + Linuron and Atrazine + Metolachlor effectively suppressed some broad-leaved weeds such as *Chenopodium album* L., *Viola arvensis* Murray., *Polygonum nodosum* L., *P. nodosum* L., *Amaranthus* sp. and *Lamium amplexicaule* L. when they applied pre-emergence.

Jodie and Potter (2002), investigated the effectiveness of Nicosulfuron against various weeds. The herbicide applied at different doses, successfully controlled *Chenopodium album*, *Amaranthus retroflexus*, and *Setaria glauca*.

Wilson et al. (2007), conducted a study to investigate the sulfonylurea herbicides that gave the best results in *Cichorium intybus* L. As a result, they reported that the most successful weed control was obtained from thifensulfuron + tribenuron, tribenuron and rimsulfuron + thifensulfuron applications.

Schuster et al. (2007), collected *C. album seeds* from four different regions of the United States (Nebraska, Ohio, North Dakota and Kansas) to determine response of C. album on glyphosate efficacy (1.1 kg / ha) at various growing stages including 2.5 cm, 7.5 cm and 15 cm shoot lengths. As a result, they determined that *C. album* was more sensitive to herbicide when it was at the earliest stage compared to other growth periods.

Uysal (2012) found that the recommended doses and double doses of rimsulfuron (5 and10 g/da), nicosulfuron (125 and 250 g/da) and foramsulfuron + Iodosulfuron-methylsodium + Isoxadifen ethyl (200 and 400 g/da) herbicides provided sufficient weed control and no injury was found on the corn plant applied recommended doses of the herbicides.

Doğan et al. (2015) determined that glyphosate, a total herbicide used to reduce the weed density in the fields where corn was planted, could be used pre-planting and pre-emergence, but this application increased the production cost. They stated that the most effective and most suitable chemical control might be obtained from the active ingredients applied pre and post-emergence in order to protect the corn plant from the negative effects of weeds.

In this study, it was aimed to determine the impacts of two pre-emergence herbicides to weed species and corn growth, which are commonly used against weeds that are a problem in corn, and their effects on some yield components in Konya province ecological conditions.

2. Materials and Methods

This study was carried out in field conditions in Aydoğmuş neighborhood of Güneysınır district of Konya province in 2018 and 2019. As trial materials, 225 g/L Isoxaflutole + 90 g/l Thiencarbazone-methyl + 150 g/L Cyprosulfamide (ITC) and 280 g/l Dimethenamide-p + 250 g/l Terbuthylazine (DT) active ingredient herbicides, grain corn variety NK Famoso (*Zea mays* L.). Soil samples taken from the experiment areas of Aydoğmuş district were analyzed in the laboratories of Selçuk University, Department of Soil Science and Plant Nutrition. In each year, the soil of the trial area, texture class clayey-loam, pH 7.2-7.35, total salt 270-266 µs, lime 9.3-12.3%, organic matter 2.52-2.91%, total nitrogen 0.126-0.145, nitrogen 24.5-19.8 ppm, phosphorus was analyzed taking 24.6-99.3 ppm and potassium 258-410.33 ppm.

Meteorological data for the years 2018-2019 of Aydoğmuş district were obtained from Konya Province Meteorology Station. This data includes monthly average temperatures, monthly average relative humidity and monthly total precipitation (Table 1).

Table 1
Meteorological data of Konya province 2018 and 2019

	Years	January	February	March	April	May	June	July	August	September	October	November	December
Mean relative humidity %	2018	80.7	64.3	52.9	47.7	61.2	54.2	40.4	38.5	41.6	62.7	66.8	83.3
	2019	79.9	73.2	61.7	66.5	40.5	51.9	43.4	44.8	44.0	55.3	65.7	
Mean Temp ºC	2018	1.4	7.0	10.6	13.6	16.7	20.4	24.0	23.5	19.8	13.4	7.9	3.0
	2019	1.2	4.0	6.2	9.2	18.1	20.8	22.1	22.6	19.2	15.7	9.7	
Total rainfall (mm=kg/m^2)	2018	97.1	19.3	55.0	19.3	103.1	90.7	4.7	3.3	4.1	33.3	26.7	84.9
	2019	80.5	56.3	24.7	35.8	3.7	36.2	5.6	8.4	6.2	17.5	41.2	

On 15.04.2018 and 14.04.2019, NK Famoso corn variety was planted in the experimental area with a pneumatic seed driller with 70 cm spacing and 15 cm row spacing. In the experimental areas, 40 kg/da 15-15-15+Zn and 20 kg/da urea (46% N) were applied during seed sowing. Following the emergence, sprinkler irrigation was applied once and then drip irrigation was applied 10 times (for 10 hours). After planting, 45 plots of 20 m^2 were designed on the trial area. 1 m and 0.5 m safety alleys were left between the blocks the plots, respectively. In order to avoid the border effect, the plots were set up at least 2 m from the field edge. Weedy control plots without weed control were also included. The

experiment was set up according to the randomized blocks design and was carried out with 3 replications.

Figure 1
General view of trial plots

The plant protection product applied to the soil with 225 g/L Isoxaflutole + 90 g/l Thiencarbazone-methyl + 150 g/L Cyprosulfamide (ITC) active ingredient is classified as Group F2: 27 according to its mechanism of action. After being absorbed by plant roots, it is carried in xylem and phloem, exerts systemic effects and inhibits carotenoid synthesis. (Barbour, 1996). This herbicide, which can be applied from planting to the post-emergence (2-3 leaves) period of the corn plant, suppresses the graminae and broad-leaved weeds that are a problem in corn and kills. (Anonymous, 2019a).

Herbicide with 280 g/l Dimethenamide-p + 250 g/l Terbuthylazine (DT) active ingredient is classified as K3+C1 according to its mechanism of action and provides inhibition of cell division and inhibition of photosynthesis. It has contact and systemic effects and is effective against some graminae and broad-leaved weeds (Barbour, 1996; Anonymous, 2019b).

