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ARAŞTIRMA MAKALESİ **RESEARCH ARTICLE**

Research on the Significant Weed Species, Densities, and Frequencies in Sunflower-Cultivated Areas of Kırşehir Province

Kırşehir İli Ayçiçeği Üretim Alanlarındaki Önemli Yabancı Ot Türleri, Yoğunlukları ve Rastlanma Sıklıkları Üzerine Bir Araştırma

Muhammed Emre GÖKTAŞ[1], Melih YILAR[2*]

Abstract

Weed competition can lead to yield losses of up to 70% in sunflower (*Helianthus annuus* L.), making its cultivation nearly impossible under severe infestations. Despite this, there is currently no comprehensive study focusing on the economically significant weed flora in the sunflower-growing regions of Kırşehir Province, Türkiye. To address this gap, surveys were conducted across sunflower production areas in Kırşehir during the 2023 and 2024 growing seasons. These surveys were systematically planned at both district and provincial levels to ensure full coverage of the region. Surveys were carried out in a total of 77 sunflower production areas. As a result of this study, 70 species of weeds belonging to 26 different families were identified in the sunflower production area of Kırşehir Province. Among them, Asteraceae was the most dominant family with 15 species, followed by Fabaceae (6 species) and Poaceae (10 species). In terms of life cycle, 45 species were annuals, 17 perennials, 2 biennials, and the remaining included annual/biennial, annual/perennial, biennial/perennial, monocarpic biennials, and parasitic species. The most dominant weed species based on plant density (plants/m²) in 2023 and 2024, respectively, were: *Heliotropium europaeum* L. (2.60–1.87), *Centaurea depressa* L. (1.97–1.56), *Chenopodium album* L. (1.83–3.02), *Sinapis arvensis* L. (1.22–1.31), *Convolvulus arvensis* L. (0.56–1.01) respectively. Regarding frequency, the most prevalent species across the two years were: *Convolvulus arvensis* L. (72.97%–70.0%), *Chenopodium album* L. (70.27%–77.5%), *Heliotropium europaeum* L. (52.94%–42.5%), *Amaranthus retroflexus* L. (45.94%), *Sinapis arvensis* L. (40.54%–57.5%). This study provides the first comprehensive identification of dominant weed species and their population dynamics in the sunflower production areas of Kırşehir. The findings offer crucial baseline data to support the development of integrated weed management strategies.

Keywords: Kırşehir, Sunflower production areas, Weed density analysis, Weed frequency, Weed flora

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*This study was summarized from the Muhammed Emre GÖKTAŞ MSc thesis.

Öz

Yabancı ot rekabeti, ayçiçeği (*Helianthus annuus* L.) veriminde %70'e kadar ulaşabilen kayıplara yol açabilmekte, ayçiçeği tarımı nerede ise imkansız hale gelebilmektedir. Bununla birlikte Kırşehir ili ayçiçeği üretim alanlarında ekonomik açıdan önemli olan yabancı ot florası hakkında kapsamlı bir çalışma bulunmamaktadır. Bu amaçla 2023 ve 2024 üretim yıllarında Kırşehir ayçiçeği üretim alanlarında survey çalışması gerçekleştirilmiştir. Surveyler tüm ili kapsayacak şekilde ilçe ve il düzeyinde planlanmıştır. Toplam 77 ayçiçeği üretim alanında survey çalışmaları yürütülmüştür. Bu çalışma sonucunda Kırşehir İli ayçiçeği üretim alanında 26 farklı familya ya dahil olan 70 tür yabancı ot türü tespit edilmiştir. Ayçiçeği üretim alanında Asteraceaenin en fazla yabancı ot türü (16 tür) içeren familya olduğu tespit edilmiş olup, bunu sırasıyla, *Fabaceae* (6 tür) ve *Poaceae* (10 tür) izlemiştir. Tespit edilen yabancı otların 45'i tek yıllık, 17'si çok yıllık, 2'si iki yıllık, 2'si tek /iki yıllık ve diğerleri ise tek /çok yıllık, iki yıllık/çok yıllık, iki yıllık/monokarpik ve parazit türler oluşturmuştur. 2023 ve 2024 yıllarında oluşturdukları yoğunluk bakımından (bitki/m^2), sırasıyla, *Heliotropium europaeum* L. (2.60-1.87), *Centaurea depressa* L. (1.97-1.56), *Chenopodium album* L. (1.83-3.02), *Sinapis arvensis* L. (1.22-1.31), *Convolvulus arvensis* L. (0.56-1.01) türleri en baskın türler olarak belirlenmiştir. Rastlanma sıklıkları birlikte değerlendirildiğinde; 2023-2024 yıllarında, sırasıyla, *Convolvulus arvensis* L. (%72.97-%70), *Chenopodium album* L. (%70.27-%77.5), *Heliotropium europaeum* L. (%52.94-%42.5), *Amaranthus retroflexus* L. (%45.94), *Sinapis arvensis* L. (%40.54-%57.5) yabancı ot türleri en yaygın türler olarak tespit edilmiştir. Bu çalışma, Kırşehir ili Ayçiçek üretim alanlarındaki başlıca yabancı ot türlerini ve bunların popülasyon dinamiklerini ortaya koyarak, bölgedeki ayçiçeği veriminin arttırılmasına yönelik entegre yabancı ot yönetimi stratejilerinin geliştirilmesine önemli bir temel veri sağlamaktadır.

