jotaf
Journal of Tekirdag Agricultural Faculty
Tekirdağ Ziraat Fakültesi Dergisi

Ekim/October 2026, 23(5)
Başvuru/Received: 24/01/26
Kabul/Accepted: 10/09/26
DOI: 10.33462/jotaf.1871098

http://dergipark.gov.tr/jotaf
http://jotaf.nku.edu.tr/

ARAŞTIRMA MAKALESİ **RESEARCH ARTICLE**

Weed Community Dynamics Under Regular Mowing in Newly Established Turfgrass Lawns

Yeni Tesis Edilen Çim Alanlarında Düzenli Biçmenin Yabancı Ot Topluluğu Dinamiklerine Etkisi

Ramazan GÜRBÜZ[1], Harun ALPTEKİN[2], Olga PANFILOVA[3], İbrahim KAHRAMANOĞLU[4], Yasin Emre KİTİŞ[5*]

Abstract

Maintaining functionality and aesthetic quality in urban lawns requires the implementation of sustainable weed management strategies that reduce herbicide use. This study aimed to determine the effects of regular mowing on weed community composition, frequency, and density in newly established lawns located at the foothills of Ağrı Mountain in Eastern Türkiye. Fieldwork was conducted during two vegetation periods between 2019 and 2020; mowing was applied at 20-day intervals from early April to early October at a cutting height of 5 cm. Weed species composition, frequency, and density were evaluated through periodic observations. In the location where the study was conducted, 39 weed species representing 15 botanical families were recorded, of which 22 were annual, 16 perennial, and one parasitic species. The most represented families were *Amaranthaceae*, *Fabaceae*, and *Poaceae*. Mowing practices significantly affected the weed community structure; Specifically, while the density of upright-growing annual species such as *Chenopodium album* decreased, the persistence of creeping and perennial species such as *Trifolium repens* and *Cynodon dactylon* increased. Although a decrease in total weed density was observed over time, perennial and monocotyledonous species were found to be more tolerant to mowing. Statistical analyses revealed that mowing had significant effects on the frequency and density of these groups, while total weed abundance showed moderate temporal variation. In conclusion, mowing practices are effective in suppressing upright-growing annual weeds, but are limited in controlling creeping and perennial species. Therefore, for long-term and sustainable weed management in turf areas, mechanical practices need to be supported by ecologically based methods. This study contributes to understanding weed dynamics in urban turf areas and provides a scientific basis for developing more effective management strategies.

Keywords: Weed density, Species diversity, Mowing management, Urban turfgrass, Perennial weeds

[1]Ramazan Gürbüz, Department of Plant Protection, Faculty of Agriculture, Iğdır University, Iğdır, Türkiye. E-mail: r_grbz@yahoo.com OrcID: 0000-0003-3558-9823
[2]Harun Alptekin, Department of Agricultural Science, Postgraduate Education Institute, Iğdır University, Iğdır, Türkiye. E-mail: harunalptekinn04@gmail.com OrcID: 0000-0001-9319-311X
[3]Olga Panfilova, Russian Research Institute of Fruit Crop Breeding (VNIISPK), Zhilina 302530, Orel District, Orel Region, Russia. E-mail: panfilova@orel.vniispk.ru OrcID: 0000-0003-4156-6919
[4]İbrahim Kahramanoğlu, Department of Horticulture, Faculty of Agricultural Sciences and Technologies, European University of Lefke, Gemikonağı, Northern Cyprus, via Mersin 10, Türkiye. E-mail: ikahramanoglu@eul.edu.tr OrcID: 0000-0002-6074-6395
[5]***Sorumlu Yazar/Corresponding Author:** Yasin Emre Kitiş, Department of Plant Protection, Faculty of Agriculture, Akdeniz University, Antalya, Türkiye. E-mail: emrekitis@akdeniz.edu.tr OrcID: 0000-0003-2949-8423
Atıf: Gürbüz, R., Alptekin, H., Panfilova, O., Kahramanoğlu, İ., Kitiş, Y. E. (2026). Yeni tesis edilen çim alanlarında düzenli biçmenin yabancı ot topluluğu dinamikleri. *Tekirdağ Ziraat Fakültesi Dergisi,* 23(5): 1799-1814.
Citation: Gürbüz, R., Alptekin, H., Panfilova, O., Kahramanoğlu, İ., Kitiş, Y. E. (2026). Weed community dynamics under regular mowing in newly established turfgrass lawns. *Journal of Tekirdag Agricultural Faculty,* 23(5): 1799-1814.

©Bu çalışma Tekirdağ Namık Kemal Üniversitesi tarafından Creative Commons Lisansı (https://creativecommons.org/licenses/by-nc/4.0/) kapsamında yayınlanmıştır. Tekirdağ 2026

Öz

Kentsel çim alanlarında işlevselliğin ve estetik kalitenin korunması, herbisit kullanımını azaltan sürdürülebilir yabancı ot yönetim stratejilerinin uygulanmasını gerektirmektedir. Bu çalışma, Türkiye'nin doğusunda Ağrı Dağı eteklerinde yeni tesis edilen çim alanlarında düzenli biçimin yabancı ot topluluğu, frekansı ve yoğunluğu üzerindeki etkilerini belirlemeyi amaçlamıştır. Arazi çalışmaları 2019 ve 2020 yıllarını kapsayan iki vejetasyon döneminde yürütülmüş; Nisan ayı başından Ekim ayı başına kadar 20 günlük aralıklarla ve 5 cm yükseklikten biçim uygulaması gerçekleştirilmiştir. Yabancı ot tür kompozisyonu, sıklığı ve yoğunluğu periyodik gözlemler yoluyla değerlendirilmiştir. Çalışmanın yürütüldüğü alanda, 15 familyaya ait toplam 39 yabancı ot türü tespit edilmiş olup, bunların 22'si tek yıllık, 16'sı çok yıllık ve biri parazit tür olarak belirlenmiştir. En yaygın familyalar *Amaranthaceae*, *Fabaceae* ve *Poaceae* olmuştur. Biçim uygulamalarının yabancı ot topluluk yapısını anlamlı düzeyde etkilediği belirlenmiştir. Özellikle *Chenopodium album* gibi dik gelişen tek yıllık türlerin yoğunluğu azalırken, *Trifolium repens* ve *Cynodon dactylon* gibi sürünücü ve çok yıllık türlerin kalıcılığının arttığı gözlenmiştir. Zaman içerisinde toplam yabancı ot yoğunluğunda bir azalma görülmekle birlikte, çok yıllık ve tek çenekli türlerin biçime karşı daha toleranslı olduğu saptanmıştır. İstatistiksel analizler, biçimin bu grupların sıklık ve yoğunlukları üzerinde anlamlı etkiler oluşturduğunu, toplam yabancı ot yoğunluğunun ise zamana bağlı olarak orta düzeyde değişim gösterdiğini ortaya koymuştur. Sonuç olarak, biçme uygulamaları dik gelişen tek yıllık yabancı otların baskılanmasında etkili olmakla birlikte, sürünücü ve çok yıllık türlerin kontrolünde sınırlı kalmaktadır. Bu nedenle, çim alanlarında uzun vadeli ve sürdürülebilir bir yabancı ot yönetimi için mekanik uygulamaların ekolojik temelli yöntemlerle desteklenmesi gerekmektedir. Bu çalışma, kentsel çim alanlarında yabancı ot dinamiklerinin anlaşılmasına katkı sağlamakta ve daha etkili yönetim stratejilerinin geliştirilmesi için bilimsel bir temel sunmaktadır.