The herbicides used pre-emergence in the trials were applied on April 19 in 2018 and April 16 in 2019. Herbicides were applied with Oleo Mac SP 126 brand motorized back sprayer with 3 atm pressure. A 2 m long boom with 5 fan jet nozzles was mounted on the sprayer. Spraying was done with an average of 400 liters of water per ha.

Determination of the species and intensities of weeds in the experimental area

Species and intensities of weeds in the experimental area were determined after crop emergence. For this purpose, a 0.25 m^2 frame (0.5 x 0.5 m) was thrown into each plot 3 times and counted, and the species and intensities of weeds were determined. Density was calculated using the following formula belonging to Odum (1971). According to this formula, the total number of plants was divided by the total area counted and the intensities in the plots were determined.

Density= T.Y./n

T.Y: Total density of each species in the counted areas (pieces)

n: Counted total area (m^2)

Determination of the effect of herbicides on weed biomass

In order to determine the effect of herbicides applied to the corn plant on weeds, 25 days after the application (DAA) of herbicides to the plots, a 0.25 m^2 frame was thrown 3 times on each plot, and the species and numbers of weeds in the frame were recorded. The weeds in each frame were then harvested from the root collar and brought to the laboratory and differentiated on the basis of species. Dry weights and number of plants per m^2 were determined by sampling from control plots with the same method at different periods of the corn plant.

In order to determine the dry weight of the weeds, after drying in an oven at 65 ºC for 48 hours, was noted by weighing them on sensitive scales (referring to Anderson (1930), Hitchcock (1931)).

Determination of the effect of herbicides on the number of weeds per m^2

In order to determine the effect of herbicides applied in the pre-emergence period of the corn plant on weeds, a 0.25 m^2 frame was applied to each plot 3 times 20-25 DAA. Weed species and numbers in the frame were counted and recorded, and the number of plants per m^2 on the basis of species and the effects of herbicides on weeds were calculated.

Determination of the effect of herbicides on corn stem diameter, plant and ear length

The root collar circumference of 10 plants (10 plants on a 1.42 m row) harvested from a random row in the middle of each plot was measured and recorded with the help of a tape measure. Then, these circumference values were calculated with the formula Circumference = 2.π.r and the diameter (R) of the body was found. Trunk length was measured from the harvested above-ground part of the corn to the last tip of the tassel. The ear length was measured from the starting point of the grains to the tip of the ear.

Determination of the effect of herbicides on corn plant and ear fresh and dry weight

When the moisture content of the obtained grains fell below 15%, 10 randomly selected plants were harvested from each plot. The corn ears of the harvested plants were separated from the plants and the fresh weight was obtained by weighing the plant stem. The plants dried in the shade were weighed after 20 days and the stem dry weights were obtained. Fresh weighing the corn ears separated from the plants was found after dried period for 20. The fresh and dry weight values of 10 randomly selected plants were divided by 10 and the average fresh and dry weight (g/plant) of a corn plant and ear was calculated.

Determination of the effect of herbicides on kernel yield and 1000 kernel weight

Kernel yields (kg/da) were calculated by separating the kernels from the corn cobs obtained from 10 plants in each plot. In addition, 1000 kernel were counted and weighed for each parcel from these kernels.

Statistical Analysis

Corn plant fresh and dry weight (g/plant), stem diameter (cm), plant height (m), fresh and dry corn ear weight (g), kernel yield (kg/da), 1000 kernel weight (g), weed dry weight (g/m^2), weed density (number/m^2) and % effect values of herbicides were subjected to statistical analysis. Variance analyses were performed and the means were seperated by Tukey multiple comparison test using Minitab software (Ver 16.0). Homogeneity test was also performed between the two years, since there were differences between most criteria, the mean of the years was not given in the results.

3. Results and Discussion

3.1. Species and Intensities of Weeds in the Trial Area

The 5 most intense weed species and densities in the field in 2018 were respectively *Amaranthus retroflexus* L. 16.83 plants/m^2, *Chenopodium album* L. 3.11 plants/m^2, *Convolvulus arvensis* L. 2.75 plants/m^2, *Alhagi pseudalhagi* (Bieb.) Desv. 1.58 plants/m^2, and *Chondrilla juncea* L. 0.77 plants/m^2 determined (Table 2).

Table 2
Weed species and densities in the experimental area (2018)

Scientific name	Family	Density (plant/m^2)
Amaranthus retroflexus L.	Amaranthaceae	16.83
Chenopodium album L.	Chenopodiaceae	3.11
Convolvulus arvensis L.	Convolvulaceae	2.75
Alhagi pseudalhagi (Bieb) Desv.	Fabaceae	1.58
Chondrilla juncea L.	Asteraceae	0.77
Aristolochia maurorum L.	Aristolochiaceae	0.75
Reseda lutea L.	Resedaceae	0.47
Hordeum vulgare L.	Poaceae	0.44
Acroptilon repens (L.) DC.	Asteraceae	0.27
Xanthium strumarium L.	Asteraceae	0.08
Citrullus lanatus L.	Cucurbitaceae	0.08
Lactuca serriola L.	Asteraceae	0.08
Salsola ruthenica Iljin	Chenopodiaceae	0.08
Sinapis arvensis L.	Brassicaceae	0.05
Polygonum aviculare L.	Polygonaceae	0.02
Hibiscus trionum L.	Malvaceae	0.02

The 5 most intense weed species and densities in the field in 2019 were respectively *A. retroflexus* 32.97 plants/m^2, *C. album* 26.55 plants/m^2, *X. strumarium* 6.94 plants/m^2, *S. nigrum* 4.44 plants/m^2, and *H. trionum* 4.27 plants/m^2 determined (Table 3).

