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Determination of Density and Frequency of Weeds in Commercial Crops of Hamur District of Ağrı, Türkiye*

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Abstract: Weeds not only cause yield and quality losses in cultivated plants but also hinder harvesting. To effectively reduce these negative effects, it's crucial to identify the weed species and choose the most appropriate control method. Conducting regular surveys in areas where crops are grown is essential for this purpose. This study was carried out to determine the weed types, densities, and frequency of occurrence in barley, wheat, alfalfa, sainfoin, and vetch cultivation areas, which are widely cultivated in the Hamur district of Ağrı province in 2022. In addition, face-to-face surveys were conducted with 100 different producers who cultivate these cultivated plants. During the surveys, 63 different weed species belonging to 19 families were determined throughout the district. At the level of cultivated plants, the highest number of weed species were found to be 42 species belonging to 17 families in sainfoin, 31 species belonging to 14 families in wheat, 27 species belonging to 13 families in barley, 25 species belonging to 16 families in alfalfa, and 18 weed species belonging to 12 families in vetch. Weeds with a higher incidence compared to cultivated plants were *Convolvulus arvensis* L. in the wheat, *Cardaria draba* L. (65%) in the barley, *Convolvulus arvensis* L. (55%) in the sainfoin, *Tragopogon pratensis* L. (45%) in the alfalfa, and *Tragopogon pratensis* L. (60%) in the vetch cultivation areas. In the face-to-face surveys conducted within the scope of the study, 65% of the farmers stated that weeds are the most important plant protection problem in agricultural production areas. The majority of the producers reported that they preferred the mechanical control method against these weeds.

Keywords: Weed species, surveys, plant protection, cultivated plants

1. Introduction

Wheat and barley are important cereal crops that are widely cultivated and consumed around the world. They provide an important source of nutrition for humans and are used in many ways, including as ingredients in food production, feed for livestock, and in traditional cultural and religious practices. Additionally, they are important for food security and the global economy (Giraldo et al., 2019; Anonymous, 2022a; Curtis, 2022). Both are also used in many other ways such as feed for livestock, ingredients for food production, and in medical fields. They are also used in many traditional cultural and religious rituals. Due to their high protein and energy content, grains are widely used to feed the growing global population, therefore these grains have importance for food security and the economy (Newton et al., 2011).

Alfalfa (*Medicago sativa* L.), vetch (*Vicia* sp.), and sainfoin (*Onobrychis sativa* L.) are forage crops that are primarily used for livestock feed. These crops play a significant role in the livestock industry and can help to improve the overall productivity of a livestock farming. Alfalfa is a popular choice for grazing animals such as cows, horses, and sheep, and is also used as feed for dairy cows. Due to these superior properties, it is referred to in the literature as the 'Queen of Forage Plants' (Barnes et al., 1988). Vetch is known for its high protein content and its ability to fix nitrogen in the soil. It is most commonly used as an intercrop with a cereal such as wheat or barley, and it can increase the protein

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content of the crop and help with the soil structure (Huang et al., 2017). Sainfoin is known for its high protein and energy content, as well as its ability to fix nitrogen and its palatability to livestock, especially horses, cows, and sheep. Sainfoin is also known for its high resistance to disease and pests, making it a valuable crop in organic farming systems. It is also a very high-quality honey extract source for bees (Yılmaz, 2020). All these forage crops provide an important source of nutrition for grazing animals, and their use can help to improve the overall productivity of a livestock operation. They also offer many benefits for soil health and fertility, such as improving soil structure, increasing organic matter, and reducing erosion through their deep root systems (Gupta et al., 2012).

Weeds pose a significant threat to agricultural productivity and food security, and effective weed management is critical to ensuring the continued growth of agricultural production. The development of sustainable weed management practices that balance the economic, environmental, and social needs of agriculture is essential for the long-term sustainability of the agricultural sector. While the damage to the quality and yield of the product due to weeds is between 10-15% in developed countries, product losses of up to 45% occur in some Asian countries, and even some plants may become impossible to cultivate (Önen, 1995). Weeds can adapt to many different ecosystems thanks to their competitiveness, allelopathic effects, vegetative and generative reproduction, and genetic diversity, which cause great decreases in quality and yield in agricultural areas and affect cultivated plants with their adverse effects. In addition, they may cause a loss of time and resources due to the activities carried out for their struggle and may pose a risk to human health and the environment (Özer et al., 1998; Güncan, 2006). With effective weed management, it may be possible to prevent these problems caused by weeds. First of all, determining the problematic weed species and their biological/ecological characteristics is very important for weed management. Then, considering the ecological characteristics of the region, solutions specific to the region should be produced. The most important damage of weeds in agricultural areas is that they cause product loss (Tepe, 1998).

The chemical control method, which is the most economical method in the fight against weeds, is most preferred. Herbicides cause many problems with their side effects as well as benefits. Cultural plants, which are of great importance to Türkiye, are affected by the damage caused by weeds, diseases, and pests. Weeds compete with cultivated plants and adversely affect product yield and quality. Recognizing weed species makes it easier to fight in cultivated plants. Weeds cause damage to cultivated plants indirectly by hosting the hosts (Özer et al., 1998). With the development of agricultural technology in the world and Türkiye, there are constant changes in the weed population with the emergence of new chemicals (Işık et al., 2000; Öğüt and Boz, 2007). Agricultural production should eliminate, minimize, or make tolerable, with the least expense, the reason or reasons that hinder the yield and quality of the product. For this reason, researchers have been carried out to determine the weeds that are a problem in the production areas of crops in various regions of Türkiye (Eşitmez and Işık, 2016).