Anahtar Kelimeler: Yabancı ot yoğunluğu, Tür çeşitliliği, Biçme yönetimi, Kentsel çim alanları, Çok yıllık yabancı otlar

1. Introduction

Lawns are an integral part of the territory of any region and are of great importance in the formation of the landscape. Besides their aesthetic beauty in the urban green area system, green areas also support sports, playing and resting (Kuşvuran, 2012; Yılmaz and Hurmanlı, 2016). Due to those relevant reasons, turfgrass areas are considered to form the basic structure of urban green areas (Oral and Açıkgöz, 2001). Furthermore, multifaceted but significant roles depending on the soil texture have been also attributed to grasses by reducing the speed of rainfall water and subsequently infiltration to the soil (Mueller and Thompson, 2009). Also, turfgrasses keep the humidity and temperature of the environment in balance, especially with irrigation (Hall et al., 2016). As common to all plant species, their photosynthesis activities release oxygen to the environment while producing organic compounds necessary for their growth. A turfgrass cover of approximately 55-60 m^2 meets the daily oxygen need of a person (Kuşvuran, 2012).

Currently, a number of draft laws are being developed, in which there is a clear division of lawns into natural and artificially landscaped territories. The main criterion for this separation is the species diversity of grasses that form the basis of the lawn (Oral and Açıkgöz, 2001). One of the relevant directions is the creation of territories belonging to the group of landscaped areas, as well as the development of scientifically based measures (including biotechnical measures), with the help of which it will be possible to control the species composition of the lawn. It often happens that the intensity of lawn care and biodiversity (the ability to self-regulate) are inversely related (Mueller and Thompson, 2009).

In Türkiye, multi-species lawns (or species-saving lawns) from wild plants are often used in the green construction of cities. To create and maintain species-saving forms of landscaping, it is necessary to test various technologies and care schemes experimentally, as well as to use foreign experience. Technological issues of designing lawn coverings and their ecological and biological justification have not been sufficiently studied. One of the main objectives in turfgrass management is the development of integrated agrotechnical measures that provide optimal conditions for the growth and development of turf-forming grasses, ensuring dense turf cover, aesthetic quality, longevity, and resistance to anthropogenic stress (Volkova and Sobolev, 2015; Min et al., 2018). The maintenance of the lawn during exploitation should be based on the organization of scientifically based care of turfgrass which consists in a system of measures such as irrigation, shearing, fertilizing, mulching, scarification, aeration, verticulation, protection from weeds, pathogens and pests of lawn grasses. Systematic care of lawns determines not only the state of their herbage but also their decorativeness and durability. The growth and development of lawn grasses in various designated areas largely depend on the quality of agrotechnical measures. In order for lawns to really meet their purpose, they must be clean of weeds and extraneous objects, they must be systematically mowed, trimmed, fertilized, watered and repaired in a timely manner (Ihtisham et al., 2020; Gastasheva and Didanova, 2020; Hahn et al., 2020).

To achieve a smooth green carpet and promote tillering and branching of lawn turfgrasses, regular mowing is essential. Mowing helps in creating a denser turfgrass, which enhances the decorative qualities of the lawn. However, the frequency of mowing may vary for lawns of different types, depending on the specific turfgrass species and growth rates (Larsen et al., 2004). In addition to promoting healthy turfgrass growth, mowing also plays a crucial role in weed control. Weeds not only compete with turfgrass plants for water and nutrients absorbed from the soil, but some weed species may gradually become dominant, leading to the loss of turfgrass characteristics of the area, deteriorating its visual quality, and increasing maintenance costs (Yazlık et al., 2019; Kara et al., 2024). Although numerous weed species can be observed in turfgrass areas, the most problematic ones are generally biennial or perennial weeds with deep root systems and rosette growth form (Kitiş, 2011). Systematic removal of weeds is an important agrotechnical practice in lawn maintenance. Perennial weeds can be particularly challenging to manage, and mowing the turfgrass is one of the primary methods used for weed control. By cutting the turfgrass regularly, weeds are suppressed, and their growth is kept in check, contributing to the overall health and beauty of the lawns (Gastasheva and Didanova, 2020). Mowing does not remove the root system of the weeds and the main types of lawn grasses are rejuvenated which causes them to be preserved in the herbage for decades (Busey, 2003). The frequency of lawn mowing depends on the characteristics of the growth of cultivated turfgrasses, the dose of nitrogen fertilizers, the moisture reserve in the soil, climatic conditions and the purpose of the turf. Frequent mowing causes the formation of a large number of internodes,

covering leaves and buds in the tillering zone of cereal grasses, and stimulates an increase in the total number of shoots due to the appearance of shoots of higher orders, thereby enhancing vegetative renewal. Still, many dicotyledonous weeds can be controlled, especially if the weeds are mowed before the seed is set (Abu-Dieyeh and Watson, 2005).

The weed species and the number of dominant weeds in agrophytocenoses are strongly influenced by the soil and climatic conditions of the region and by cultivation techniques (Torikov et al., 2018). The weeds also react differently to mowing. Khan et al. (2021) reported that *Euphorbia hirta* was controlled by mowing but bindweed (*Convolvulus arvensis*) was not controlled. Up to 40% of the reserves stored in perennial weed rhizomes were depleted after six years of mowing; however, complete weed suppression in turfgrass areas was not achieved (Stoll et al., 1998). Timmons (1950) stated that the bindweed (*C. arvensis*) population was controlled by mowing every two weeks but the dandelion (*Taraxacum officinale*) was not controlled by the mowing process. In addition, weeds such as dandelion (*T. officinale*) and white clover (*Trifolium repens*) pose a major problem in turfgrass areas because they cannot be controlled by mowing when they are too close to the ground (Larsen et al., 2004). Studies show that weed densities can often be reduced, but never fully controlled by mowing alone (Busey, 2003).

This study aims to assess the effects of mowing on the frequency and density of weed species in newly established turfgrass areas located at the foothills of Mount Ararat in eastern Türkiye. Specifically, the research seeks to elucidate the role of mowing as a physical weed management practice in shaping weed community composition and abundance, with the broader objective of reducing reliance on chemical herbicides and promoting more sustainable lawn management strategies. To achieve these aims, a two-year field experiment (2019–2020) was conducted to evaluate the impacts of regularly applied mowing regimes on weed populations, with particular emphasis on the differential responses of annual and perennial weed species.

2. Materials and Methods

2.1. Turfgrass materials, characteristic of the experimental soils and climatic conditions of the region

A two-year field experiment was carried out between 2019 and 2020 to evaluate the effects of regular mowing on weed species composition, frequency, and density in newly established turfgrass areas located at the Iğdır University Şehit Bülent Yurtseven Campus. The total turfgrass area evaluated in the study covered approximately 14.5 ha and consisted of newly established lawn areas managed under the same maintenance conditions. Weed surveys were conducted within representative assessment areas selected from the experimental site. During each survey period, four 1 m² quadrats were randomly placed within a 0.1 ha sampling area, and weed species and densities were recorded. Mowing operations were performed using a lawn tractor (Alpina® AT8 122 HW) equipped with a 122 cm cutting deck, adjusted to a cutting height of 5 cm. The lawns were established using a hydroseeding technique on March 15, 2019. The turfgrass seed mixture applied in the experimental area consisted of perennial ryegrass (*Lolium perenne*) at 25%, tall fescue (*Festuca arundinacea*) at 45%, Kentucky bluegrass (*Poa pratensis*) at 10%, and red fescue (*Festuca rubra*) at 20%. Depending on climatic conditions, irrigation was carried out with a sprinkler irrigation system, taking into account the water need of the turfgrass plants. The properties of the experimental soils were pH (8.37), texture: sandy loam, lime (10.51%), P_2O_5 (1917.60 kg/ha), K_2O (139.79 kg/ha), organic matter (1.95%), salt (0.04%), and saturation (71.55%). The climatic conditions of the region are presented in *Table 1*.