Table 3
Weed species and densities in the experimental area (2019)

Scientific name	Family	Density (plant/m^2)
Amaranthus retroflexus L.	Amaranthaceae	32.97
Chenopodium album L.	Chenopodiaceae	26.55
Xanthium strumarium L.	Asteraceae	6.94
Solanum nigrum L.	Solanaceae	4.44
Hibiscus trionum L.	Malvaceae	4.27
Elymus repens (L.) Gould	Poaceae	4.19
Convolvulus arvensis L.	Convolvulaceae	3.19
Sinapis arvensis L.	Brassicaceae	3.11
Bifora radians Bıeb.	Apiaceae	3.05
Solanum tuberosum L.	Solanaceae	2.44
Ecballium elaterium (L)A.Rich.	Cucurbitaceae	1.5
Chondrilla juncea L.	Asteraceae	0.94
Heliotropium europaeum L..	Boraginaceae	0.47
Veronica hederifolia Poiret	Scrophulariaceae	0.36
Lactuca serriola L.	Asteraceae	0.21
Conium maculatum L.	Apiaceae	0.16
Phalaris paradoxa L.	Poaceae	0.08
Chrozophora tinctoria (L) Rafin	Euphorbiaceae	0.05
Polygonum aviculare L.	Polygonaceae	0.02

Tepe (1997), reported that weed species that are a problem in corn in general, *Aristolochia clematitis* L., *A. retroflexus*, *Artemisia vulgaris* L., *Cirsium arvense* (L.) Scop., *C. album*, *Cynodon dactylon*, *C. arvensis*, *Cyperus rotundus*, *Datura stramonium* L., *Digitaria sanguinalis*, *Echinochloa crus–galli*, *Echinochloa* *colonum*, *Portulaca oleracea*, *Polygonum* spp., *Setaria* spp., *S. nigrum*, *S. arvensis* L., *Sorghum halepense*, *X. strumarium*. Yavuz and Şahin (2021), on the other hand, detected *E. crus-galli*, *Amaranthus retroflexus*, *S. halepense*, *Abuliton theophrastii*, *Solanum nigrum* and *Chenopodium album* species in corn experimental areas.

It is thought that the difference in weed density between 2018 and 2019 is due to the different weed seed reserve, soil structure and environmental factors.

3.2. Effect of Herbicides on Weeds

In 2018, the plots on which soil herbicides were applied pre-emergence were observed on the 25th and 50th DAA, and three quadrats were placed on the control and sprayed plots. Although weeds were found in the control plots, they were not found in the sprayed plots. In 2019, weeds were found in the plot observations 25 DAA in the plots where soil herbicide was applied, and the dry weight in m^2 and the species number of the plants are given in Tables 4 and Table 5. Despite the application of the same active ingredients, this difference between years is thought to be due to the location difference of the trial area, weed seed reserve in the soil, seed dormancy, soil structure and environmental factors.

When we look at the effect of the ITC herbicide applied in the trials on the dry weight of the weeds, 100% and 80% effect was obtained against *L. serriola* and *X. strumarium*, respectively, while the DT herbicide was 93% effective against *C. arvensis* (Table 4). Pannaci and Covarelli (2003) indicated that mesotrion, imazamox and thifensulfuron controlled corn weeds including *C. album*, *X. strumarium*, *S. nigrum*, and *A. retroflexus* even if they used lower rate than recommended rate.

Table 4
Effect of herbicides on weed dry weight per m^2 (2019)

Application	*S. tuberosum*		*X. strumarium*		*C. arvensis*		*L. serriola*	
	Dry weight	%Effect	Dry weight	%Effect	Dry weight	%Effect	Dry weight	%Effect
ITC	2.11	68	0.16	80	0.04	73	0	100
DT	3.18	51	0.63	24	0.01	93	0.23	23
Control	6.60	0	0.83	0	0.15	0	0.30	0

ITC and DT killed *Lactuca serriola* L. whereas *C. arvensis* control by DT was 91% (Table 5).

Table 5
Effect of herbicides on the number of weeds per m^2 (plant/m^2 in 2019)

Uygulamalar	*S. tuberosum*		*X. strumarium*		*C. arvensis*		*L. serriola*	
	Plant/m^2	%Effect	Plant/m^2	%Effect	Plant/m^2	%Effect	Plant/m^2	%Effect
ITC	5.77	27	2.22	83	4.00	24	0	100
DT	6.66	16	3.10	76	0.44	91	0.88	66
Control	7.99	0	13.33	0	5.33	0	2.66	0

3.3. Effect of Herbicides on Corn Yield Components

The effects of ITC and DT on corn yield elements are given in Table 6.

Table 6
Effect of herbicides on corn yield components (2018 and 2019)

Yield parameters	Weedy control		Pre-emergency herbicides			
			ITC		DT	
	2018	2019	2018	2019	2018	2019
Stem diameter (cm)	1.01	0.48^{B}	1.24	1.35^{A*}	1.22	1.29^{A}
Corn ear length (cm)	20.40^{B}	17.2^{B}	23.13^{A}	24.5^{A}	21.20^{B}	25.3^{A}
Plant height (m)	2.69	2.22^{B}	2.81	2.89^{A}	2.83	2.75^{AB}
Stem fresh weight (kg)	0.245	0.130^{B}	0.330	0.400^{A}	0.283	0.360^{A}
Stem dry weight (kg)	0.155	0.070^{B}	0.236	0.220^{A}	0.196	0.185^{A}
Corn ear fresh weight (kg)	0.270	0.182	0.340	0342	0.306	0.335
Corn ear dry weight (kg)	0.220	0.170	0.303	0.330	0.266	0.320
1000 kernel weight (g)	345.22	346.90	358.32	383.69	352.83	394.90
Yield (kg/da)	0	1616^{B}	0	2650^{A}	0	2633^{AB}

* Means followed by the same letter are not different (p>0.05).

Although the effect of the applied herbicides on the stem diameter of corn was found to be insignificant as a result of the statistical analysis made on the data of 2018, the difference between them was found to be significant when compared to the herbicide control. The difference between the results obtained in 2019 was found to be statistically significant. The stem diameters of the plants in the herbicides applied plots increased approximately 3 times compared to the plants in the weedy control plots (Table 6; Figure 2).