The study aimed to identify the types of weed species that are present in the Hamur district of Ağrı-Türkiye province, as well as their frequency and density in wheat, barley, alfalfa, sainfoin, and vetch crops that are commonly cultivated by farmers in the area. Additionally, the study aimed to identify the approaches and control methods used by farmers to address weed problems in their crops.

2. Materials and Methods

2.1. Materials

Barley, wheat, vetch, alfalfa, and sainfoin are mostly produced in the Hamur district of Ağrı province. For this reason, surveys were carried out in 20 fields for each crops with a total of 100 fields to determine the weed species that are problematic in the cultivation areas of barley, wheat, alfalfa, vetch, and sainfoin in the villages of Hamur district of Ağrı province in 2022. Identification of the weed species was carried out with the help of Flora of Turkey (Davis, 1965-1989). In addition, face-to-face interviews were conducted with 100 farmers who grew these plants, and a questionnaire with 24 questions was conducted. Hamur is located between the 42° 59ᴵᴵ 26ᴵᴵ eastern longitude and the 39º 36ᴵᴵ 41ᴵᴵ northern latitude. It is 12 kilometers away from the province of Ağrı, with an altitude of 1675 meters and a surface area of 898 km^2. Some meteorological data of the province for the years 1940-2020 are presented in Table 1. The table provides weather data, including mean temperature, average maximum and minimum temperatures, minimum precipitation days, and average monthly total rainfall for each month from January to December. Additionally, the data shows that Ağrı has very cold winters, with mean temperatures ranging from -10.0 °C in January to -6.0 °C in December, and average maximum temperatures ranging from -4.6 °C in January to -1.1 °C in December. Summers are much warmer, with mean temperatures reaching a high of 21.8 °C in August, and average maximum temperatures reaching a high of 30.8 °C in August.

Rainfall is relatively low throughout the year, with the highest average monthly total rainfall of 76.4 mm occurring in May. The mean of long year data shows that the highest maximum temperature recorded in Ağrı is 39.9 °C and the lowest minimum temperature is -45.6 °C (Table 1).

Table 1. Some meteorological data for the province between 1940-2020 in Ağrı (Anonymous, 2022b)

Meteorological data / Mounths	January	February	March	April	May	June	July	August	September	October	November	December
Mean temperature (°C)	-10.0	-8.6	-1.7	6.7	11.9	16.9	21.3	21.8	16.7	9.8	1.5	-6.0
Average maximum temperature (°C)	-4.6	-2.6	3.7	12.9	18.8	24.9	29.8	30.8	25.7	18.0	8.2	-1.1
Average minimum temperature (°C)	-14.8	-13.8	-6.4	1.4	5.5	8.9	12.9	13.0	7.8	2.9	-3.7	-10.2
Average monthly total rainfall (mm)	36.4	39.5	49.3	75.1	76.4	42.8	22.6	13.7	20.9	51.5	41.8	42.9

2.2. Methods

2.2.1. Survey study

This research, which was carried out to determine the weed types, densities, and incidence frequencies in barley, wheat, alfalfa, vetch, and sainfoin fields in the Hamur district of Ağrı province, was continued in a total of 100 fields, 20 of which were grown for each culture plant during the vegetation period of 2022. Care was be taken to ensure that the fields sampled during the surveys are far from each other and that samples were taken from different parts of the district visited in different directions. A total of 100 fields were visited for surveys in the study conducted in the Hamur district of Ağrı province in different locations.

Before the surveys fields were determined, and then, by going to these areas in straight lines, it was stopped randomly every 10 km and the nearest field was entered (Uygur, 1985). Following Sırma et al. (2001), frames were set according to the size of the field (Table 2).

Table 2. Number of frames thrown according to field size in surveys

Field size (da)	Frame number
0-5	4
5-10	6
10-20	8
20-50	12
50	16

To remove the edge effect in the fields selected for survey purposes, 1 m² frames were thrown and counted, starting from 10 m from the edge of the field, and weeds entering the frame were determined (Bora and Karaca, 1970). Weed species outside the 1 m² frame were also detected and the frequency of occurrence was found. The number of villages, the number of fields, and the total area (da) visited according to the crops in the surveys carried out in the study are given in Table 3.

Table 3. Number of frames thrown according to the number of decares

Crops	Village number	Field number	Decare
Barley	11	20	411
Wheat	12	20	422
Alfalfa	7	20	473
Sainfoin	11	20	596
Vetch	11	20	553

Frames of 1 m² were counted 12 times in 20-50 decare areas and 16 times in larger areas and the weeds entering the frame were detected (Bora and Karaca, 1970). Weed species outside the 1 m^2 frame were also determined and the frequency of occurrence was calculated. After determining the weed species and their numbers, the frequency of occurrence of each species used to evaluate the population was calculated. The necessary Equtaions are listed below (Uygur, 1991). When determining the frequency of occurrence (FO, %), all weeds found in the environment were recorded and evaluated regardless of whether they entered the framework or not (Equtaion 1).

$$FO= (N/M)x100 \quad (1)$$

The value of N represents the number of fields where the species was observed, while the value of M corresponds to the total number of fields that were surveyed.

Density (plant m^{-2}) was calculated by dividing the total number of plants in m^2 by the number of surveys performed at the census point (Odum, 1971).

To compare the determined weed species with other crops, similarity index (SI) were determined by using the Sorensen Equation 2 (Sorensen, 1948).

$$SI= (2xC)/(A+B)x100 \quad (2)$$

The value of C represents the number of weed species that are common to both crop A and crop B, while the value of A corresponds to the total number of weed species observed in crop A, and the value

of B corresponds to the total number of weed species observed in crop B.