Table 1. Meteorological data from the research area (2019-2020)

Months	Mean Temperature (°C)			Total Rainfall (mm)			Mean Relative Humidity (%)		
	2019	2020	MLY*	2019	2020	MLY*	2019	2020	MLY*
March	6.8	10.4	6.2	23.5	18.1	22.1	69.6	65.6	52.2
April	12.1	11.5	13.0	25.1	83.6	33.8	66.6	76.6	49.9
May	19.9	18.8	17.7	25.9	76.1	46.5	58.1	63.1	51.5
June	25.6	24.2	22.1	13.6	15.7	32.0	51.6	48.3	47.3
July	27.3	26.2	25.9	0.6	0.9	13.7	44.2	53.4	45.3
August	27.0	25.2	25.3	0.6	1.2	9.7	46.0	55.3	47.1
September	19.9	18.2	20.4	15.4	16.0	11.5	62.0	68.8	46.2
October	15.8	14.6	13.1	4.5	6.1	26.3	66.0	75.2	48.5

**MLY: Mean of long years from 1941 to 2019 (Anonymous, 2020).*

2.2 Determining the effects of mowing on weed species and populations

The first mowing was done on the 5th of April 2019 and then, a total of 8 mows with 20 days of interval were conducted at a height of 5 cm till the first week of October. This was done in both years and a total of 16 mows in two consecutive years were evaluated. Surveys were carried out to determine the effects of the mowing process and time on weed species and population. The first survey was conducted before the initial mowing treatment, and subsequent surveys were performed after every two mowing applications. In total, eight surveys were conducted during the 2019–2020 experimental period. In the survey, one m^2 quadrat was randomly thrown four times in a 0,1-hectare area and the weed species and numbers found in the quadrats were counted (Üremiş et al., 2020). The identification of weed species followed references, Davis (1965-1985), Davis et al. (1988) and Özer et al. (1999). The species, numbers and the areas covered by weeds were recorded and the number of plants per square meter and frequency of occurrence was calculated using the following formula (1) (Odum, 1971).

$$\text{Coincidence (Absolute) frequency (C.F.\%)} = (n/m)\, x\, 100 \quad \text{(Eq.1).}$$

n: number of samples, where a species is observed; m: total number of samples

Species-specific weed density was determined by dividing the total density by the number of sampled quadrats. In addition, the number of shoots of turfgrass contaminated with dodder per square meter, the method used by Güncan, (1972) was taken into consideration.

$$\text{Density (plant.}\, m^{-2}) = B/m \quad \text{(Eq.2).}$$

B: total number of individuals in the samples; m: total number of samples

Similarity indexes (also called as Sørensen community similarity index) were determined using Sorensen's equation in order to compare the weed species determined during the surveys in the turfgrass area with other studies (Magurran, 2021).

$$\text{Similarity Index } (SI) = \frac{2xC}{A+B}\, x\, 100 \quad \text{(Eq.3).}$$

C: number of common weeds seen in both surveys; A: number of weed species in Survey A; B: number of weed species in Survey B

2.3 Statistical analysis

The surveyed weed species were evaluated separately according to their leaf structures (monocot or dicot) and their life cycle (annual or perennial), and the changes in the average, frequency and density of surveys were noted. Statistical analyses were performed using SPSS (Version 22) (Allen et al., 2014) in order to determine the significant effects of mowing on the different weed species over time. Repeated measurements were analyzed using the GLM procedure. Mean comparisons among survey periods were performed using Duncan's multiple range test at the 5% significance level ($p < 0.05$).

3. Results and Discussion

The results indicated that a total of 39 weed species belonging to 15 botanical families were identified in the turfgrass area throughout the 2019–2020 experimental period. Detailed information on the identified species and their life cycles is presented in *Table 2*. Among the recorded weed species, 22 were annual, 16 were perennial, and one species was parasitic. Among the 15 recorded families, Amaranthaceae, Fabaceae, and Poaceae were the most represented, each comprising six species. The dominance of these families may be associated with their ecological adaptability, competitive ability, and successful establishment under turfgrass conditions. In addition, the high diversity of dicotyledonous (dicot) weed species may be related to their broad ecological adaptability and competitive growth characteristics. Several dicots weed species possess well-developed taproot systems that enhance water and nutrient uptake under different environmental conditions, contributing to their persistence and successful establishment in turfgrass areas.

Table 2. Scientific name, common names and life cycles of the species

Family	Scientific name	Common name	Life cycle*
Monocot			
Cyperaceae	*Cyperus rotundus* L.	Purple nutsedge	P
Poaceae	*Alopecurus pratensis* L.	Meadow foxtail	WA
	Cynodon dactylon (L.) Pers.	Bermudagrass	P
	Hordeum murinum L.	Mouse barley	WA
	Phragmites australis (Cav.) Trin. Ex St.	Common reed	P
	Setaria verticillata (L.) P.B.	Bristlegrass	SA
	Sorghum halepense (L.) Pers.	Johnson grass	P
Dicot			
Amaranthaceae	*Amaranthus blitoides* S. Wats	Prostrate pigweed	SA
	Atriplex spp.	Saltbush species	SA
	Ceratocarpus arenarius L.	Ceratocarpus	WA
	Chenopodium album L.	Fat hen	SA
	Chenopodium botrys L.	Jerusalem-oak	SA
	Suaeda altissima (L.) PALL.	Seablite	SA
Asteraceae	*Cirsium arvense* (L.) Scop.	Canada thistle	P
	Lactuca serriola L.	Prickly lettuce	P
	Sonchus oleraceus L.	Sow thistle	WA
	Taraxacum officinale F.H. Wigg.	Dandelion	P
	Xanthium strumarium L.	Rough cocklebur	SA
Boraginaceae	*Onosma* spp.	Onosma species	P
Brassicaceae	*Capsella bursa-pastoris* (L.) Medik.	Shepherd's-purse	WA
	Raphanus raphanistrum L.	Radish	WA
	Sinapis arvensis L.	Charlock mustard	WA
Caryophyllaceae	*Stellaria media* (L.) Vill.	Chickweed	WA
Convolvulaceae	*Convolvulus arvensis* L.	Field bindweed	P
Fabaceae	*Alhagi pseudalhagi* (BIEB.) DESV.	Camel thorn	P
	Melilotus albus Medik.	Honey clover	WA
	Glycyrrhiza glabra L.	Liquorice	P
	Trifolium pratense L.	Red clover	P
	Trifolium repens L.	White clover	P
	Trigonella foenum-graecum L.	Fenugreek	SA
Lamiaceae	*Ziziphora capitata* L.	Ziziphora	SA
	Mentha longifolia L.	Horsemint	P
Malvaceae	*Malva sylvestris* L.	Mallow	P
Papaveraceae	*Papaver rhoeas* L.	Common poppy	WA
Plantaginaceae	*Plantago lanceolata* L.	Buckhorn plantain	P
	Plantago major L.	Broad-leaved plantain	P
Polygonaceae	*Polygonum arenastrum* Bor.	Common knotgrass	SA
	Rumex crispus L.	Curly dock	P
Parasite			
Cuscutaceae	*Cuscuta* sp.	Dodder	SA

**P: perennial; SA: summer annual; WA: winter annual*

Consequently, relatively fewer species were recorded in the Asteraceae (5 species) and Brassicaceae (3 species) families, while Lamiaceae (2 species), Plantaginaceae (2 species), and Polygonaceae (2 species) were represented by a limited number of taxa, and the remaining families were represented by only one species each. In addition, certain weed species belonging to these families have been reported to release secondary metabolites that may influence neighboring plants through allelopathic interactions (Callaway et al., 2005). *Table 3* presents the similarity index of weed species observed across the surveys. The similarity index indicates the percentage of shared weed species

between different survey pairs. Values ranged from 55.5% to 100%, with higher percentages reflecting greater similarity in weed species composition among the surveyed areas. For instance, survey pairs 7–8 and 6–8 exhibited similarity indices of 100% and 94.1%, respectively, indicating a high degree of similarity in weed species composition. In contrast, survey pairs 1–7 and 1–8 showed the lowest similarity index (55.5%), suggesting relatively lower overlap in weed species between these surveys. Similar weed species composition was also reported by Gürbüz and Alptekin (2022) in turfgrass areas located at the Iğdır University Şehit Bülent Yurtseven Campus, where species such *as Chenopodium album, Convolvulus arvensis, Plantago lanceolata*, and *T. officinale* were identified as problematic weeds in lawn ecosystems.