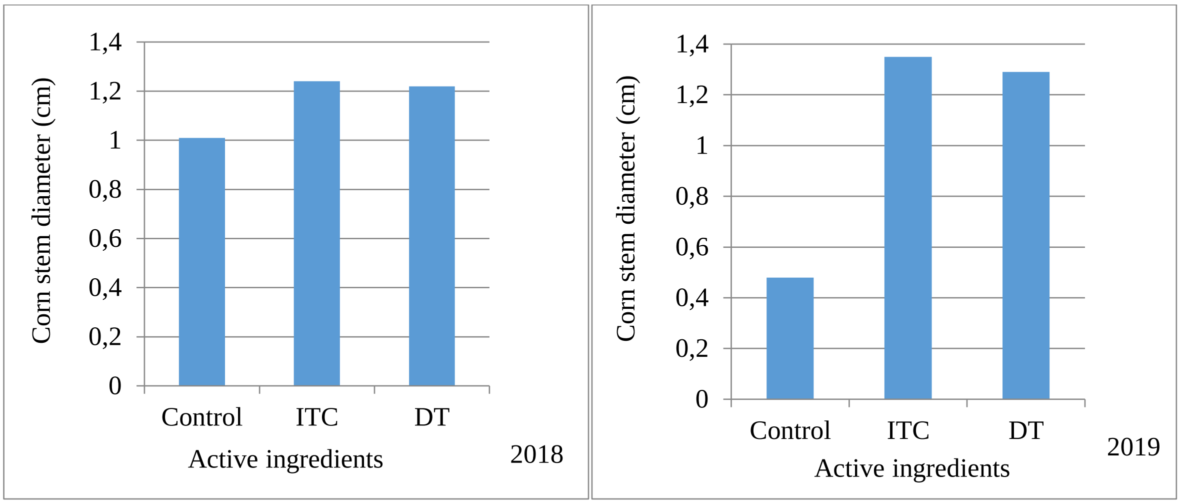

Figure 2
Effect of herbicides on corn stem diameter (2018 and 2019)

The effect of applied herbicides on corn ear length was found to be statistically significant in both years when compared to the weedy control. In 2018, the longest corn ear length was obtained from the plot where the ITC asset was used. In 2019, the longest corn ear length was obtained from the plots where the DT asset was applied (Table 6; Figure 3).

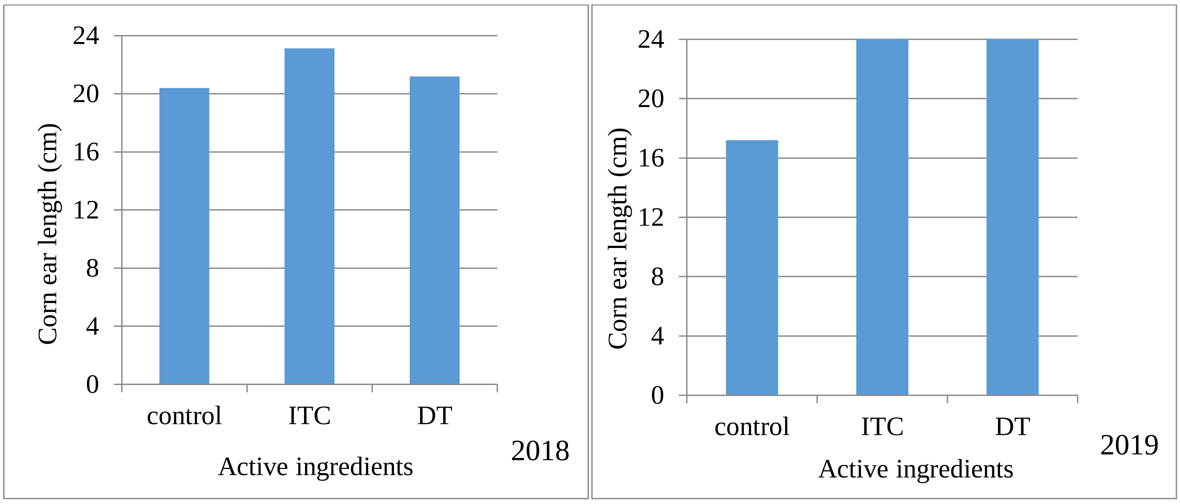

Figure 3
Effect of herbicides on corn ear length (2018 and 2019)

When we look at the effect of herbicides on corn plant height, the difference was statistically insignificant in 2018, but significant in 2019 compared to weedy control. The differences in corn height in the pre-emergence herbicide applied plots are presented in the table and figure (Table 6; Figure 4). Boz et al. (2015) also set up field trials in their studies on the symptoms caused by non-recommended herbicides in corn. While yellowness and whiteness of the leaves and shortening of the plant were observed at the dose of 37.5 ml/da of glyphosate applied in the first week, in addition to these symptoms at the dose of 75 ml/da, wilt and drought were observed in the plant. At doses of 150 ml/da and higher, drying and death were observed in the plant. They found that the leaves were yellow and white, shortened in length at 37.5 and 75 ml/da doses of glyphosate applied in the second week, and after the appearance of necrotic spots on the plant at 150 ml/da and higher doses, drying and death were observed in the plant.