Anahtar Kelimeler: *Helianthus annuus* L., Kırşehir, Yabancı ot yoğunluk analizi, Yabancı ot rastlanma sıklığı, Yabancı ot florası

1. Introducion

Sunflower (*Helianthus annuus* L.) is a cultivated plant belonging to the Asteraceae family. Sunflower is significant for industrial raw material and consumption due to its oil content of nearly 50% and is an important product grown in many countries (Meral, 2019). Sunflower seeds contain high levels of high-quality oil (Kaya, 2004). Sunflower is considered one of today's most important oil crops (Karkanis et al., 2022) and is believed to have originated in North America (Kaya, 2016). Sunflower was first cultivated in Europe in the 16th century, but at that time, it was used as an ornamental plant. However, it was subsequently identified that the plant's seeds contain a high oil content, and thus, the cultivation of sunflowers for oil production became a significant economic activity (Duke, 1983). The ability of the sunflower plant to access surface water is facilitated by its robust root structure, which can extend up to three meters in length. Furthermore, the plant's ability to thrive in rows has led to widespread agricultural cultivation (Tan, 2006). It is estimated that the sunflower is one of the four most significant crops worldwide, cultivated for the purpose of edible oil or biodiesel production (Agostinetto et al., 2020). In 2023, the global area under sunflower cultivation was 27.795 thousand decares, producing 51,642 thousand tons. In the 2022-2023 production season, the top three producers were Russia, Ukraine, and the EU, collectively accounting for 71% of global sunflower production, with Türkiye ranking sixth (Anonymous, 2024). In 2023, the sunflower production area in Türkiye was 9.526 decares, yielding a total production of 2.198,000 tons. This production represents a 55.44% share of the country's total oil production, making sunflower the leading crop in this category. According to the 2023 production data, Tekirdağ province emerged as the leader with an area of 18.32%. Edirne follows with 13.58%, and Kırklareli with 10.25% (TÜİK, 2024). Kırşehir province has shown a consistent increase in sunflower production. Between 2020 and 2023, the sunflower cultivation area in Kırşehir increased by 98.929 decares (TÜİK, 2024). As demonstrated in the relevant literature, the production of sunflowers is of significant importance in Türkiye and on a global scale. This assertion is further substantiated by the observed annual escalation in sunflower production in the province of Kırşehir.

Weeds have been identified as a significant factor contributing to yield loss in agricultural areas. This is primarily due to the limited availability of postemergence herbicides authorized for cultivated plants. The weed control problem is exacerbated by the wide gaps between rows and the low plant population per hectare, which renders sunflowers more vulnerable to weed competition during the early stages of development (Elezovic et al., 2012). Consequently, weeds have been observed to reduce sunflower yields by up to 81% (Fried et al., 2006). The extent of crop damage is influenced by the weed species and population in the field (Rizzardi et al., 2003), with the initial emergence and phenological stage of crop development affecting competition against weeds (Agostinetto et al., 2014). Competition between weeds and cultivated plants can cause irreversible losses due to morphological and physiological changes that jeopardize the development of reproductive organs in plants, leading to a reduction in yield even after eliminating the stress (Breccia et al., 2011; Yazlık et al. 2019; Kara and Ata, 2021). Weeds also act as alternate hosts for insect pests and pathogens, exacerbating crop losses and increasing production costs. In short, weeds adversely affect sunflower production/yield by competing for water and nutrients, harboring diseases and pests (Özkil et al., 2019). In studies conducted in different regions where sunflower production is identified weeds such as *Ambrosia artemisiifolia, Amaranthus retroflexus, Alopecurus myosuroides, Anagallis arvensis, Anthemis* spp.*, Atriplex* spp.*, Capsella bursa-pastoris, Cardaria draba, Centaurea* species*, Chenopodium album, Cirsium arvense, Convolvulus arvensis, Cynodon dactylon, Cyperus rotundus, Datura stramonium, Digitaria sanguinalis, Echinochloa crus-galli, Elymus repens, Equisetum* spp.*, Eryngium bithynicum,Euphorbia* spp.*, Galinsoga parviflora, Galium species, Geranium molle, Gypsophyla muralis, Heliotropium europaeum, Lactuca* spp.*, Matricaria chamomilla, Mercurialis annua, Orobanche* spp.*, Phragmites australis, Plantago major, Polygonum aviculare, Polygonum lapathifolium, Polygonum* spp.*, Ranunculus* spp., *Raphanus raphanistrum, Rorippa austriaca, Setaria* spp., *Sinapis arvensis, Solanum nigrum, Sonchus* spp., *Sorghum halepense, Tribulus terrestris* and *Xanthium strumarium* species (Štefanıć et al., 2021; Önen, 2023).

The severity of damage caused by weeds can vary. While some weed species cause problems only in a specific crop, others can cause severe yield losses in more than one crop (Savcı and Gürbüz 2023). Various weed species are a problem in sunflower production (Karabacak and Uygur, 2017) and this situation leads to significant yield losses (Kaya, 2016). Therefore, controlling weeds in sunflower growing areas is important, and inadequate weed

control can cause severe crop losses (Pannacci et al., 2007). Therefore, different control methods should be applied to control weeds. This requires the development of integrated weed strategies by identifying the weed species that are spreading in the production area.

To date, no research has examined the weed flora in sunflower production areas of Kırşehir Province. Therefore, this study aims to determine the problematic weed species, their frequency, density, dominance, and to provide baseline data for sustainable weed management in the region.

2. Materials and Methods

2.1. Study Area

The primary focus of this study is the weed flora in sunflower cultivation areas of Kırşehir Province. In 2023 and 2024, field studies were conducted in 77 sunflower production areas in the center and seven districts. Weed bags, 1 m^2 quadrats for weed counting, and GPS to determine the coordinates were also utilized in field studies.