Table 3. Similarity index between observed weed species based on the surveys (%)

Surveys compared	Number of common weed species among surveys	Similarity index (%)
1-2	29	85.29
1-3	24	73.84
1-4	21	70.00
1-5	19	64.40
1-6	18	63.15
1-7	15	55.55
1-8	15	55.55
2-3	34	90.41
2-4	29	85.29
2-5	28	94.91
2-6	26	91.22
2-7	23	85.18
2-8	23	85.18
3-4	30	92.30
3-5	29	90.62
3-6	28	90.32
3-7	24	81.35
3-8	24	81.35
4-5	27	91.52
4-6	25	87.71
4-7	23	85.18
4-8	23	85.18
5-6	27	96.42
5-7	23	86.79
5-8	23	86.79
6-7	24	94.11
6-8	24	94.11
7-8	24	100.00

The effects of regular mowing on weed composition in turfgrass areas can be complex and depend on various factors, including the specific weed and turfgrass species present, mowing frequency and height, environmental conditions, and management practices (Uddin et al., 2010). During the two years of the observations, a total of 22

annual, 16 perennials and one parasitic weed species were identified. Weed community composition changed over time in response to regular mowing practices. Although the frequency and density of several upright-growing annual weeds decreased during the survey periods, some perennial and low-growing species exhibited increasing trends. These differences may be associated with species-specific ecological adaptations, seasonal emergence patterns, and tolerance to repeated mowing (Abu-Dieyeh and Watson, 2007; Fan et al., 2020). In particular, perennial species such as Trifolium repens, *T. officinale*, and *Cynodon dactylon* increased during later survey periods, indicating greater adaptation to mowing conditions. Similarly, some annual species, including *Setaria verticillata* and *Trigonella* sp., also exhibited increasing trends, possibly due to continuous seed emergence and seasonal growth characteristics (Supek et al., 2017). Overall, mowing tended to suppress several dicotyledonous and upright-growing annual weeds while favoring perennial and prostrate-growing species (Kitiş et al., 2017). Research showed that weed densities can generally be reduced but can never be completely controlled by mowing and fertilizing (Abu-Dieyeh and Watson, 2007; Fan et al., 2020). The extent to which overall weed densities can be reduced also depends on the competitiveness of the turfgrass species composition (DeBels et al., 2012; Hahn et al., 2020). Results from the eight surveys conducted during 2019–2020 indicated that *C. album* was the most frequent weed species in the first three surveys, with frequencies of 86%, 52%, and 34%, respectively. In contrast, *T. repens* and *C. dactylon* showed the highest frequencies in the fourth survey (24%) (*Table 4*). Although mowing led to a reduction in the frequency and density of some weed species over time, others exhibited an increase. This increase was not directly attributable to the mowing practice itself, but rather to the inherent biological characteristics of certain weed species and the limited effectiveness of mowing as a control method for these species (Kitiş et al., 2017).

While mowing effectively suppressed several sensitive weeds, the frequency and density of *Trifolium repens* increased throughout the study period. Similarly, *T. pratense* and *Melilotus albus*, which share comparable growth traits, demonstrated a high tolerance to mowing. These three species, all belonging to the Fabaceae family, possess nitrogen-fixing capabilities and exhibit resistance to nutrient-deficient conditions. Moreover, a single mowing event is insufficient to eliminate these weeds, as they can easily regrow after mowing. In addition, *T.officinale*, another widespread grassland weed, also increased over time and showed strong resistance to mowing effects.

In a two-year study conducted between 2019 and 2020 to evaluate changes in weed frequency in newly established turfgrass areas located at the foothills of Mount Ararat in eastern Türkiye, data obtained from eight surveys were used to assess temporal fluctuations in weed populations. Among monocotyledonous weeds, *Cynodon dactylon* showed a slight increase in frequency, rising from 22 (%) frequency in 2019 to 24 in 2020, whereas *Cyperus rotundus* remained relatively stable, with 12 (%) frequency recorded in both years. *Phragmites australis* exhibited a notable increase, increasing from 12 (%) frequency in 2019 to 18 (%) in 2020. In contrast, *Hordeum murinum* declined to zero in 2020, as it was not detected during that year's surveys. *Sorghum halepense* showed a moderate increase, from 8 (%) frequency in 2019 to 12 (%) in 2020. Similarly, *Alopecurus pratensis* and *Setaria verticillata* exhibited upward trends, increasing from 2 (%) frequency in 2019 to 8 (%) and 6 (%) frequency in 2020, respectively. Among the dicot weeds, *C. album* showed a significant decrease in frequency, dropping from 86 (%) frequency in 2019 to 6 (%) frequency in 2020. *S. altissima* had its frequency decrease to zero in 2020, while *C. botrys* and *S. arvensis* also demonstrated significant decreases in frequency. *Atriplex* sp. experienced a significant decrease, decreasing from 32 (%) frequency in 2019 to 4 (%) frequency in 2020. *Amaranthus blitoides* remained relatively stable initially, but it disappeared in 2020 as it was not detected during that year's surveys. *R. crispus, P. arenastrum, C. arvensis, Onosma* sp., *C. bursa-pastoris, R. raphanistrum, L. serriola,* and *A. pseudalhagi* remained relatively stable in their frequencies. In contrast, *T. repens* showed a significant increase in frequency, rising from 8 (%) frequency in 2019 to 32 (%) frequency in 2020. Similarly, *C. arenarius* and *T. officinale* demonstrated an increase in frequency from the first to the second year. *T. pratense* remained relatively stable, but with a slight increase in frequency from 2 (%) frequency in 2019 to 6 (%) frequency in 2020. *M. albus, S. oleraceus, G. glabra, Trigonella* sp., and *P. lanceolata* all showed an increase in frequency in 2020 compared to 2019. Several weed species belonging to both dicotyledonous and monocotyledonous groups disappeared in 2020. These findings reflect the dynamic nature of weed population changes over the two-year period and emphasize the importance of understanding temporal shifts in weed communities to develop effective weed management strategies in turfgrass areas.

Table 4. Scientific name and frequency (%) of weeds detected in eight surveys conducted in 2019-2020