2.2.2. Data analysis

The data obtained as a result of the survey were analyzed using the Statistical Package for the Social Sciences version 20.0 (SPSS Inc., Chicago, Illinois, USA). The results were shown as frequency and percentage distribution.

3. Results and Discussion

3.1. Frequency and density of weed species detected in wheat, barley, sainfoin, alfalfa, and vetch fields

As a result of the surveys, 31 weed species belonging to 14 families for wheat, 27 weed species belonging to 13 families for barley, 43 weed species belonging to 16 families for sainfoin, 25 weed species belonging to 16 families for alfalfa and 18 weed species belonging to 12 families for vetch were determined in the crop fields as shown in Figure 1. It seems like there are a variety of weed species present in the crop fields, with different numbers of species and families for each crop. the difference in weed species and numbers in each crop could be due to various factors, including the type of cultivation practices used for each crop. Different crops require different growing conditions and management practices, and these can impact the types of weeds that grow in the fields (Bourgeois et al., 2019). Some crops may be planted earlier or later in the season, which can impact the timing and types of weeds that germinate and grow.

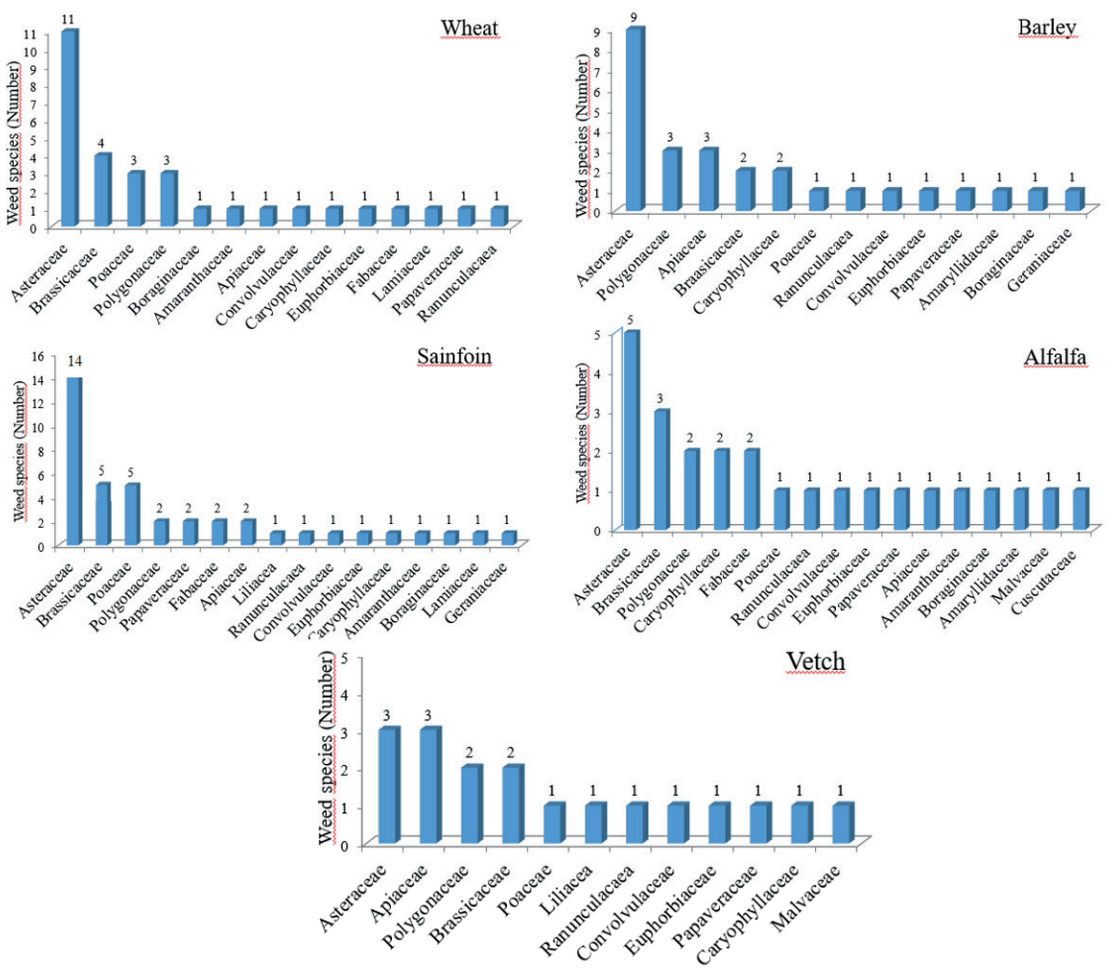

Figure 1. Distribution of the detected weed families according to the number of weed species they have in wheat, barley, sainfoin, alfalfa, and vetch fields

Additionally, the type and timing of herbicide applications, as well as other weed management practices, can also impact the weed species present in the fields and also soil type, climate, and other environmental factors, as well as the history of weed management practices in the field (Pala et al.,

2020). Weed families identified in our current study and those identified by Çoruh (2010) during their investigation of sainfoin cultivation areas in Erzurum province include Asteraceae, Brassicaceae, Poaceae, Apiaceae, Polygonaceae, Fabaceae, Papaveraceae, Caryophyllaceae, Liliaceae, Boraginaceae, Euphorbiaceae, Convolvulaceae, Amaranthaceae, Ranunculaceae, Lamiaceae, and Geraniaceae. Similarities were observed between these families.