Kırşehir province, situated within the Central Kızılırmak basin of Central Anatolia, is the 53rd largest province in Türkiye, with a surface area of 6.570 km^2, constituting 8 per thousand of Türkiye's total surface area and 2.9% of the surface area of the Central Anatolia region. The province's geographical location is situated between 38°50'-39°50' North latitude and 33°30'-34°50' East longitude, with an elevation of 985 m above sea level. The climate of Kırşehir is classified as continental, characterized by hot and dry summers and cold and snowy winters. The province's average temperature is 11.3°C, with an annual precipitation average of less than 400 mm. The Kırşehir massif, the largest of Türkiye's nine massifs, is a notable geographical feature of the region (Anonymous, 2024a). The 2024 climatic data for Kırşehir Province can be found in *Figures 1* and *2* (Anonymous, 2024b).

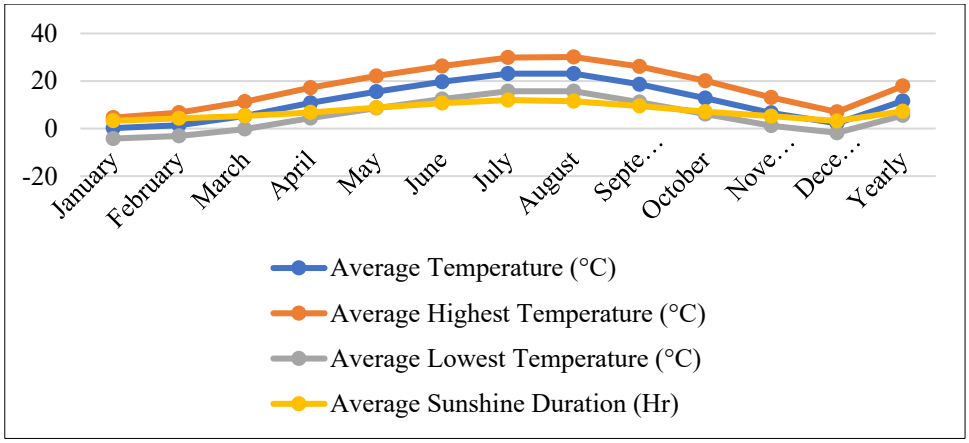

Figure 1. Kırşehir average temperature, lowest and highest average temperature, average sunshine duration (2024)

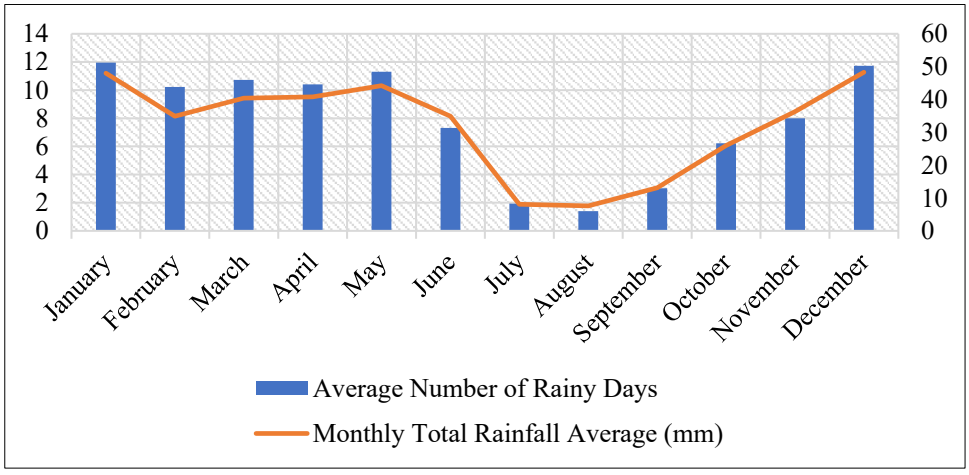

Figure 2. Kırşehir average number of rainy days and monthly total rainfall average (2024)

Weed survey studies: Surveys were conducted in sunflower production areas in the center of Kırşehir province and Akçakent, Akpınar, Boztepe, Çiçekdağı, Kaman, and Mucur districts during the 2023 and 2024 production seasons. The survey points in 2023 and 2024 are illustrated in *Figure 3*.

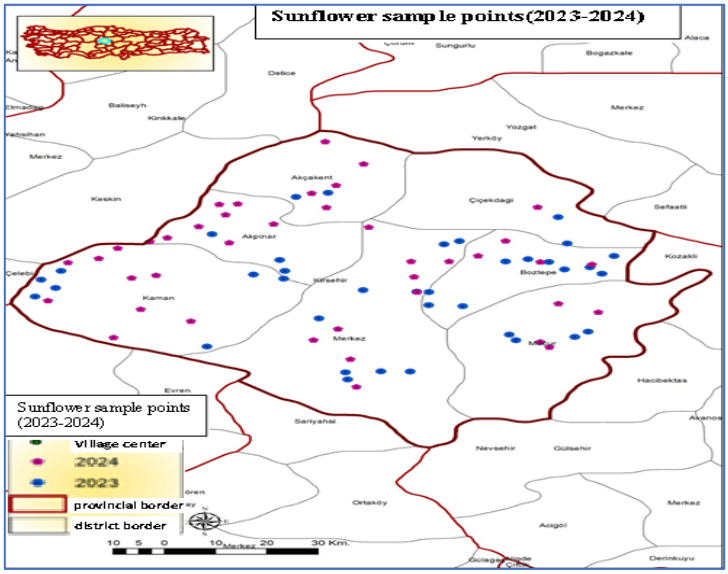

Figure 3. Survey points

2.2. Data analysis

This study utilized arithmetic averages to ascertain weed density and frequency of occurrence in sunflower-cultivated areas. The following formula (Eq. 1, Eq. 2) were employed to determine weed species 'frequency of occurrence and density'. In addition, the weed species similarity index between the two years was determined according to the following formula (Eq. 3) (Pala et al., 2018).