Scientific name	2019				2020			
	1.S* (Apr)	2.S (May)	3.S (Jun)	4.S (Jul)	5.S (Apr)	6.S (May)	7.S (Jun)	8.S (Jul)
Monocot								
Alopecurus pratensis L.	2	4	6	6	8	8	10	12
Cynodon dactylon (L.) Pers.	22	24	26	24	22	24	24	28
Cyperus rotundus L.	12	10	8	8	10	10	12	16
Hordeum murinum L.	8	2	0	0	0	0	0	0
Phragmites australis (Cav.) Trin. Ex St.	12	12	12	10	18	20	20	22
Setaria verticillata (L.) P.B.	0	4	8	8	6	8	10	10
Sorghum halepense (L.) Pers.	8	12	12	16	12	14	16	10
Dicot								
Alhagi pseudalhagi (M.Bieb.) Desv.	8	4	2	0	0	0	0	0
Amaranthus blitoides S. Watson	28	16	10	4	0	0	0	0
Atriplex sp.	32	14	8	8	4	4	2	2
Capsella bursa-pastoris (L.) Medik.	14	10	4	0	4	2	0	0
Ceratocarpus arenarius L.	4	4	2	4	6	6	2	2
Chenopodium album L.	86	52	34	12	6	6	0	0
Chenopodium botrys L.	50	22	8	2	2	0	0	0
Cirsium arvense (L.) Scop.	0	2	2	4	6	6	8	10
Convolvulus arvensis L.	16	16	20	18	16	24	28	20
Glycyrrhiza glabra L.	0	2	2	2	2	4	6	8
Lactuca serriola L.	12	12	14	14	14	16	18	22
Malva sylvestris L.	0	4	4	6	8	8	12	10
Melilotus albus Medik.	0	0	4	4	12	20	22	28
Mentha longifolia (L.)	2	2	2	0	2	2	4	2
Onosma sp.	14	10	4	2	2	0	0	0
Papaver rhoeas L.	6	2	0	0	0	0	0	0
Plantago lanceolata L.	0	2	2	6	10	12	12	16
Plantago major L.	0	6	6	8	8	8	12	12
Polygonum arenastrum Bor.	20	12	4	0	0	0	0	0
Raphanus raphanistrum L.	14	8	4	2	0	0	0	0
Rumex crispus L.	22	22	20	20	20	22	28	28
Sinapis arvensis L.	36	22	8	2	2	2	0	0
Sonchus oleraceus L.	0	2	6	6	8	10	10	8
Stellaria media (L.) Vill.	6	2	0	0	0	0	0	0
Suaeda altissima (L.) PALL.	78	34	18	6	0	0	0	0
Taraxacum officinale F.H. Wigg.	2	6	6	8	10	14	18	22
Trifolium pratense L.	2	2	8	6	6	16	18	18
Trifolium repens L.	8	12	12	24	32	40	38	54
Trigonella sp.	0	6	6	10	8	12	14	14
Xanthium strumarium L.	6	4	2	0	0	0	0	0
Ziziphora capitata L.	2	2	0	0	0	0	0	0
Parasite								
Cuscuta sp.	6	6	8	8	8	10	12	12

**S- Survey*

This result conforms to the results of Supek et al. (2017), who conducted a 10-years of study on the management of *T. officinale* in grasslands showing that grazing and mowing and grazing treatments supported the presence of *Taraxacum*. Similar to these weeds, the frequency of *S. oleraceous* was also noted to increase in time. However, the reason for this increase was different from the other weeds and was mostly related to the high number of seeds produced by this weed and the continuous germination of its seeds (Supek et al., 2017).

Changes in weed frequencies over the two-year period in response to mowing were evaluated using the Greenhouse–Geisser correction within the GLM procedure. No statistically significant difference was detected in overall weed frequencies associated with mowing when all weed groups were considered together ($F = 0.509$, $p = 0.117 > 0.05$) (*Figure 1*). In addition, weed species were classified according to leaf morphology (monocotyledonous and dicotyledonous) and life cycle (annual and perennial). The Greenhouse–Geisser results revealed statistically significant differences for monocot weeds ($F = 5.619$, $p = 0.011$), annual weeds ($F = 6.086$, $p = 0.020$), and perennial weeds ($F = 8.621$, $p = 0.004$) (*Figure 1*). Moreover, the frequency of both annual and perennial weeds, including monocots and dicots, tended to increase in 2020. This trend can be attributed to the absence of soil tillage. It has been reported that approximately 90% of weed seeds are preserved within the upper 2 cm of the soil profile (Yenish et al., 1996). When seeds are mixed with decomposing plant residues, favorable microenvironmental conditions particularly soil moisture is created, which promote weed seed germination. This process generally results in a shift toward annual grasses, small-seeded dicot weeds, and certain perennial species. This practice represents a form of no-tillage system in which soil disturbance is avoided and weed seeds remain on the soil surface. Taking into account the better preservation of soil moisture in the upper soil horizon and the presence of weed seeds on the soil surface, as well as adjustments in their management in this system, the density of weeds during the first few years may increase in relation to technologies based on tillage. However, after 4-10 years of using no-till technology, the total density of weeds here are often lower than during tillage (Anderson, 2008; Korotkikh and Vlasenko, 2014).

In the course of eight surveys conducted between 2019 and 2020, the first survey exhibited the highest average weed frequency, reaching 14.00%. Conversely, the lowest total weed frequency was observed in the fourth and fifth surveys, with values of 6.58% and 6.95%, respectively (*Figure 1C*). Although numerical differences were observed among survey periods, total weed frequency did not differ significantly according to repeated measures analysis ($F = 0.509$, $p = 0.117$). The frequency of dicot and annual weeds decreased over time due to mowing practices. Conversely, an increase was observed in several perennial weed species. The increased frequency of perennial weeds such as *T. officinale, Trifolium pratense*, *T. repens, Convolvulus arvensis, Plantago lanceolata*, and *P. major* may be attributed to their low-growing and creeping growth habits, which enable them to survive repeated mowing. These species are less affected by cutting because their vegetative growth points remain close to the soil surface. In addition, certain monocotyledonous species, particularly *Cynodon dactylon*, also exhibited increased frequency during later survey periods. It is widely recognized that there is a strong correlation between lower cutting heights and increased mowing frequency, which is often associated with a higher incidence of weed infestation. (Dernoeden et al., 1993; Pirchio et al., 2018). These weeds endure by maintaining protected growth points and tend to dominate ecosystems subject to periodic defoliation through fire, grazing, or mowing (Busey, 2003).

The data presented in *Table 5* show the densities of different weed species in 2019 and 2020. The species are divided into two groups: "Monocot weed species" and "Dicot weed species." *C. dactylon* consistently exhibited the highest densities among the monocot species for both 2019 and 2020, with densities ranging from 6.32 to 11.24 plants.m^{-2} across different surveys. On the other hand, within the dicot group, *C. album* emerged as the species with the highest densities, ranging from 26.32 to 0.00 plants.m^{-2} during the 2019 and 2020 surveys. The data reveals significant variations in weed species densities over different surveys and years, indicating dynamic changes in the weed population over time. Notably, species such as *Phragmites australis* and *R. crispus* exhibited considerable fluctuations in density between survey periods. These variations may be related to their perennial growth habits, seasonal vegetative development, and capacity for regrowth following repeated mowing treatments. It's crucial to recognize that this data serves as a starting point for analysis, and further investigations involving statistical tests and comparisons with other factors would be necessary to draw comprehensive conclusions and gain deeper insights from the information presented in the table.