A total of 31 weed species belonging to 14 families, including 1 narrow-leaved and 13 broad-leaved, were identified in the surveys carried out in wheat cultivation areas. Of these weeds, 3 were narrow-leaved and 28 are broad-leaved, 13 species were annual and 18 species were perennial. Among these weeds, there were 2 annual and 1 perennial species in narrow-leaved weeds. Among broad-leaved weeds, 11 species were annual and 17 species were perennial (Table 4).

In his study, Sırrı (2019) detected a total of 137 weed species belonging to 30 families, including 1 seedless, 4 narrow-leaved and 25 broad-leaved, in wheat fields. Topcu Esim and Çoruh (2021), in their two-year study, determined a total of 109 weed species belonging to 22 families and 76 genera in wheat cultivation areas. Gürbüz et al. (2018) determined a total of 22 weed species belonging to 22 plant families (in the range of 96 to 99) as a result of their two-year study. It has been observed that our study is similar to the species mentioned in the related studies.

Weed species with the highest frequency (%) are respectively; *C. arvensis* (50%), *C. draba* (40%), *C. arvense* (35%), *S. vulgaris* (30%), *T. pratensis* (25%), *R. arvensis* (20%), *S. arvensis* (20%), *T. latifolia* (20%), *L. seriola* (15%), *C. vulgare* (15%) and *S. loselii* (15%) (Table 4). When we look at the results we have obtained, it is similar to the studies that many researchers have

Table 4. Weed species, families, scientific names, common names, life cycles, frequencies and densities detected in wheat fields

Family	Scientific names	Common names	Life cycles	Frequencies (%)	Densities (weeds m^{-2})
		Narrowleaf			
Poaceae	*Avena fatua* L.	Wild oat	A	20	0.46
	Elymus repens L.	Quack grass	P	5	0.1
	Poa pratensis L.	Spreading bluegrass	A	5	0.06
		Broadleaf			
Amaranthaceae	*Chenopodium album* L.	Common lambsquarters	A	5	0.15
Apiaceae	*Turgenia latifolia* (L.) Hoffm.	Broadleaf false carrot	P	20	1.93
Asteraceae	*Achillea millefollium* L	Common yarrow	P	5	0.36
	Anthemis cretica L.	Dog fennel	A	5	0.12
	Centaurea cyanus L.	Cornflower	A	5	0.19
	Cichorium intybus L.	Common chicory	P	10	0.1
	Cirsium arvense (L.) Scop.	Creeping thistle	P	35	0.92
	Cirsium vulgare L.	Spear thistle	P	15	0.21
	Erigeron strigosus Bigel.	Prairie fleabane	A	5	0.17
	Lactuca serriola L.	Prickly lettuce	P	15	0.12
	Senecio vernalis L.	Common groundsel	A	5	0.03
	Tragopogon pratensis L.	Meadow salsify	P	25	0.56
	Xanthium strumarium L.	Cocklebur	A	10	0.15
Boraginaceae	*Anchusa azurea* Mill.	Italian bugloss	P	10	0.1
Brassicaceae	*Cardaria draba* L.	Hoary cress	P	40	1.95
Caryophyllaceae	*Silene vulgaris* L.	Maidenstears	P	30	1.04
Convolvulaceae	*Convolvulus arvensis* L.	Field bindweed	P	50	1.21
Euphorbiaceae	*Euphorbia helioscopia* L.	Sun spurge	A	10	0.26
Fabaceae	*Melilotus officinalis* L.	Yellow sweetclover	P	5	0.06
Lamiaceae	*Salvia nemorosa* L.	Woodland sage	P	5	0.1
Papaveraceae	*Papaver rhoeas* L.	Common poppy	A	10	0.36
Polygonaceae	*Rumex acetosella* L.	Sheep sorrel	P	10	0.12
Ranunculacaea	*Erysinum diffusum* L.	Diffuse wallflower	P	5	0.18
	Polygonum cognatum L.	Knotgrass	P	5	0.46
	Ranunculus arvensis L.	Corn buttercup	A	20	0.65
	Rumex obtusifolius L.	Bitter dock	P	10	0.29
	Sinapis arvensis L.	Wild mustard	A	20	0.17
	Sisymbrium loeselii L.	Small tumbleweed mustard	A	15	0.35

A: Annual, P: Perennial

done on wheat in different provinces (Gökalp and Üremiş, 2015; Gürbüz et al., 2018; Sırrı, 2019; Topcu Esim and Çoruh, 2021; Ateş and Üremiş, 2022). When we analyze the weed densities detected in wheat fields during our current study (Table 4), we find similarities between the high-density weeds in our study and the weeds identified in wheat cultivation areas of Ağrı province by Gürbüz et al. (2018). Farmers have expressed that weeds pose a significant problem, particularly in wheat crops. According to Alptekin et al. (2022), when examining the weed problem at the level of cultivated plants in the province of Mardin, wheat is the most affected crop with a rate of 87.5%.

As a result of the survey conducted in barley fields, 27 weed species belonging to 13 families in total, including 1 narrow-leaved and 12 broad-leaved, were determined. One of the detected weeds was narrow-leaved and 26 of them were broad-leaved. Of the detected weeds, 9 species were annual and 18 species were perennial. Among these weeds, 1 species of narrow-leaved annuals, 8 species of annual and 18 species of perennial broad-leaved weeds were found (Table 5). Kordali and Zengin (2009) determined 56 species belonging to 15 families in the fields where barley is grown, as a result of their survey in Bayburt. The weed species they detected were similar to the weed species we detected in our study.