$$\text{Frequency of occurrence} = n/m * 100 \quad \text{(Eq. 1)}$$

n = The number of samplings that detected the same species, m= The total number of samplings.

$$\text{Density} = B/n \quad \text{(Eq. 2)}$$

B= The total number of individuals in the sample, n= The number of samples taken

$$\text{Similarity index (SI)} = 2c / (a + b) \quad \text{(Eq. 3)}$$

a = number of species in (a) habitat, b = number of species in (b) habitat, c = number of common species in habitat (a) and (b)

Table 1. Grading of the density and prevalence of the identified weeds (Arslan, 2018)

Frequency			Density		
Symbol	**Meaning**	**Ratio**	**Symbol**	**Meaning**	**Ratio**
V	very common	≥%50	A	very density	≥10 adet/m^2
C	common	%25-49	B	density	5.00 - 9.99 adet/m^2
M	medium ommon	%13-24	C	medium density	1.00 - 4.99 adet/m^2
L	low common	≤%12	D	low density	0.10 - 0.99 adet/m^2
			E	very low density	0.01 - 0.09 adet/m^2
			F	rare	<0.01 adet/m^2

The technique collected samples of weed species/species that could not be identified during the surveys. The collected samples were then placed in paper envelopes and transported to the Herbology Laboratory of Kırşehir Ahi Evran University, Faculty of Agriculture, Department of Plant Protection, for identification by Dr. Melih YILAR, who based his identification on literature information. The scientific nomenclature of the weed species identified as a result

of the surveys was based on the Flora of Turkey (Davis, 1965-1989). The weeds identified in the fields as a result of the surveys were classified according to their diversity, prevalence, and density, and the scale values (*Table 1*) with the determination of essential species were made according to Arslan (2018). The identified weed species were also evaluated according to the "plant life form categories" developed by Raunkiaer (1934).

3. Results and Discussion

In the years 2023 and 2024, the densities, frequency of occurrence, similarity indices, and life forms of weed species detected in Kırşehir sunflower cultivation areas are given in *Table 2*, densities by families are presented in *Figure 4*, and information on dominant species in production seasons is presented in *Figure 5*. According to the study results, 70 taxa belonging to 26 families were identified. The Asteraceae family (15 taxa) had the highest number of taxa, followed by Poaceae (10 taxa), Fabaceae (6 taxa), Boraginaceae (3 taxa), Brassicaceae (3 taxa), Chenopodiaceae (3 taxa), Lamiaceae (2 taxa), Malvaceae (3 taxa), Amaranthaceae(2 taxa), Euphorbiaceae (2 taxa), Papaveraceae (3 taxa), Plantaginaceae (2 taxa), Polygonaceae (2 taxa), Solanaceae (2 taxa), Apiaceae, Caryophyllaceae, Convolvulaceae, Geraniaceae, Orobanchaceae, Portulacaceae, Primulaceae, Scrophulariaceae, Ranunculaceae, Rubiaceae, Urticaceae and Zygophyllaceae (*Figure 4*). According to the life cycle, 45 of the taxa are annual, 17 are perennial, 2 are biennial, two are annual/biannual, and one is annual/perennial. 1 annual/perennial, biannual/perennial, biannual/monocarpic, and one parasitic taxon. The general characteristics (life form, life span, natural distribution area, and impacts) of these taxa are presented in *Table 2*.