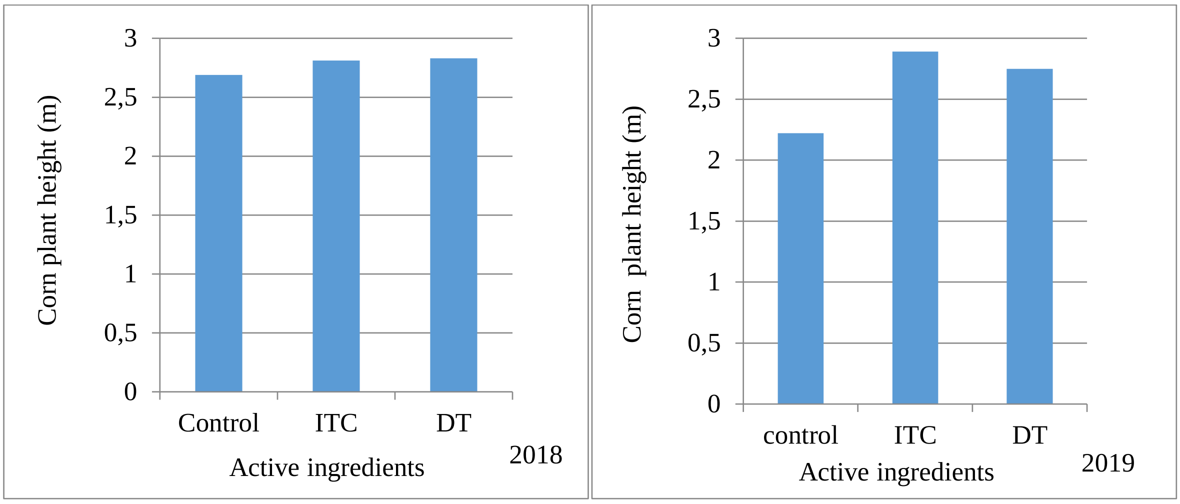

Figure 4
Effect of herbicides on corn plant height (2018 and 2019)

While the effect of ITC and DT herbicides applied on the corn plant on the stem fresh weight of the corn plant was statistically insignificant in 2018, but significant in 2019. In the herbicide-treated plots, corn plant stem fresh weight was significantly different compared to the weedy control plots. (6; Figure 5).

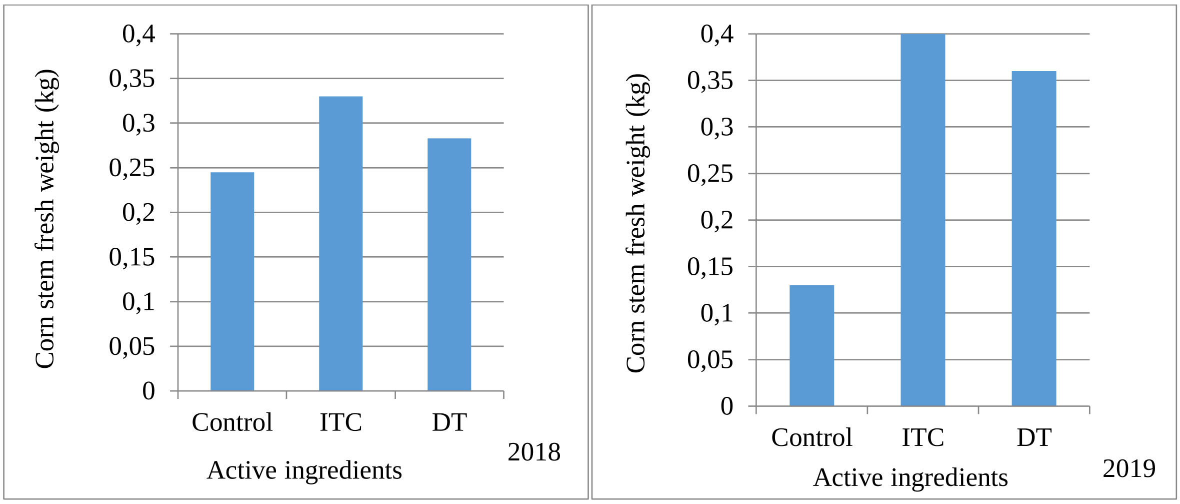

Figure 5
Effect of herbicides on corn stem fresh weight (2018 and 2019)

The impact of ITC and DT herbicides applied on the corn plant on the stem dry weight of the corn plant was statistically insignificant in 2018 while the difference between them was significant in the next year. In the herbicide-treated plots, corn stem dry weight was significantly different from the weedy control plots. (Table 6; Figure 6). Similarly, Yavuz et al. (2018) applied glufosinate, glyphosate, isoxaflutole + thiencarbazonemethyl + cyprosulfamide and imazamox active ingredient herbicides to 25 corn lines under greenhouse conditions to determine the effects of some herbicides on dry weight of weeds and corn. Corn biomass of corn lines were the highest in plants applied to isoxaflutole+thiencarbazone-methyl+cyprosulfamide and the least in plants treated to glpyhosate.

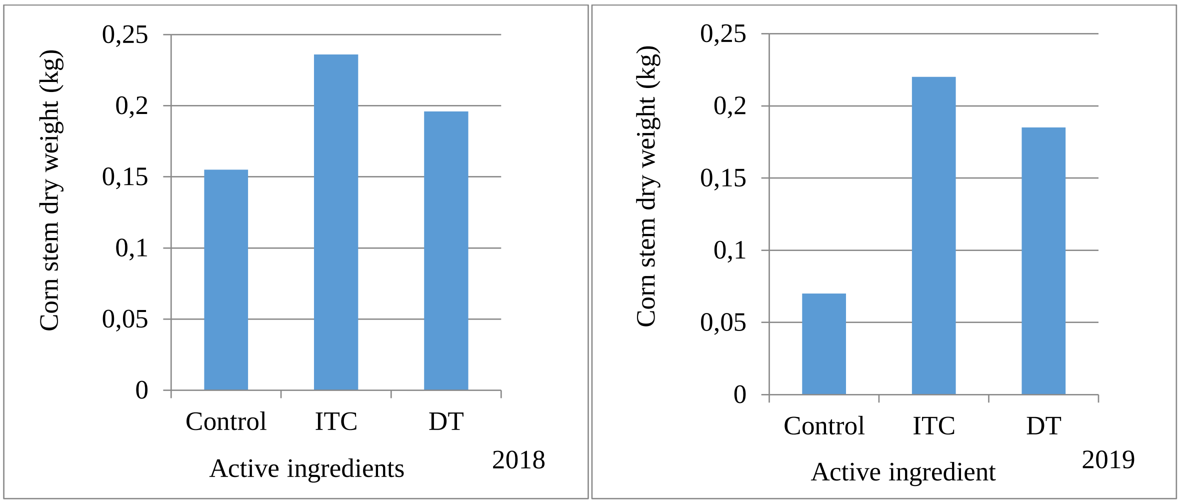

Figure 6
Effect of herbicides on corn stem dry weight (2018 and 2019)

Although the effect of ITC and DT herbicides applied on corn ear fresh and dry weights of corn was not significant statistically in both years, an apparent difference between the weedy control and sprayed plots were seen, especially in 2019 (Table 6; Figure 7; Figure 8).