The 10 most common weed species according to the frequency (%) in the barley fields were foun as; *C. draba* (65%), *C. arvensis* (45%), *R. arvensis* (45%), *T. pratensis* (40%), *C. arvensis* (30%), *B. bulbocustonum* (30%), *A. nigrum* (25%), *S. loeselii* (15%), S. vulgaris (15%), *S. officinalis* (10%), *R. crispus* (10%), *R. dotusifolium* (10%), *T. latifolia* (10%), *A. sylvestris* (10%) and *P. rhoeas* (10%). Kordali and Zengin (2011) identified weeds in barley cultivation areas as *Ranunculus arvensis* (22.22%), *Rumex crispus* (11.11%), *Turgenia latifolia* (11.11%), *Cirsium arvense* (66.66%), *Convolvulus arvensis* (55.55%). Similarities were found between the species and our findings. The highest density in barley cultivation areas were found in *R. arvensis* (6.58 plants m^{-2}), *C. arvensis* (2.42 plants m^{-2}), *P. cognatum* (2.28 plants m^{-2}) and *C. draba* (1.88 plants m^{-2}) weed species restpectively (Table 5).

Table 5. Weed species, families, scientific names, common names, life cycles, frequencies and densities detected in barley fields

Family	Scientific names	Common names	Life cycles	Frequencies (%)	Densities (weeds m^{-2})
		Narrowleaf			
Poaceae	*Avena fatua* L.	Wild oat	A	5	0.9
		Broadleaf			
Amaryllidaceae	*Allium nigrum* L.	Black garlic	P	25	0.8
Apiaceae	*Angelica sylvestris* L.	Woodland angelica	P	10	0.56
	Bunium bulbocustonum L.	Earth-nut	P	30	1.41
	Turgenia latifolia L.	Broadleaf false carrot	P	10	0.25
Asteraceae	*Achillea millefollium* L.	Common yarrow	P	5	0.38
	Anthemis cretica L.	Dog fennel	P	5	0.13
	Centaurea cyanus L.	Cornflower	A	5	0.17
	Cirsium arvense (L.) Scop.	Creeping thistle	P	30	1.31
	Cirsium vulgare L.	Spear thistle	P	15	0.23
	Lactuca serriola L.	Prickly lettuce	P	10	0.25
	Senecio vernalis L.	Common groundsel	A	5	0.04
	Tragopogon pratensis L.	Meadow salsify	P	40	1.53
	Xanthium strumarium L.	Cocklebur	A	9	0.12
Braasicaceae	*Cardaria draba* L.	Hoary cress	P	65	1.88
	Sisymbrium loeselii L.	Small tumbleweed mustard	A	15	0.7
Boraginaceae	*Anchusa azurea* Mill.	Italian bugloss	P	5	0.02
Caryophyllaceae	*Saponaria officinalis* L.	Soapwort	A	10	0.07
Convolvulaceae	*Silene vulgaris* L.	Maidenstears	P	15	1.13
Euphorbiaceae	*Convolvulus arvensis* L.	Field bindweed	P	45	2.42
Geraniaceae	*Euphorbia helioscopia* L.	Sun spurge	A	5	0.01
Papaveraceae	*Geranium tuberosum* L.	Tuberous cranesbill	P	5	0.05
Polygonaceae	*Papaver rhoeas* L.	Common poppy	A	10	0.7
Convolvulaceae	*Rumex crispus* L.	Curly dock	P	10	0.42
	Rumex obtusifolius L.	Bitter dock	P	10	0.04
	Polygonum cognatum L.	Knotgrass	P	5	2.28
Ranunculacaea	*Ranunculus arvensis* L.	Corn buttercup	A	45	6.58

A: Annual, P: Perennial

As a result of the survey conducted in the sainfoin fields, 41 weed species belonging to a total of 16 families, 2 narrow-leaved and 14 broad-leaved, were identified. Of the detected weeds, 6 were narrow-leaved and 31 were broad-leaved. It has been determined that out of the weeds detected in the sainfoin field, 20 are annual and 21 are perennial weeds (Table 6). Çoruh (2010) found 79 different weed species belonging to 26 families and 67 genera, including 1 seedless, 11 monocotyledonous (moncotyledonous) and 67 bicotyledonous (dicotyledonous) in their study on sainfoin cultivation areas in Erzurum region. Our study showed similarities with the species found in the study of Çoruh (2010).

Table 6. Weed species, families, scientific names, common names, life cycles, frequencies and densities detected in sainfoin fields