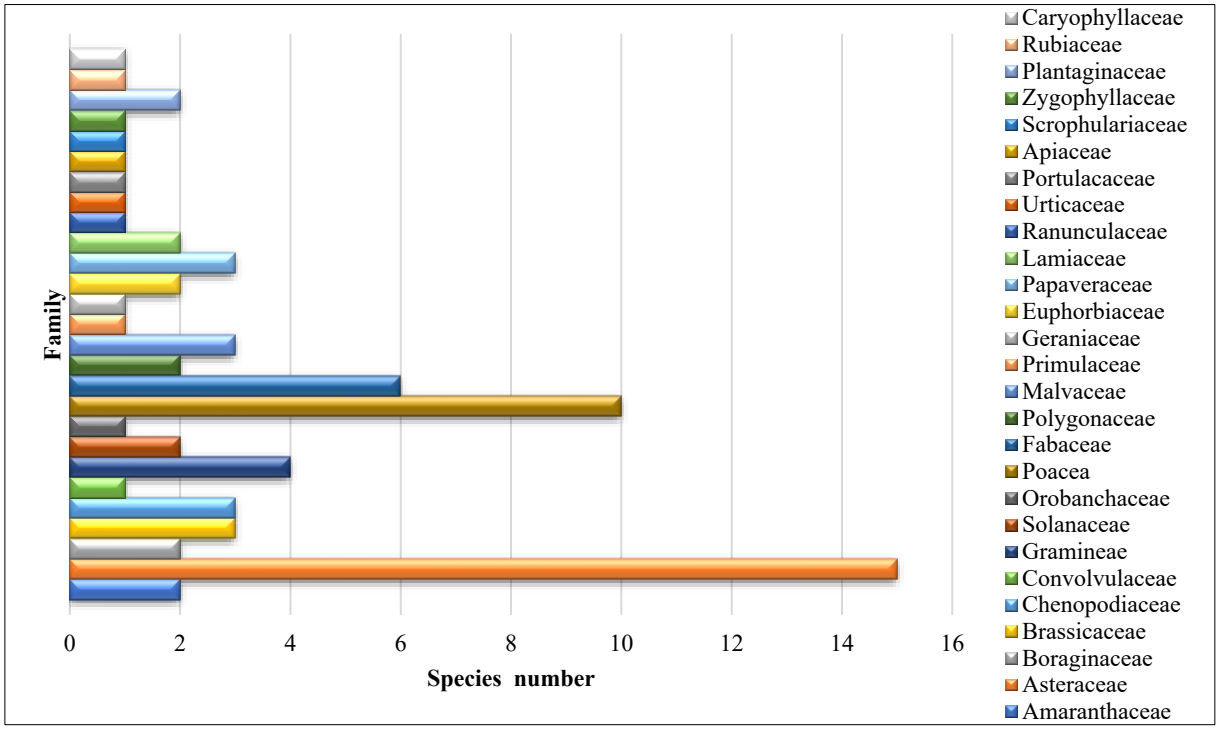

Figure 4. Distribution of weed species detected in sunflower fields in Kırşehir province according to families (number of species)

A review of the extant literature reveals a paucity of research focusing on weeds in sunflower production areas across different regions and geographies. Indeed, in studies conducted in sunflower production areas, *S. arvensis*, *A. retroflexus*, *C. album*, *Heliotropium europaeum*, *C. arvense*, and *C. arvensis* were identified as the dominant species (Karabacak and Uygur, 2017). These weeds were identified as particularly important in Istanbul, Kırklareli, and Sakarya sunflower fields. In the Aegean Region, *S. arvensis*, *C. album*, *A. retroflexus*, *S. nigrum*, *H. europaeum*, *Mercurialis annua*, *Veronica* sp., *C. arvensis*, *C. arvense*, and *Sonchus* sp. were identified as the dominant species (Zengin, 1999). In Haymana, Bala, and Sereflikoçhisar sunflower fields; *Portulaca oleracea*, Amaranthus albus, Tribulus Terrestris, C. arvensis, and *Cynodon dactylon* were found in sunflower fields in the Aegean Region (Asav and Serim, 2019). İyigün et al. (1997a) identified 96 different weed species belonging to 30 families in sunflower fields in Tokat province, with Asteraceae (13%), Poaceae (10%), Amaranthaceae (7%)

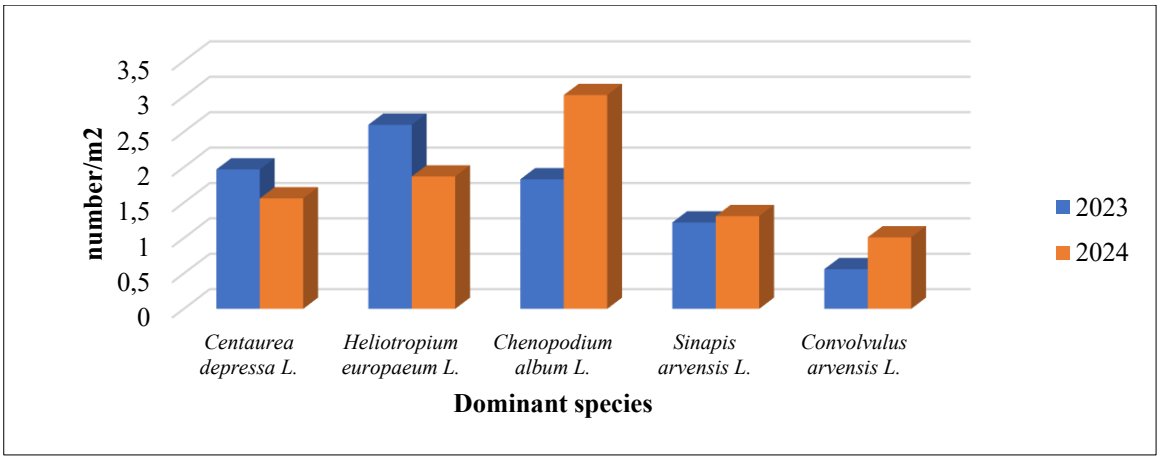

Figure 5. The dominant weed species detected in sunflower fields in Kırşehir province

and Brassicaceae (7%) being the families with the highest number of species. In a subsequent study, Yay (2015) detected 36 different weed species from 17 families in sunflower production areas in Edirne province, reporting that Asteraceae (6 species), Poaceae (5 species), Fabaceae (3 species) and Apiaceae (3 species) were the most common families. In Adana province, 52 weed species belonging to 23 families were reported. The same study also reported that the most common families were Poaceae, Asteraceae, Fabaceae, and Amaranthaceae (Karabacak, 2017). Özkil et al., (2019) found that the most common plant species belonging to the Asteraceae (11 species), Poaceae (9 species), and Fabaceae (6 species) families were present in sunflower fields in Adana province. In the present study, the families with the highest number of species were Asteraceae (15 species), Poaceae (10 species) and Fabaceae (6 species). A study of this kind was previously conducted, and the results indicated that the Asteraceae family had the most species. These two studies' findings were similar, and in fact, the similarities were almost identical. In a study of sunflower fields in Ukraine, 78 weed species belonging to 27 families were identified. Of these species, 18 taxa belonged to the Asteraceae family (Aksyonov, 2025). Within the Kırşehir sunflower production area, the Asteraceae family was identified as the family with the highest number of taxa, with 15 recorded. In the sunflower, the following taxa were identified: *Cirsium arvense* (L.) Scop., *Elytrigia repens* (L.) Desv., *Chenopodium album* L., *Amaranthus retroflexus* L., *Chenopodium hybridum* L., *Sinapis arvensis* L., *Datura stramonium* L., *Echinochloa crus-galli* (L.) P. Beauv. and *Persicaria lapathifolia* Raf. S. F. Gray, *Persicaria maculata* Raf. S. F. Gray, *Fallopia convolvulus* L. A. Love, *Avena fatua* L., *Convolvulus arvensis* L., *Tripleurospermum perforatum* (L.) Schultz-Bip., Iva xanthiifolia Nutt. (Akysyonov, 2025).