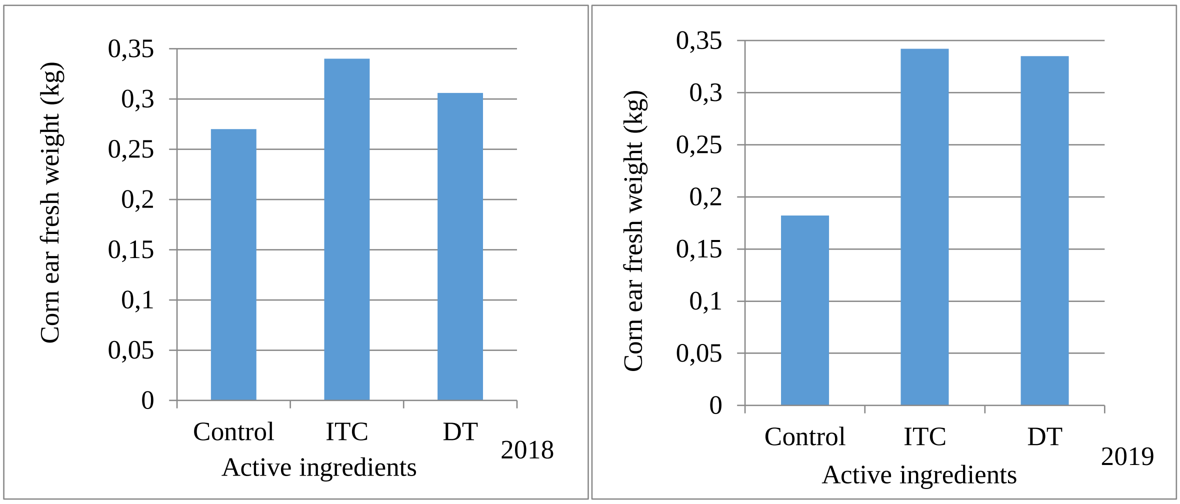

Figure 7
Effect of herbicides on corn ear fresh weight (2018 and 2019)

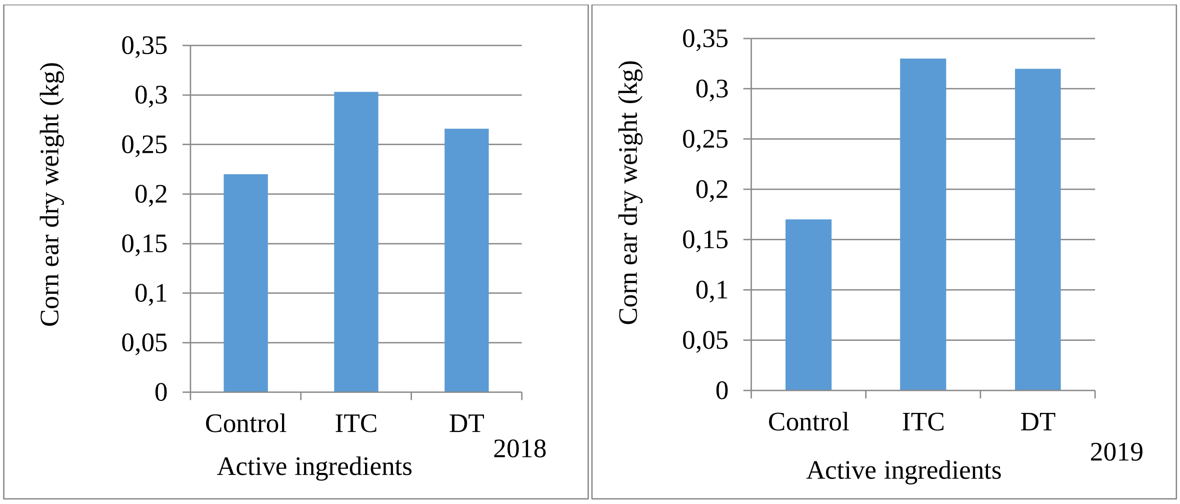

Figure 8
Effect of herbicides on corn ear dry weight (2018 and 2019)

When we look at the effect of herbicides applied on the pre-emergence corn plant on the 1000 kernel weight of corn, the difference was found to be insignificant in 2018 and 2019. When we compare the 1000 kernel weight of 2018 with the weedy control plots, the 1000 kernel weight was obtained from the plots with the highest ITC active ingredient applied. When we compare the 1000 kernel weights obtained in 2019 with the weedy control plots, the highest 1000 kernel weight was obtained from the plots of DT active ingredient applied. The difference between the years is thought to be due to the field and environmental conditions (Table 6; Figure 9).