Family	Scientific names	Common names	Life cycles	Frequencies (%)	Densities (weeds m^{-2})
		Narrowleaf			
Liliacea	*Allium rotundum* L.	Round Leek	A	10	0.25
Poaceae	*Avena fatua* L.	Wild oat	A	40	2.68
	Bromus tectorum L.	Downy brome	A	5	0.1
	Elymus repens L.	Quack grass	P	5	0.32
	Poa bulbosa L.	Bulbous bluegrass	A	45	0.23
	Poa pratensis L.	Spreading bluegrass	A	5	0.09
		Broadleaf			
Amaranthaceae	*Chenopodium album* L.	Common lambsquarters	A	5	0.22
Apiaceae	*Bunium bulbocastanum* L.	Earth-nut	P	5	0.09
	Turgenia latifolia L.	Broadleaf false carrot	P	20	0.73
Asteraceae	*Anthemis cretica* L.	Dog fennel	A	15	0.2
	Carum carvi L.	Carway	P	25	0.19
	Centaurea cyanus L.	Cornflower	A	5	0.03
	Centaurea fenzlii Reichardt	Battalbaş	P	5	0.16
	Cirsium vulgare L.	Spear thistle	P	10	0.36
	Cirsium arvense (L.) Scop.	Creeping thistle	P	55	0.93
	Cichorium intybus L.	Common chicory	P	15	0.24
	Erigeron strigasus L.	Prairie fleabane	A	10	0.01
	Lactuca serriola L.	Prickly lettuce	P	25	0.42
	Senecio vernalis L.	Common groundsel	A	15	0.18
	Sonchus arvensis L.	Field sowthistle	A	10	0.14
	Toraxacum officinale L.	Dandelion	P	5	0.03
	Tragopogon pratensis L.	Meadow salsify	P	10	0.64
	Xanthium strumarium L.	Cocklebur	A	30	0.02
Boraginaceae	*Anchusa azurea* Mill.	Italian bugloss	P	25	0.07
Brassicaceae	*Capsella bursa pastoris* L.	Shepherd's purse	A	5	0.12
	Cardaria draba L.	Hoary cress	P	40	0.67
	Sinapis arvensis L.	Wild mustard	A	50	0.38
	Sisymbrium loselii L.	Small tumbleweed mustard	A	10	0.17
	Thlaspi arvense L.	Field pennycress	A	10	0.1
Caryophyllaceae	*Silene vulgaris* L.	Maidenstears	P	40	0.69
Convolvulaceae	*Convolvulus arvensis* L.	Field bindweed	P	10	0.8
Euphorbiaceae	*Euphorbia helioscopia* L.	Sun spurge	A	25	0.73
Fabaceae	*Melilotus officinalis* L.	Yellow sweetclover	P	5	0.02
	Trifolium repens L.	White clover	P	5	0.15
Geraniaceae	*Geranium tuberosum* L.	Tuberous cranesbill	P	5	0.11
Lamiaceae	*Lamium amplexicaule* L.	Common henbit	P	5	0.03
Papaveraceae	*Fumaria officinalis* L.	Common fumitory	A	5	0.05
	Sideritis montana L.	Mountain ironwort	A	5	0.02
Polygonaceae	*Rumex obtusifuolius* L.	Bitter dock	P	10	0.23
	Rumex crispus L.	Curly dock	P	15	0.26
Ranunculacaea	*Ranunculus arvensis* L.	Corn buttercup	A	5	0.46

A: Annual, P: Perennial

The most common 10 weed species according to the frequency (%) in sainfoin fields were found as; *C. arvense* (55%), *S. arvensis* (50%), *P. bulbosa* (45%), *A. fatua* (40%), *S. vulgaris* (40%), *C. draba* (40%), *X. strumarium* (30%), *L. serriola* (25%), *C. carvi* (25%), *A. azurea* (25%) and *E. helioscopia*

(25%) respectively (Table 6). It's interesting to note that there is parallelism between the weed species identified in Çoruh (2010)'s study, particularly with regard to *C. arvense*, *S. arvensis*, *P. bulbosa*, *S. vulgaris*, *C. draba*, *L. serriola*, *C. carui*, *A. azurea* and *E. helioscopia*, which were also identified in cureent study as common weed species in vetch fields. The highest density in sainfoin cultivation areas was *A. fatua* (2.68 plants m^{-2}), *T. latifolia* (0.73 plants m^{-2}) and *E. helioscopia* (0.73 plants m^{-2}) weed species were determined (Table 6).

As a result of the survey conducted in the alfalfa fields, 25 weed species belonging to 16 families in total, including one narrow-leaved, one parasitic and 14 broad-leaved, were determined. One of the detected weed was parasitic, one was narrow-leaved, and 23 were broad-leaved. Among these weeds, one parasitic species and one species with narrow leaves are annual. Among broadleaf weeds, 9 species are annual and 14 species are perennial (Table 7). Çoruh and Zengin (2009) determined 79 different weed species belonging to 22 families and 63 genera, including 2 seedless, 15 monocotyledonous (moncotyledonous) and 62 dicotyledonous (dicotyledonous) in alfalfa fields. Özmen (2019) determined 87 different weed species belonging to 26 plant families as a result of his surveys in the alfalfa fields. Our study was found to be similar to the species mentioned in related studies.

The 10 most common weed species according to the frequency (%) in the alfalfa fields; *T. pratensis* (45%), *C. draba* (45%), *S. loselii* (45%), *R. obtusifolius* (40%), *C. arvensis* (30%), *C. arvense* (25%), *A. fatua* (25%), *E. helioscopia* (25%), and *C. album* (25%) were respectively (Table 7). The most common weed species in the alfalfa fields of Hamur district are *Tragopogon pratensis* L., *Cardaria draba* L., *Sisymbrium loselii* L., *Rumex obtusifolius* L., *Convolvulus arvensis* L., *Cirsium arvense* (L.) Scop., *Avena fatua* L., *Euphorbia. helioscopia* L., *Chenopodium album* L., and *Malvella deprosa* L. were found to be common species, and it was found to be similar to the mentioned species in studies on alfalfa and sainfoin in Erzurum, Van and Ankara (Çalı et al., 1993; Tepe, 1998; Çoruh and Zengin, 2009). In alfalfa cultivation areas, the higest densities (weeds m^{-2}) were found in *A. fatua* (4.01), *T. pratensis* (2.08), *C. arvense* (1.64), *S. loeselii* (1.49), *R. obtusifuolius* (1.41) with a descending order (Table 7).