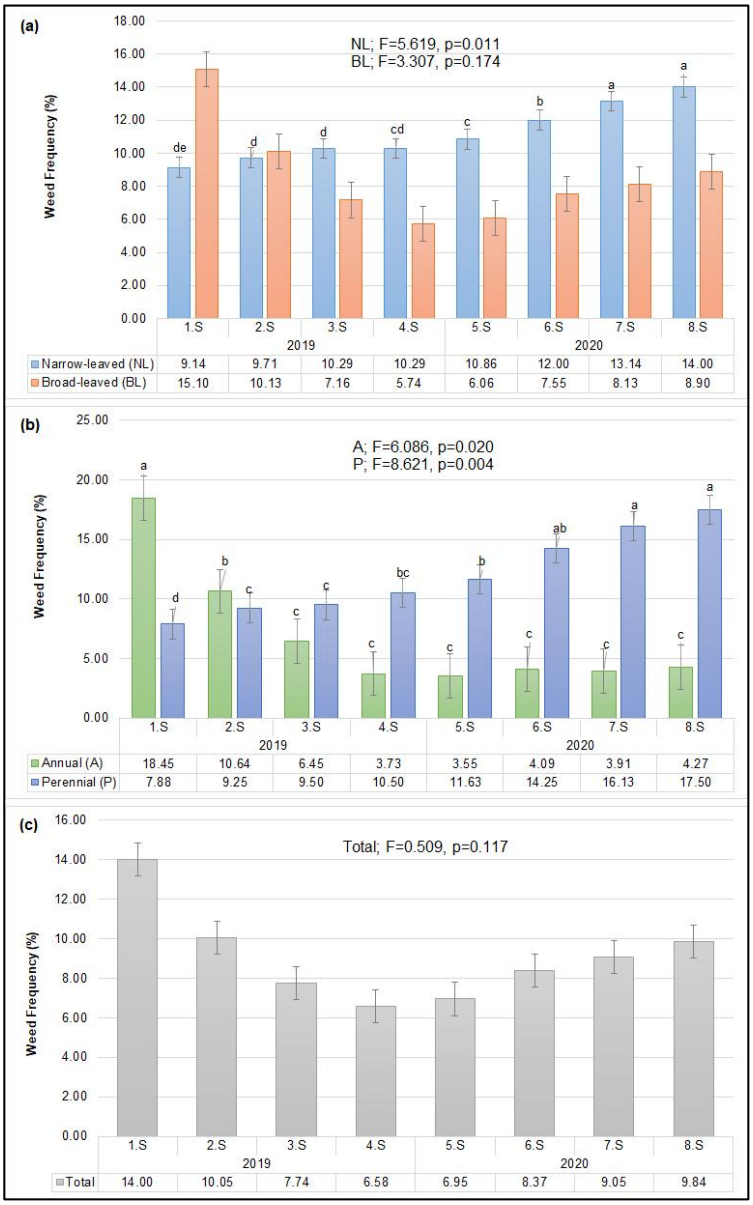

Figure 1. Statistical analysis of the weed frequency (%) with different characteristics according to greenhouse-geisser results. (a) Monocot and dicot weeds: (b) Annual and perennial weeds and (c) Total occurrence of all types of weeds. S- Survey; Different letters next to the values in each row represent significant difference among the means according to the Duncan's multiple range test ($p < 0.05$)

An assessment of the effects of mowing on weed density with respect to life cycle and morphological traits (monocotyledonous and dicotyledonous) revealed a decline in dicot weed species, whereas monocot species exhibited an increasing trend. In addition, mowing led to a marked reduction in annual weeds, while perennial species showed an increase. On the other hand, when it comes to the comparison of annual and perennial weeds separately, it was observed that mowing affected significantly the densities of perennial weeds (F=6,565; p=0.007). The rest of the variables were not substantially influenced by mowing (*Figure 2*). The highest average weed densities were noted in the first survey with 2.13 plants.m^{-2}, while the lowest density was seen in the 4th survey with an average of 0.44 plants.m^{-2}. A scientifically based set of measures including agrotechnical and biological techniques aimed at the destruction of weeds and prevention of their spread is of particular relevance. In agriculture, there are a large number of ways to control weeds, which differ essentially in terms of economic costs, labour intensity, biological and economic efficiency. The mowing regimes have demonstrated notable efficacy in controlling upright-growing weeds, effectively reducing their abundance in turfgrass areas. However, their effectiveness is limited when

dealing with perennial prostrate-growing weeds, as these low-growing weeds can better withstand the mowing process and persist in the turf.

Table 5. Densities of the weed species identified in 2019 and 2020 (plants.m^{-2})

Scientific name	2019				2020			
	1.S* (Apr)	2.S (May)	3.S (Jun)	4.S (Jul)	5.S (Apr)	6.S (May)	7.S (Jun)	8.S (Jul)
Monocot								
Cynodon dactylon (L.) Pers.	6.32	10.3	8.54	7.20	9.14	10.98	11.3	11.24
Sorghum halepense (L.) Pers.	1.09	1.10	1.10	1.23	1.09	1.45	1.85	1.16
Cyperus rotundus L.	0.98	0.84	0.65	0.24	0.74	0.85	0.85	1.09
Phragmites australis (Cav.) Trin. Ex St.	0.25	0.42	0.14	0.36	0.80	1.20	1.23	1.36
Hordeum murinum L.	0.05	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Alopecurus pratensis L.	0.01	0.10	0.20	0.10	0.30	0.30	0.35	0.85
Setaria verticillata (L.) P.B.	0.00	0.05	0.10	0.10	0.09	0.12	0.40	0.60
Dicot								
Chenopodium album L.	26.32	12.3	3.52	0.98	0.2	0.01	0.00	0.00
Suaeda altissima (L.) PALL.	18.2	6.23	1.36	0.02	0.00	0.00	0.00	0.00
Chenopodium botrys L.	12.3	2.13	0.92	0.01	0.01	0.00	0.00	0.00
Sinapis arvensis L.	2.35	0.65	0.05	0.01	0.01	0.01	0.00	0.00
Amaranthus blitoides S. Wats	2.18	0.98	0.48	0.01	0.00	0.00	0.00	0.00
Atriplex halimus L.	1.98	0.52	0.02	0.02	0.01	0.01	0.01	0.01
Rumex crispus L.	1.98	1.12	1.22	1.86	2.03	1.97	1.25	2.36
Lactuca serriola L.	1.20	1.23	2.15	1.23	2.49	1.84	3.05	2.91
Polygonum arenastrum Bor.	1.20	0.32	0.01	0.00	0.00	0.00	0.00	0.00
Convolvulus arvensis L.	0.89	0.72	0.98	1.02	1.07	1.20	1.50	1.98
Onosma sp	0.85	0.23	0.03	0.01	0.01	0.00	0.00	0.00
Capsella bursa-pastoris (L.) Medik.	0.65	0.23	0.05	0.00	0.01	0.01	0.00	0.00
Raphanus raphanistrum L.	0.65	0.01	0.01	0.01	0.00	0.00	0.00	0.00
Alhagi pseudalhagi (BIEB.) DESV.	0.60	0.20	0.01	0.00	0.00	0.00	0.00	0.00
Trifolium repens L.	0.33	0.32	0.54	1.30	1.90	2.78	3.20	3.49
Xanthium strumarium L.	0.15	0.10	0.05	0.00	0.00	0.00	0.00	0.00
Ceratocarpus arenarius L.	0.11	0.12	0.11	0.09	0.10	0.13	0.09	0.05
Taraxacum officinale F.H. Wigg.	0.05	0.11	0.11	0.22	0.13	0.90	1.50	1.50
Papaver rhoeas L.	0.10	0.05	0.00	0.00	0.00	0.00	0.00	0.00
Stellaria media (L.) Vill.	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Trifolium pratense (L.)	0.02	0.01	0.09	0.10	0.10	0.80	0.90	1.23
Mentha longifolia (L.)	0.02	0.02	0.01	0.01	0.02	0.02	0.01	0.01
Plantago lanceolata L.	0.00	0.05	0.06	0.08	0.10	0.10	0.40	0.68
Plantago major L.	0.00	0.20	0.20	0.23	0.20	0.10	0.50	0.66
Ziziphora capitata L.	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Cirsium arvense (L.) Scop.	0.00	0.05	0.06	0.05	0.04	0.10	0.09	0.12
Sonchus oleraceus L.	0.00	0.02	0.10	0.10	0.12	0.12	0.50	0.40
Melilotus albus Medik.	0.00	0.00	0.05	0.05	0.10	0.65	1.25	1.97
Glycyrrhiza glabra (L.)	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.16
Trigonella foenum-graecum L.	0.00	0.10	0.12	0.10	0.08	0.20	0.58	0.49
Malva sylvestris L.	0.00	0.05	0.04	0.04	0.10	0.09	0.16	0.12
Parasite								
Cuscuta sp.								