In the 2023, in the area dedicated to sunflower production, the following plant species were identified: *Heliotropium europaeum* L. (2.60 plants/m^2), *Centaurea depressa* L. (1.97 plants/m^2), *Chenopodium album* L. (1.83 plants/m^2), *Sinapis arvensis* L. (1.22 plants/m^2), and *Convolvulus arvensis* L. (0.56 plants/m^2), *Amaranthus retroflexus* L. (0.52 plants/m^2), *Avena fatua* L. (0.28 plants/m^2), *Datura stramonium* L. (0.17 plants/m^2), *Cirsum arvense* L. (0.16 plants/m^2), *Elymus repens* (L.) Gould. (0.12 plants/m^2) were identified as significant species. In the 2024 production season, the following species were identified: *Chenopodium album* (3.02 plants/m^2), *Heliotropium europaeum* (1.87 plants/m^2), *Centaurea depressa* (1.56 plants/m^2), *Sinapis arvensis* (1.31 plants/m^2), and *Convolvulus arvensis* (1.01 plants/m^2), *Xanthium strumarium* (0.41 plants/m^2), *Salsola kali* L. (0.37plants/m^2), *Orobanche cumana* Wallr. (0.30 plants/m^2), *Xanthium spinosum* (0.27 plants/m^2), *Tribulus terrestris* L. (0.21 plants/m^2). It was determined that there were similar species in terms of density between the two vegetation periods, but only proportional differences were observed.

Studies conducted in different places revealed the following in terms of weed density(plants/m$^{2)}$ that *Convolvulus* spp. (2.40), *Chenopodium album* (2.28), *Cynodon dactylon* (1.60), *Raphanus raphanistrum* L. (1.56), *Echinochloa crus-galli* (1.20) and *Elymus repens* (L.) Gould (1.00), *Amaranthus retroflexus* (0.87), *Sinapis arvensis* (0.84), *Orobanche cernua* (0.83), and *Cirsium arvense* (0.76) were reported as the densest species (Arslan and Kara, 1997). *Portulaca oleracea* (2.12), *Xanthium strumarium* (1.87), *Cynodon dactylon* (1.73), *Convolvulus arvensis* (1.30), *Amaranthus retroflexus* (1.25), *Sinapis arvensis* (1.15), *Solanum nigrum*

Table 2. Weed species, density (plant/m2), frequency (%), and plant life form in sunflower production areas in Kırşehir province

			Plant life form		2023				2024			
Family	**Scientific name**	**Bayer code**	**Growth**	**Raunkiaer**	**Frequency (%)**	**Density (number/m²)**	**FrSD**	**YoSD**	**Frequency (%)**	**Density (number/m²)**	**FrSD**	**YoSD**
Amaranthaceae	*Amaranthus retroflexus* L.	AMARE	An	Th	45.94	0.523	C	D	15.00	0.2034	M	D
	Amaranthus albus L.	AMAAL	An	Th	8.10	0.025	L	E	7.5	0.0271	L	E
Apiaceae	*Bifora radians* Bieb.	BİFRA	An	Hemic	2.70	0.008	L	F	5.00	0.0135	L	E
Asteraceae	*Acroptilon repens* L.	CENRE	Per	Hemic/Geo	10.81	0.056	L	E	7.50	0.0542	L	E
	Onopordum acanthium L.	ONRAC	Bi	Hemic	2.70	0.002	L	F	--	--	-	-
	Centaurea depressa L.	CENDE	An	Th	37.83	1.220	C	C	37.50	0.6210	C	D
	Sonchus oleraceus L.	SONOL	An/ Bi	Hemic	8.10	0.023	L	E	10.00	0.0329	L	E
	Cirsium arvense (L.) Scop	CIRAR	Per	Geo	21.62	0.161	M	D	20	0.1197	0	D
	Cichorium intybus L.	CICIN	An	Th	--	--	-	-	5.00	0.0077	L	F
	Artemisia vulgaris L.	ARTVU	Per	Hemic	--	--	-	-	2.50	0.0038	L	F
	Conyza canadensis (L.) Cronq.	ERICA	An	Th	2.70	0.004	L	F	2.50	0.0058	L	F
	Lactuca serriola L.	LACSE	Bi	Hemic	5.40	0.010	L	E	7.50	0.0155	L	E
	Anthemis arvensis L.	ANTAR	An	Th	5.40	0.016	L	E	5.00	0.0213	L	E
	Sonchus arvensis L.	SONAR	Per	Hemic	5.40	0.008	L	F	5.00	0.0058	L	F
	Xanthium spinosum	XANSP	An	Th	10.81	0.023	L	E	15	0.2732	0	D
	Xanthium strumarium L.	XANST	An	Th	27.02	0.113	C	D	15	0.4127	0	D
	Chondrilla juncea L.	CHOJU	Bi/Per	Hemic/Geo	8.10	0.090	L	E	10.00	0.1120	L	D
	Tragopogon dubius Scop.	TRODM	An	Th	--	--	-	-	2.5	0.0019	L	F
Boraginaceae	*Anchusa officinalis* L.	ANCOF	Per	Hemic	5.40	0.025	L	E	2.50	0.0038	L	F
	Heliotropium europaeum L.	HEOEU	An	Th	52.94	1.525	V	C	42.50	0.8275	C	D
	Echium vulgare L.	EHİVU	Bi/mo	Hemic	2.70	0.002	L	F	--	--	-	-