Table 7. Weed species, families, scientific names, common names, life cycles, frequencies and densities detected in alfalfa fields

Family	Scientific names	Common names	Life cycles	Frequencies (%)	Densities (weeds m^{-2})
		Narrowleaf			
Poaceae	*Avena fatua* L.	Wild oat	A	25	4.01
		Broadleaf			
Amaranthaceae	*Chenopodium album* L.	Common lambsquarters	A	25	0.4
Amaryllidaceae	*Allium nigrum* L.	Black garlic	P	5	0.05
Apiaceae	*Bunium bulbocastanum* L.	Earth-nut	P	5	0.13
Asteraceae	*Anthemis chia* L.	Chios chamomile	A	10	0.33
	Cichorium intybus L.	Common chicory	P	5	0.0,3
	Cirsium arvense (L.) Scop.	Creeping thistle	P	25	1.64
	Tragopogon pratensis L.	Meadow salsify	P	45	2.08
	Xanthium strumarium L.	Cocklebur	A	20	0.57
Boraginaceae	*Echium vulgare* L.	Blueweed	P	5	0.03
Brassicaceae	*Cardaria draba* L.	Hoary cress	P	45	1.13
	Sisymbrium loeselii L.	Small tumbleweed mustard	A	45	1.49
	Thlaspi arvense L.	Field pennycress	A	20	0.75
Caryophyllaceae	*Angelica sylvestris* L.	Woodland angelica	A	5	0.7
Convolvulaceae	*Convolvulus arvensis* L.	Field bindweed	P	30	1.24
Euphorbiaceae	*Euphorbia helioscopia* L.	Sun spurge	A	25	0.95
Fabaceae	*Argyrolobium biebersteinii* L.		P	5	0.15
	Trifolium repens L.	White clover	P	10	0.36
Malvaceae	*Malva sylvestris* L.	Common mallow	P	20	0.95
Papaveraceae	*Fumaria officinalis* L.	Common fumitory	A	5	0.18
Polygonaceae	*Rumex acetosella* L.	Sheep sorrel	P	5	0.05
	Rumex obtusifuolius L.	Bitter dock	P	40	1.41
Ranunculacaea	*Ranunculus arvensis* L.	Corn buttercup	A	10	1.02
Parasitic					
Cuscutaceae	*Cuscuta* spp.	Dodders	Ps	15	0.36

A: Annual, P: Perennial, Ps: Parasitic

As a result of the survey conducted in the vetch fields, 18 weed species belonging to 12 families, 2 narrow-leaved and 16 broad-leaved, were identified. Among the detected weeds, 7 species were annual and 11 species were perennial (Table 8). Çoruh (2012) determined 89 different weed species in 76 genera belonging to 31 families, including 1 seedless, 14 monocotyledonous (Monocotyledoneae) and 74 dicotyledoneae class, as a result of their study in vetch cultivation areas in Erzurum region. Our study was found to be similar to the species mentioned in the related study. It's interesting to note that they found a much larger number of weed species (89) compared to the 18 identified in our study. This could be due to differences in the sampling methods, study area, or time of year when the study was conducted. However, the fact that there is a close relation between the weed species identified in your study and the species identified in Çoruh (2012)'s study is a positive finding. It suggests that there may be some consistency in the types of weeds that are commonly found in vetch fields in the Erzurum region. This consistency can be helpful in developing more targeted and effective weed management strategies.

Table 8. Weed species, families, scientific names, common names, life cycles, frequencies and densities detected in vetch fields

Family	Scientific names	Common names	Life cycles	Frequencies (%)	Densities (weeds m^{-2})
		Narrowleaf			
Liliacea	*Allium vineale* L.	Crow garlic	A	5	0.05
Poaceae	*Avena fatua* L.	Wild oat	A	5	1.15
		Broadleaf			
Apiaceae	*Bunium bulbocastanum* L.	Earth-nut	P	15	0.39
	Ornithogalum umbellatum L.	Star of Bethlehem	P	5	0.3
	Turgenia latifolia L.	Broadleaf false carrot	P	5	0.12
Asteraceae	*Anthemis chia* L.	Chios chamomile	A	5	0.07
	Cirsium arvense (L.) Scop.	Creeping thistle	P	25	0.43
	Tragopogon pratensis L.	Meadow salsify	P	60	2.14
Brassicaceae	*Cardaria draba* L.	Hoary cress	P	40	1.89
	Sisymbrium loeselii L.	Small tumbleweed mustard	A	10	1.11
Caryophyllaceae	*Silene vulgaris* L.	Maidenstears	P	5	0.07
Convolvulaceae	*Convolvulus arvensis* L.	Field bindweed	P	15	0.48
Euphorbiaceae	*Euphorbia helioscopia* L.	Sun spurge	A	10	0.38
Malvaceae	*Malva sylvestris* L.	Common mallow	P	5	0.23
Papaveraceae	*Papaver rhoeas* L.	Common poppy	A	15	0.5
Polygonaceae	*Polygonum cognatum* L.	Knotgrass	P	5	0.2
	Rumex obtusifuolius L.	Bitter dock	P	20	0.37
Ranunculacaea	*Ranunculus arvensis* L.	Corn buttercup	A	30	7.65

A: Annual, P: Perennial

According to the frequency (%) in the vetch fields of Hamur district, the 10 most common weed species were *T. pratensis* (60%), *C. draba* (40%), *R. arvensis* (30%), *Cirsium arvense* (25%), *R. obtusifolius* (20%), *B. bulbocustonum* (15%), *C. arvensis* (15%), *E. helioscorpia* (10%), *S. loselii* (10%) 10 weed species were detected respectively. In his study, Çoruh (2012) demonstrated parallelism between *Convolvulus pratensis* L. and *Cirsium arvense* (L.) Scop. The study found that the highest weed density in the vetch cultivation areas consisted of *R.arvensis* (7.65 plants m^{-2}), *T. pratensis* (2.14 plants m^{-2}), *C.draba* (1.89 plants m^{-2}), and *A. fatua* (1.15 plants m^{-2}) weed species (Table 8).