**S – survey*

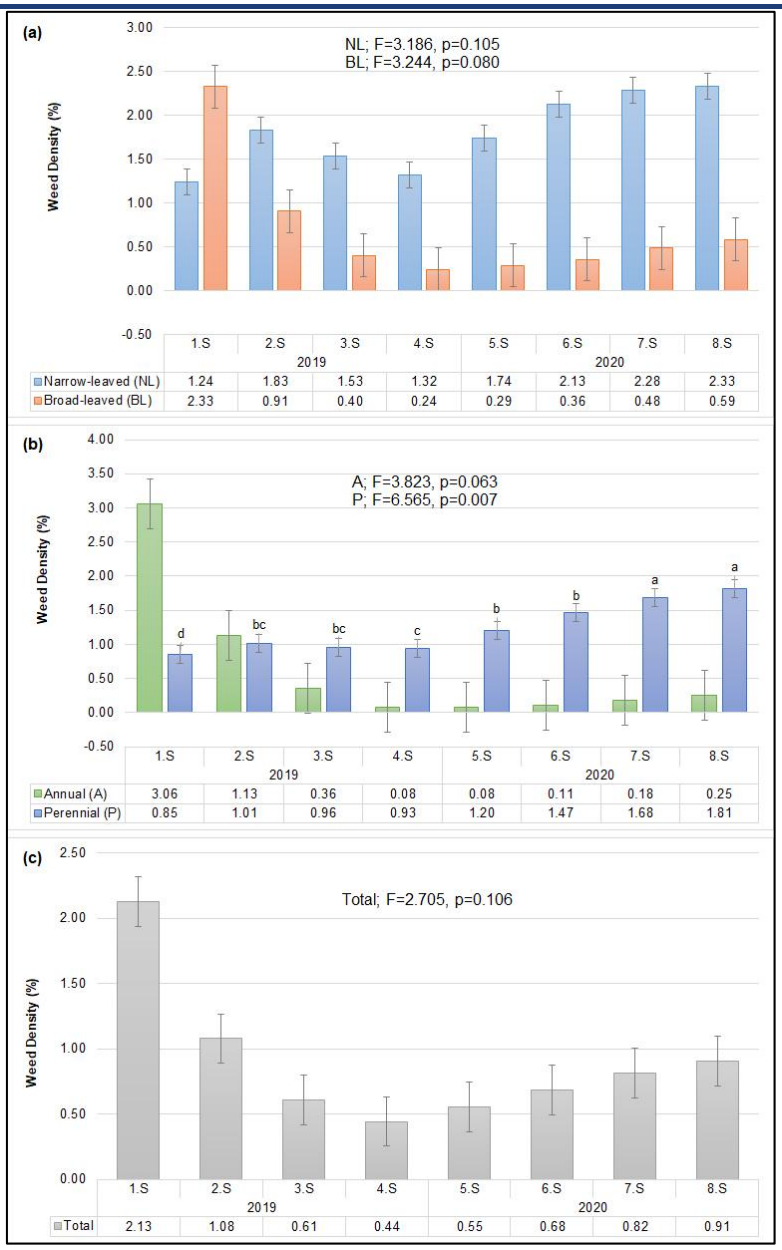

Figure 2. Statistical analysis of the weed densities (plants.m^{-2}) with different characteristics according to Greenhouse-Geisser results. (a) Monocot and dicot weeds: (b) Annual and perennial weeds and (c) Total occurrence of all types of weeds. S- survey; Different letters next to the values in each row represent significant differences among the means according to Duncan's multiple range test (p< 0.05)

4. Conclusion

This study identified a total of 39 weed species belonging to 15 plant families in newly established turfgrass areas. Among these families, Amaranthaceae, Fabaceae, and Poaceae were the most dominant, each represented by six species. Of the recorded weed species, 22 were annuals, 16 were perennials, and one was parasitic. The highest average weed frequency was observed in the first survey (13.8%), whereas the lowest weed frequencies were recorded in the fourth and fifth surveys, with values of 6.58% and 6.95%, respectively. Similarly, weed density was highest in the first survey (2.13 plants m^{-2}) and lowest in the fourth survey (0.44 plants m^{-2}).

The results clearly demonstrate that mowing exerts a selective pressure on weed communities. Creeping species such as *Cynodon dactylon* exhibited strong adaptation to frequent mowing by maintaining growth below cutting height, whereas upright-growing species such as *Chenopodium album* showed a marked decline in abundance. Overall, mowing promoted an increase in monocotyledonous and perennial weeds, while reducing the density of

dicotyledonous and annual species. However, the findings also indicate that mowing alone is insufficient to completely suppress weed populations.

The presence of weed species with different growth habits and seasonal emergence patterns represents a major challenge for sustainable turfgrass management. Therefore, continuous monitoring of weed flora and periodic assessment of population dynamics are essential to develop site-specific and adaptive weed management strategies.

Future research should focus on integrating mowing practices with complementary management approaches, such as optimized mowing height and frequency, mechanical removal, selective herbicide application, and the use of precision turf management technologies. In addition, long-term studies evaluating weed community shifts under different mowing regimes and environmental conditions would provide valuable insights into the sustainability of turfgrass weed control.

In conclusion, this study highlights the complex and dynamic nature of weed communities in turfgrass systems. Although mowing plays a significant role in shaping weed composition, effective and sustainable weed management requires an integrated, multi-strategy approach that considers species-specific responses and long-term ecological dynamics.

Ethical Statement

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

Conflicts of Interest

We declare that there is no conflict of interest between us as the article authors.

Authorship Contribution Statement

Concept: Gürbüz, R., Alptekin, H., Kahramanoğlu, İ., Panfilova, O., Kitiş, Y. E.; Data Collection or Processing: Gürbüz, R., Alptekin, H., Kahramanoğlu, İ., Panfilova, O., Kitiş, Y. E.; Statistical Analyses: Gürbüz, R., Alptekin, H., Kitiş, Y. E.; Literature Search: Gürbüz, R., Alptekin, H.; Writing, Review and Editing: Gürbüz, R., Alptekin, H., Kahramanoğlu, İ., Panfilova, O., Kitiş, Y. E.

References

Abu-Dieyeh, M. and Watson, A. (2005). Impact of mowing and weed control on broadleaf weed population dynamics in turf. *Journal of Plant Interactions*, 1(4): 239-252. https://doi.org/10.1080/17429140601015226

Abu-Dieyeh, M. H. and Watson, A. K. (2007). Population dynamics of broadleaf weeds in turfgrass as influenced by chemical and biological control methods. *Weed Science*, 55(4): 371-380.

Allen, P., Bennett, K. and Heritage, B. (2014). SPSS Statistics Version 22: A Practical Guide. Cengage Learning Australia.

Altınışık, N. and Kadıoğlu, İ. (2003). Study on the determination of weed species and their control measures in the turfgrass areas of Sabiha Gökcen. *Journal of Agricultural Faculty of Gaziosmanpaşa University*, 20(2): 1-8.

Anderson, R. L. (2008). Diversity and no-till: keys for pest management in the US Great Plains. *Weed Science*, 56(1): 141-145. https://doi.org/10.1614/WS-07-007.1.

Anonymous (2020). Statistic Department of The Meteorology General Directorate of Türkiye. https://www.mgm.gov.tr/eng/forecast-cities.aspx?m=IGDIR (Accessed Date: 13.11.2022).

Busey, P. (2003). Cultural management of weeds in turfgrass: a review. *Crop Science*, 43(6): 1899-1911. https://doi.org/10.2135/cropsci2003.1899

Callaway, R. M., Ridenour, W. M., Laboski, T., Weir, T. and Vivanco, J. M. (2005). Natural selection for resistance to the allelopathic effects of invasive plants. *Journal of Ecology*, 93: 576-583. https://doi.org/10.1111/j.1365-2745.2005.00994.x

Davis, P. H. (1965-1985). Flora of Turkey and the East Aegean Islands (Volume 1-9). Edinburgh University Press.

Davis, P. H., Mill, R. R. and Tan, K. (1988). Flora of Turkey and the East Aegean Islands (Volume 10). Edinburgh University Press, U. K.

DeBels, B. T., Griffith, S. E., Kreuser, W. C., Melby, E. S. and Soldat, D. J. (2012). Evaluation of mowing height and fertilizer application rate on quality and weed abundance of five home lawn grasses. *Weed Technology*, 26(4): 826-831. https://doi.org/10.1614/WT-D-12-00062.1.