Table 2(continued)

Brassicaceae	*Boreava orientalis* Jaub and Spach	BOAOR	An	Hemic	5.40	0.006	L	F	5.00	0.0135	L	E
	Capsella bursa-pastoris (L.) Medik	CAPBP	An	Th	10.80	0.014	L	E	7.50	0.0193	L	E
	Sinapis arvensis L.	SINAR	An	Th	40.54	0.691	C	D	57.50	0.5290	V	D
Caryophyllaceae	*Gypsophila paniculata* L.	GYPPA	Per	Th	2.70	0.008	L	F	5.00	0.0116	L	E
Chenopodiaceae	*Chenopodium album* L.	CHEAL	An	Th	70.27	1.018	V	C	77.50	1.0639	V	C
	Salsola kali L.	SASKA	An	Th	16.21	0.117	M	D	32.50	0.3720	C	D
	Chenopodium vulvaria L.	CHEVU	An	Th	13.51	0.031	M	E	15.00	0.0271	0	E
Convolvulaceae	*Convolvulus arvensis* L.	CONAR	Per	Hemic	72.97	0.560	V	D	70.00	0.4806	V	D
Euphorbiaceae	*Euphorbia* spp.	-	Per	Th	8.10	0.006	L	F	5.00	0.0077	L	F
	Chrozophora tinctoria (L.) Rafin	CRZTI	An	Th	13.51	0.016	M	E	12.50	0.0271	0	E
Fabaceae	*Trifolium* spp.	-	Per	Hemic	5.40	0.008	L	F	--	--	-	-
	Vicia faba L.	VICFX	An	Th	2.70	0.002	L	F	--	--	-	-
	Alhagi pseudalhagi (Bieb.) Desv.	ALHPS	Per	Hemic	2.70	0.002	L	F	--	--	-	-
	Vicia sativa L.	VISA	An	Th	--	--	-	-	2.50	0.0038	L	F
	Lathyrus aphaca L.	LTHAP	An	Th	--	--	-	-	2.50	0.0019	L	F
	Melilotus officinalis L. Ders.	MEUOF	An	Th	2.70	0.002	L	F	--	--	-	-
Geraniaceae	*Erodium cicutarium* (L.) L'Herit.	EROCI	An	Th	5.40	0.012	L	N	2.50	0.0096	L	F
Lamiaceae	*Salvia* spp.	-	An/Per	Th	--	--	-	-	2.50	0.0019	L	F
	Galeopsis tetrahit L.	GAETE	An	Th	2.70	0.006	L	F	--	--	-	-
Malvaceae	*Malva sylvestris* L.	MALSI	An	Hemic	5.40	0.006	L	F	2.50	0.0038	L	F
	Hibiscus trionum L.	HIBTR	An	Th	--	--	-	-	2.50	0.0019	L	F
	Abutilion theophrasti Medik	ABUTH	An	Th	2.70	0.006	L	F	2.50	0.0019	L	F
Orobanchaceae	*Orobanche cumana* Wallr.	ORAKM	Par.	Geofit	13.51	0.100	M	D	15.00	0.3042	0	D

Table 2(continued)

Papaveraceae	*Fumaria vaillantii* Loisel.	FUMVA	An	Th	2.70	0.002	L	F	--	--	-	-
	Fumaria officinalis L.	FUMOF	An	Th	2.70	0.002	L	F	5.00	0.0058	L	F
	Papaver rhoeas L.	PAPRH	An	Th	2.70	0.004	L	F	2.50	0.0019	L	F
Plantaginaceae	*Veronica arvensis* L.	VERAR	An	Th	2.70	0.006	L	F	2.50	0.0038	L	F
	Plantago lanceolata L.	PLALA	Per	Hemic	2.70	0.002	L	F	2.50	0.0038	L	F
Poaceae	*Agropyron repens* (L.) Gould	AGRRE	Per	Cham/Geo	16.21	0.128	M	D	12.5	0.0193	0	E
	Lolium spp.	-	Per	Hemic	--	--	-	-	2.50	0.0038	L	F
	Avena fatua L.	AVEFA	An	Th	27.02	0.281	C	D	15	0.1844	0	D
	Hordeum vulgare L.	HORVX	An	Hemic	13.51	0.069	M	E	10.00	0.0639	L	E
	Triticum aestivum L.	TRZAS	An	Th	2.70	0.010	L	E	--	--	-	-
	Bromus spp.	-	An	Th	10.80	0.048	L	E	12.50	0.0562	0	E
	Phragmites australis (Cav.)	PHRAU	Per	Geo	--	--	-	-	2.50	0.0019	L	F
	Echinochloa crus -galli (L.) Beauv.	ECHCG	An	Th	13.51	0.052	M	E	10.00	0.0465	L	E
	Secale cereale L.	SECCE	An	Th	5.40	0.017	L	E	5.00	0.0135	L	E
	Setaria verticillata (L.)P.B.	SETVE	An/Bi	Th	5.40	0.029	L	E	7.50	0.0368	L	E
Polygonaceae	*Polygonum convolvulus* L.	POLCO	Per	Hemic	13.51	0.039	M	E	25.00	0.0445	C	E
	Rumex obtusifolius L.	RUMOB	Per	Hemic	2.70	0.002	L	F	2.50	0.0038	L	F
Portulacaceae	*Portulaca oleracea* L.	POROL	An	Th	5.40	0.018	L	E	7.50	0.0232	L	E
Primulaceae	*Anagallis arvensis* L.	ANGAR	An	Th	2.70	0.004	L	F	--	--	-	-
Scrophulariaceae	*Verbascum nigrum* L.	VESNI	Per	Hemic	2.70	0.002	L	F	--	--	-	-
Solanaceae	*Datura stramonium* L.	DATST	An	Th	18.91	0.170	M	D	10.00	0.0368	L	E
	Solanum nignum L.	SOLNI	An	Th	8.10	0.084	L	E	17.50	0.0058	0	F
Ranunculaceae	*Adonis flammea* Jacq.	ADOFL	An	Th	2.70	0.002	L	F	--	--	-	-
Rubiaceae	*Galium aparine* L.	GALAP	An	Hemic	2.70	0.002	L	F	--	--	-	-
Urticaceae	*Urtica urens* L.	URTUR	An	Th	2.70	0.008	L	F	2.50	0.0038	L	F
Zygophyllaceae	*Tribulus terrestris* L.	TRBTE	An	Hemic	10.81	0.056	L	E	17.5	0.2148	0	D