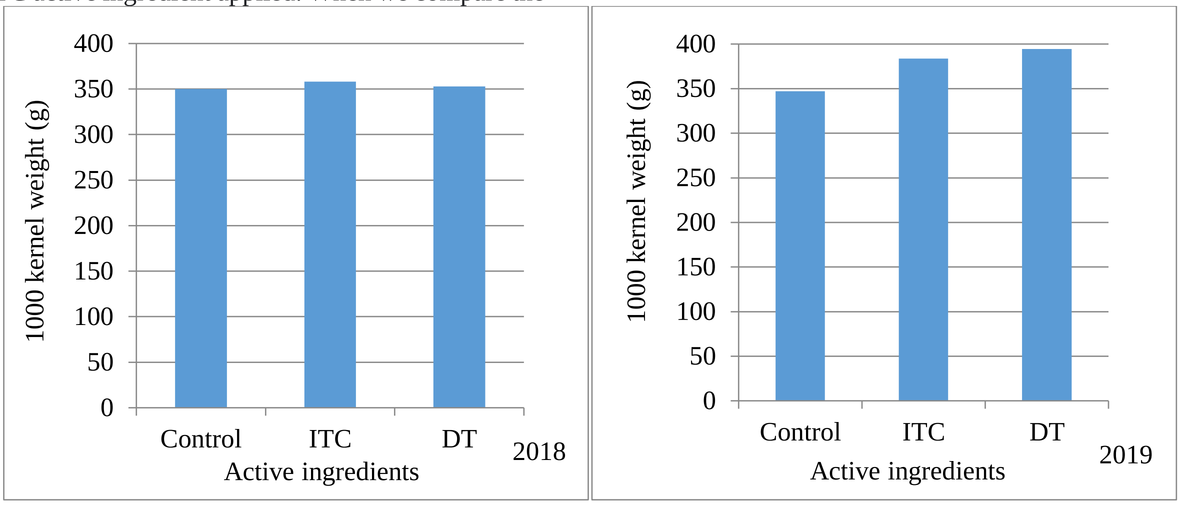

Figure 9
Effect of herbicides on 1000 kernel weight (2018 and 2019)

When we look at the effect of ITC and DT herbicides applied on corn plant on corn yield, the highest yield was obtained from the plot where ITC active ingredient was applied compared to the weedy control plots. It is seen that both herbicides provide a significant increase in corn yield. According to the data obtained, the highest yield in the corn plant was obtained from the herbicide applied pre-emergence (Table 6). With the herbicides applying from the soil, absence of competitive weeds that can share the water, light and nutrient elements in the environment from the corn plant comes to the surface of the soil has ensured that the plant grows physiologically in the critical period, and in the following periods, high yield was obtained compared to weedy control plots (Table 6; Figure 10).

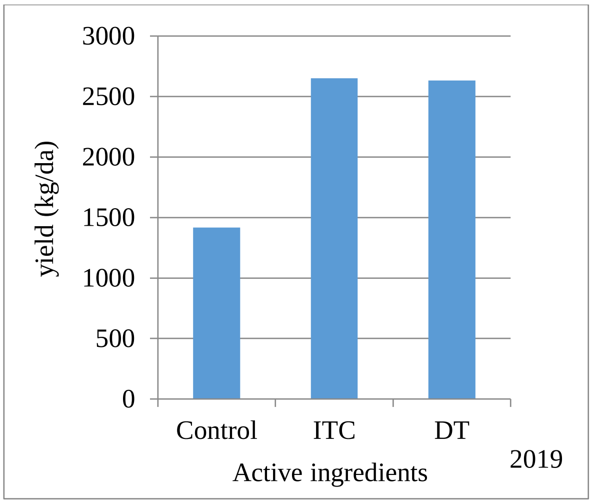

Figure 10
Effect of herbicides on kernel yield (2018 and 2019)

4. Conclusions

Due to the slow growth of the corn plant in the early stages of seedling development and the large distance between the rows, it cannot compete with weeds sufficiently and remains under the pressure of weeds. The development period after the emergence of the corn, when it has 3 to 10 leaves, is the critical period for weeds. If they are not effectively controlled at this period, serious decreases in corn yield could not be inevitable. Corn, which is an important crop in the world and in Türkiye, is faced with various problems in different periods of its development like weeds.

Both of these herbicides controlled *A. retroflexus*, *C. album*, *X. strumarium*, *C. arvensis* and *S. nigrum*, which are the most common species in the experimental areas.

Considering the corn stem diameter, cob length, corn stem length, corn stem dry and fresh weight, dry and fresh cob weight, thousand-grain weight and yield per decare in both years, it was determined that the active substances used increased in yield 2 to 3 times compared to the weed control plots. Similarly, it is reported that the competition of corn against weeds is weak during the emergence of the corn plant to the soil surface and the seedling growth period. If weeds are not controlled, the yield loss can reach 80%. Also that many weeds may use more nutrients than corn. For example, *Chenopodium* spp. absorb 3 times more phosphorus, 2 times more nitrogen than corn, and potassium as much as corn from soil (Anonymous, 2019c).

Both herbicides used pre-emergence provided an excellent increase in yield when compared to the weedy control. Although there is no significant difference between the impact of them, ITC was more successful in terms of grain yield per ha than DT. Although the herbicides used pre-emergence vary depending on soil seed bank, soil structure and environmental factors. However, if the land is heavily infested with weeds, weed emergence can be observed 20 days after spraying, albeit a little. In this case, a post-emergence herbicide may be recommended considering the weed density. When deciding to post-em application, the economic damage thresholds of the weeds should be considered. Otherwise, the input costs will increase and environmental pollution will be caused by the extra herbicides applied to the land.

As in all cultivated plants in the world and in Türkiye, weed control methods such as cultural, mechanical or chemical do not provide sufficient benefit if they use alone. Therefore, weed control methods should be combined. Among these methods, the most commonly used hoeing and herbicide application. Since hoeing increases labor and production costs, farmers tend to use herbicides with a lower cost, short duration of action and high success rate.

Despite the residue problem and some negative effects of herbicides on ecology, yield losses can be prevented with timely and correct use. However, at this point, it is necessary to comply with the recommended dose and pay attention to the application time. Another important issue is that herbicides with different mechanisms of action should be used alternately against the problem of weeds developing resistance to herbicides. Herbicides that act in the soil in a short time and have high selectivity should be avoided.

5. Acknowledgements

This research was summarized from MS thesis of Merve Koç and supported by Selcuk University BAP Coordinator, project number 19201065.