Dernoeden, P. H., Carroll, M. J. and Krouse, J. M. (1993). Weed management and tall fescue quality as influenced by mowing, nitrogen, and herbicides. *Crop Science*, 33: 1055–1061.

Fan, J., Zhang, W., Amombo, E., Hu, L., Kjorven, J. O. and Chen, L. (2020). Mechanisms of environmental stress tolerance in turfgrass. *Agronomy*, 10(4): 522. https://doi.org/10.3390/agronomy10040522.

Gastasheva F. A. and Didanova E. N. (2020). Fundamentals of creating a sustainable lawn phytocenosis. *New Technologies*, 3(53): 125–133.

Güncan, A. (1972). Weeds that pose a problem in Erzurum and its surroundings and should be named in this region. *Atatürk University Journal of Faculty of Agriculture*. 3(2): 135–140.

Gürbüz, R. and Alptekin, H. (2022). The efficiency of some post-emergence herbicides for controlling problematic weeds of lawn areas. *Proceedings on Applied Botany, Genetics and Breeding*, 183(2):159–168. https://doi.org/10.30901/2227-8834-2022-2-159-168

Hahn, D., Sallenave, R., Pornaro, C. and Leinauer, B. (2020). Managing cool-season turfgrass without herbicides: Optimizing maintenance practices to control weeds. *Crop Science*, 60(5): 2204-2220. https://doi.org/10.1002/csc2.20175

Hall, S.J., Learned, J., Ruddell, B., Larson, K. L., Cavender-Bares, J., et al. (2016). Convergence of microclimate in residential landscapes across diverse cities in the United States. *Landscape Ecology*, 31(1): 101-117. https://doi.org/10.1007/s10980-015-0297-y

Ihtisham, M., Liu, S., Shahid, M. O., Khan, N., Lv, B., et al. (2020). The optimized N, P, and K fertilization for bermudagrass integrated turf performance during the establishment and its importance for the sustainable management of urban green spaces. *Sustainability*, 12(24): 10294. https://doi.org/10.3390/su122410294

Kara, A., Ermeç, H. and Dıblan, S. (2024). Determination of Important Weed Species, Densities and Frequencies in Hazelnut (*Corylus avellana* L.) Orchards in Düzce Province. *Journal of Tekirdağ Agricultural Faculty*, 21(5): 1252-1266. https://doi.org/10.33462/jotaf.1519243

Khan, L., Amin, N., Hussain, Z. and Khan, M. I. (2021). Importance value indices of various weeds and their management in turf grass. *Pure and Applied Biology*, 5(4), 804-814. http://dx.doi.org/10.19045/bspab.2016.50101

Kitiş, Y.E. (2011). Weed control in turfgrass, *Agricultural Agenda*, 2(1): 18-22.

Kitiş, Y. E., Kolören, O. and Uygur, F. N. (2017). The Effects of Mulch Textile Application on Weed Control and Mandarin Growing in Newly Established Mandarin Orchard. *Turkish Journal of Agriculture -Food Science and Technology*, 5(6): 568-580.

Korotkikh, N. A. and Vlasenko, N. G. (2014). Dynamics of soil seed bank of weeds depending on cultivating technologies of agricultural crops. *Russian Agricultural Sciences*, 40(3): 191-194. https://doi.org/10.3103/S1068367414030100

Kuşvuran, A. (2012). Evaluation of grass covers used in recreation areas in terms of environment, human health and aesthetics. *1st Recreation Research Congress.* 12-15 April, P. 509-523, Antalya, Türkiye.

Larsen, S. U., Kristoffersen, P. and Fischer, J. (2004). Turfgrass management and weed control without pesticides on football pitches in Denmark. *Pest Management Science: formerly Pesticide Science*, 60(6): 579-587. https://doi.org/10.1002/ps.845

Magurran, A. E. (2021). Measuring biological diversity. *Current Biology*, 31(19): R1174-R1177.

Mueller, G. D. and Thompson, A. M. (2009). The ability of urban residential lawns to disconnect impervious area from municipal sewer systems. *Journal of the American Water Resources Association*, 45(5): 1116-1126. https://doi.org/10.1111/j.1752-1688.2009.00347.x

Odum, E. P. (1971). Fundamentals of Ecology (Third Edition). W.B. Saunders Co. Publishers, Philadelphia, U.S.A.

Oral, N. and Açıkgöz, E. (2001). Effects of nitrogen application timing on growth and quality of a turfgrass mixture. *Journal of Plant Nutrition*, 24(1): 101-109. https://doi.org/10.1081/PLN-100000315

Özer, Z., Önen, H., Tursun, N. and Uygur, F.N. (1999). Some Important Weeds of Turkey. Gaziosmanpaşa University, Book Series of Faculty of Agriculture, 38:16, Tokat, Türkiye.

Pirchio, M., Fontanelli, M., Frasconi, C.; Martelloni, L.; Raffaelli, M.; Peruzzi, A.; Gaetani, M.; Magni, S.; Caturegli, L.; Volterrani, M.; et al. (2018). Autonomous mower vs. rotary mower: Effects on turf quality and weed control in tall fescue lawn. *Agronomy*, 8: 15.

Stoll, P., Egli, P. and Schmid, B. (1998). Plant foraging and rhizome growth patterns of Solidago altissima in response to mowing and fertilizer application. *Journal of Ecology*, 86(2): 341-354. https://doi.org/10.1046/j.1365-2745.1998.00263.x

Supek, Š., Pavlů, V., Pavlů, L., Gaisler, J., Hejcman, M., et al. (2017). Effects of long-term grazing management on dandelion (*Taraxacum officinale*) in *Agrostis capillaris* grassland. *Grass and Forage Science*, 72(3): 516-523. https://doi.org/10.1111/gfs.12260

Timmons, F. L. (1950). Competitive relationships of four different lawn grasses with field bindweed and dandelion under frequent close clipping. *Ecology*, 31(1): 1-5. https://doi.org/10.2307/1931355

Torikov, V. E., Melnikova, O. V. and Osipov A. A. (2018). Changes in the composition of weeds in agrophytocenosis with different cultivation technologies of field crops in crop rotation. *Vestnik of the Bryansk State Agricultural Academy,* 6(70): 15–21.

Uddin, M. K., Juraimi, A. S., Ismail, M. R. and Brosnan, J. T. (2010). Characterizing weed populations in different turfgrass sites throughout the Klang Valley of Western Peninsular Malaysia. *Weed Technology*, 24(2): 173-181.

Üremiş,İ., Soylu, S., Kurt, Ş., Soylu, E. M. and Sertkaya, E. (2020). Evaluation of Weed Species, Their Frequencies, Densities and Current Status in Carrot Fields in Hatay Province *Journal of Tekirdağ Agricultural Faculty,* 17(2): 211-228. https://doi.org/10.33462/jotaf.645336

Volkova, L. and Sobolev, N. (2015). Meadow lawn in the modern concept of city landscaping (the example of Moscow). *Forestry Bulletin,* 19(5): 145-52.

Yazlık, A., Çöpoğlu, E., Özçelik, A. and Tembelo, B. (2019). Weed Species and Their Impacts: Fruit Nursery Area Sample in Düzce. *Journal of Tekirdağ Agricultural Faculty,* 16(3): 389-401. https://doi.org/10.33462/jotaf.578999

Yenish, J. P., Fry, T. A., Durgan, B. R. and Wyse, D. L. (1996). Tillage effects on seed distribution and common milkweed (*Asclepias syriaca*) establishment. *Weed Science,* 44(4): 815-820. https://doi.org/10.1017/S0043174500094765

Yılmaz, Ş. and Hurmanlı, İ. (2016). The effect of top seeding on grass quality in degraded lawns in the Mediterranean Region. *Journal of Field Crops Central Research Institute*, 25(2): 246-252. https://doi.org/10.21566/tarbitderg.282502