(0.99), *Tribulus terrestris* (0.98), *Daucus carota* (0.86), *Datura stramonium* (0.81) (Yay, 2015). In a subsequent study, Karabacak (2017) reported that *Chenopodium album* (3.24), *Convolvulus arvensis* (2.35), and *Cyperus rotundus* L. (1.62) were identified as the most prevalent species in the study area. *Avena sterilis* (1.20), and *Amaranthus retroflexus* (1.04) were identified as the most dense species in sunflower cultivation areas in Adana province in 2015. In 2016 surveys, *Chenopodium album* (3.40), *Echinochloa colonum* (L.) Link. (1.86), *Orobanche cernua* (1.41), *Cyperus rotundus* (1.30) and *Heliotropium europaeum* (0.60) were reported as the most dense species. In Ankara, sunflower production areas, *Xanthium strumarium* (5.65), *Sinapis arvensis* (4.32), *Orobanche ramosa* (3.18) were reported as the most prevalent weeds (Asav and Serim, 2019). In a separate study, *Chenopodium album* (6.76), *Heliotropium europaeum* (3.75) and C. arvensis (3.05) were identified as the most dominant species in sunflower production areas of Adana province during the initial survey period (Özkil et al., 2019). In the subsequent survey period, *Chenopodium album* emerged as the most prevalent species, with a density of 5.13 plants per square meter, followed by *C. vulvaria* (2.42) and *Cyperus rotundus* (1.98) (Özkil et al., 2019).

Concerning the prevalence (frequency of occurrence) of weed species, *Convolvulus arvensis* L. (72.97%), *Chenopodium album* L. (70.27%), *Heliotropium europaeum* L. (52.94%), *Amaranthus retroflexus* L. (45.94%), and *Sinapis arvensis* L. (4 0.54%); in 2024, *Chenopodium album* (77.5%), *Convolvulus arvensis* (70%), *Sinapis arvensis* (57.5%), *Heliotropium europaeum* (42.5%), *Centaurea depressa* (37.5%) were the most common species (*Table 2*).

Within the context of sunflower fields in Kırşehir, *Centaurea depressa* L., *Heliotropium europaeum* L., *Chenopodium album* L., *Sinapis arvensis* L. and *Convolvulus arvensis* L. emerged as the predominant species, exhibiting densities per m^2 (*Figure 5*). Zengin (1999) reported that *Sinapsis arvesis*, *Convolvulus arvensis*, *Cirsium arvense*, and *Chenopodium album* ranked first in frequency and density in sunflower fields in Erzurum province. Karabacak (2017) identified *Chenopodium album* (73.58%), *Convolvulus arvensis* (66.04%), *Amaranthus retroflexus* (62.26%), *Cyperus rotundus* L. (37.74%) and *Euphorbia prostrata* Aiton. (26.42%), and in 2016, *Chenopodium album* (61.90%), *Convolvulus arvensis* (57.14%), *Heliotropium europaeum* (52.38%), *Amaranthus retroflexus* (40.48%), and *Polygonum aviculare* (30.35%).

4. Conclusions

It is conceivable that the weed species, densities, and dominant species present in sunflower production locations may vary or be analogous. Due to the disparities in agricultural production patterns, soil tillage, water availability, crop rotation systems, herbicide selection, applications, and the variances in the ecological requirements of weeds, alterations in weed species can be expected. Consequently, ascertaining the predominant weeds in a production area through surveys is imperative for formulating integrated control programs. Therefore, surveys in different years are recommended to identify dominant weed species, given the potential for variation in weed species and densities due to changes in crop rotation systems, soil tillage, and climatic conditions. In the context of weed control in agricultural areas, it is imperative to understand the type of weed, its botanical characteristics, the entire weed flora, the relationships between them, and the environmental conditions. In this respect, it is imperative to ascertain the weed species proliferating in production areas. The selection of an effective weed control method in the sunflower production area of Kırşehir province is contingent on identifying the weed species in the area. In this context, it is hypothesized that the initial study's findings on identifying problematic weeds in sunflower production in Kırşehir province will be instrumental in investigating weed control possibilities and the sustainability of agriculture.

Ethical Statement

There is no need to obtain permission from the ethics committee for this study.

Conflicts of Interest

There is no conflict of interest between the article authors.

Authorship Contribution Statement

Concept: Yılar, M., Göktaş, M. E.; Design: Yılar, M., Göktaş, M. E.; Data Collection or Processing: Göktaş, M. E.; Literature SearchGöktaş, M. E., Yılar, M.; Writing, Review and Editing: Göktaş, M. E., Yılar, M.

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