6. References

Anderson RS (1930). Reports of the standard gelatin committee (unpublished). Referred to in: Hitchcock DI (1931) The combination of a standard gelatin preparation with hydrochloric acid and with sodium hydroxide. The Journal of General Physiology, pp. 125-138.

Anonymous (2012). Mısır Raporu. Ulusal Hububat Konseyi. Ekim, 2012.

Anonymous (2019a). tarim.www.bayer.com.tr. Erişim tarihi: 02.11.2019.

Anonymous (2019b). agro.www.basf.com.tr. Erişim tarihi: 02.11.2019.

Anonymous (2019c). http://www.cinetarim.com.tr/dergi. Erişim tarihi:

Anonymous (2022). https://www.fao.org/faostat/en/#data/QCL. Erişim tarihi: 18.08.2022

Barbour M (1996). California landscapes before the invaders. In; Lovich, J.E., Randall, J. and Kelly M.D. (eds.). Proceedings of the California Exotic Pest Plant Council Symposium. Vol. 2, 5-9.

Boz Ö, Unay A, Doğan MN, Şimşek S, Arat BB, Keşşaf D (2015). Tavsiye dışı uygulanan herbisitlerin kültür bitkisi üzerinde oluşturduğu simptomlar. *Adnan Menderes Üniversitesi Ziraat Fakültesi Araştırma (Tez Hariç) Kitabı*, 41-66 s.

Doğan MN, Ünay A, Boz Ö, Albay F (2004a). Determination of optimum weed control timing in maize (*Zea mays* L.). *Turkish Journal of Agriculture and Forestry*, 28, 349-354 s.

Doğan MN, Boz Ö, Ünay A, Albay F (2004b). Aydın ili mısır ekim alanlarında sorun olan yabancı otların belirlenmesi ve yabancı otlarla mücadelede en uygun dönemin (Kritik periyot) saptanması, Bilimsel Araştırma Projeleri Kurulu, ZRF- 02009, 01.01.2002, 01.01.2004.

Doğan I, Dok M, Altop EK, Mennan H (2015). Mısır yetiştiriciliğinde erken toprak işleme ve Glyphosate‟nin çıkış öncesi ve çıkış sonrası yabancı ot mücadele yöntemleri ile birlikte kullanılabilirliğinin araştırılması. *Tarım Bilimleri Dergisi*, 21, 596- 605.

Güncan A, Karaca M (2018). Yabancı Ot Mücadelesi. Güncellenmiş ve ilaveli dördüncü baskı. Selçuk Üniversitesi Basımevi, 334 s. ISBN: 975 448 1784

Hitchcock DI (1931). The combination of a standard gelatin preparation with hydrochloric acid and with sodium hydroxide. *The Journal of General Physiology*, 125-138.

Jodie K, Potter KB (2002). Weed control with nicosulfuron in corn, southwest research and outreach center, University of Minnesota, Lamberton.

Odum P (1971). Fundamentals of Ecology. W.B. Saunders Company, 574 p.

Oerke EC, Dehne HW, Schönbeck F, Weber A (1999). *Crop Production and Crop Protection*. Elsevier. Oxford, Tokyo vb. p 808.

Oerke EC (2006). Crop losses to pests. *Journal of Agrıcultural Science*, 144, 31-43.

Özcan S (2009). Modern Dünyanın Vazgeçilmez Bitkisi Mısır: Genetiği Değiştirilmiş (Transgenik) Mısırın Tarımsal Üretime Katkısı. Türk Bilimsel Derlemeler Dergisi 2(2): 01-34. ISSN:1308-0040

Pannaci E, Covarelli G (2003). Control of common cocklebur (*Xanthium strumarium* L.) in maize using different herbicides at reduced doses. Proceedings of 7th EWRS (European Weed research Society) Mediterranean Symposium, s; 91-92. Adana, Turkey.

Schuster CL, Shoup DE, Al-Khatib K (2007). Response of common lambsquarters (*Chenopodium album*) to glyphosate as affected by growth stage. *Weed Science*, 55 (2);147-151.

Skrzypczak G, Pudelko J, (1993). Assessment and Economic Aspect of Herbicides Used For Weed Control in Maize (*Zea mays* L.), Crop and Soil Cultivation Department, University of Mazowiecka Agriculture, 8th EWRS Syposium, Poland, 267 – 273.

Tepe I (1997). Türkiye‟de Tarım ve Tarım Dışı Alanlarda Sorun Olan Yabancı Otlar ve Mücadelesi, *Yüzüncü Yıl Üniversitesi Ziraat Fakültesi Bitki Koruma Bölümü Ders Kitabı,* No: 18, Van, 237 s.

TUİK (2019). Türkiye İstatistik Kurumu Tarım İstatistikleri Özeti 2019. Erişim tarihi: 24.09.2019

Uysal B (2012). Farklı dozlarda kullanılan bazı herbisitlerin mısırda yabancı otlanmaya etkisi (Yüksek Lisans Tezi), *Gaziosmanpaşa Üniversitesi Fen Bilimleri Enstitüsü*, Tokat, 58 s.

Wilson RG, Desprez B, Edwards MT (2007). Identifying the best sulfonylurea herbicide for weed control and crop tolerance in sulfonylurea-resistant chicory (*Cichorium intybus*). *Weed Technology*, 21 (2); 537-541.

Yavuz R, Esmeray M, Urin V (2018). Bazı herbisitlerin mısır ve yabancı ot biyomasına etkisi, *Bahri Dağdaş Bitkisel Araştırma Dergisi Journal of Bahri* Dagdas Crop Research 6 (2): 1-6, 2017 ISSN: 2148-3205, www.arastirma.tarim.gov.tr/bahridagdas.

Yavuz, R, Şahin B (2021). Mısırda çıkış öncesi ve sonrası herbisitlerin yabancı otlar üzerine etkileri. 8. Uluslararası Katılımlı Bitki Koruma Kongresi, Bildiri özetleri. 24-28 Ağustos (Online).