3.2. Similarity index results

As a result of the surveys carried out in the district, the similarity rates among the weed species detected in the cultivated plants, the number of common weed species, and the similarity index ratio are given in Table 9.

Table 9. Similarity index (%) between weed species found due to surveys

Crops	Number of common weed species	Similarity index (%)
Barley-Wheat	22	75.86
Barley-Vetch	13	68.42
Barley-Alfalfa	11	48.88
Barley-Sainfoin	14	45.16
Wheat-Vetch	13	53.06
Wheat-Alfalfa	12	42.85
Wheat-Sainfoin	23	63.01
Alfalfa-Vetch	13	60.46
Alfalfa-Sainfoin	15	44.77
Alfalfa-Vetch	12	40.00

In the survey study of barley, wheat, vetch, sainfoin, and alfalfa grown in the Hamur district of Ağrı province, aimed to identify common weed species among different crops grown in the Hamur district of Ağrı province and determine the similarity index between them. The results of the study indicate that there are several common weed species among the crops, and the similarity index between them varies. For example, the study found 22 common weed species among barley, wheat, vetch, sainfoin, and alfalfa, with a high similarity index (75.86%) between barley and wheat. In contrast, there were only 11 common weed species between barley and alfalfa, with a similarity index of 48.88%. Similarly, there were 13 common weed species between alfalfa and vetch, with a similarity index of 60.47%. The results of this study could be useful for farmers and agricultural organizations in the Hamur district of Ağrı province to develop effective weed management strategies that are tailored to the specific crop and weed species present. By understanding the common weed species and their similarity across different crops, farmers can better plan and implement their weed control measures, potentially reducing crop yield losses and improving overall productivity.

3.3. Questionnaire data results

The aim of a face-to-face survey in agriculture can vary depending on the specific objectives of the survey. Our aims of a face-to-face survey in weed problems include: Collecting data on crop yields, understanding farmers' attitudes and behaviors, collecting demographic information, such as age, gender, education level, and income. Overall, the aim of a face-to-face survey in weed management is to collect reliable and accurate data that can be used to inform agricultural policies and practices, as well as to support research and development efforts in the plant protection sectors. For these purposes, the answers to these questions were tried to be obtained through face-to-face surveys with the farmers who cultivate cultural plants (barley, wheat, vetch, sainfoin and alfalfa) in Hamur district of Ağrı province. When we look at the education levels of the farmers participating in the survey, 28% of them stated that they were primary school graduates, 23% were illiterate, 16% were secondary school graduates, 20% were high school graduates and 13% were university graduates. While 52% of the farmers know what herbicide is, the rest do not know what herbicides are. Similar results were obtained in the question of what pesticides are. It is seen that 46% of the producers know what pesticides are, while 54% do not have any information about what pesticides are. When we look at the ratio, we see that more producers have information about what herbicides are. How do you irrigate your field?" 60% of the answers given to the question stated that they used furrow irrigation, 22% of them carried out flood irrigation and 18% of them said that they used sprinkler irrigation. Drip irrigation is a highly efficient method of irrigation because it minimizes water wastage due to evaporation and runoff (Kaushal et al., 2012). It can also save on labor and energy costs by reducing the need for manual watering. "Have you attended any training meeting organized by the agricultural organization on the cultivation of cultural plants?" 40% of the answers to the question never attended, 28% sometimes, 14% often, 12% very rarely, 6% stated that they attended all meetings. Do you follow the farmer education programs on TV?" 52% of the answers given to the question stated as yes and 48% as no. "How often do you meet with engineers in the agricultural organization?" 38% of the answers given to the question stated that they meet very rarely, 30% sometimes, 18% often, 12% never, and 6% of them constantly. When we look at these answers, farmers are generally not very willing to participate in the training programs organized. But, farmer education and training programs can be a valuable resource for farmers to learn new techniques and best practices for improving their crop yields, reducing input costs, and adapting to changing environmental conditions (Valerio et al., 2014).

It is seen that 36% of the producers are moderately satisfied with their yield, 22% are satisfied, 18% are not at all satisfied, 16% are very satisfied and 8% are somewhat satisfied. They think that 65% of these yield losses are caused by weeds, 23% by diseases, 7% by insect damage and 5% by other animal pests.

"How important is the weed problem for yield?" 28% of the answers given to the question stated that it is important, 24% moderately important, 22% very important, 14% not at all important and 12% less important. "What is the weed density in your field?" 44% of the answers given to the question stated that it was medium intense, 18% less intense, 14% intense, 12% very intense and 12% none at all. Weeds are a significant problem for many farmers because they compete with crops for resources such as water, nutrients, and sunlight. Weeds can reduce crop yields, lower crop quality, and increase production costs. They can also serve as hosts for pests and diseases, making it more challenging to control these threats to crops (Moss, 2019). When we look at the answers given, we see that the farmers are aware of this. "What are the important weed species that are a problem in your field?" 46% of the answers given to the question of field bindweed 30% meadow salsify, 22% for wild cress, 20% fathen, 12% for curly labada, 6% for creeping

thistle and 24% stated other weeds. These findings are largely consistent with the survey results. When we look at the stage of the farmers' decision to fight against weeds, 24% stated that they decided to management by looking at the weed population and consulting the agricultural engineer in the agricultural district organization, 22% by consulting the pesticide dealer and 10% by looking at what my neighbors did. In the weed control methos, 42% stated that they used mechanical control, 38% chemical control, 16% cultural control and 4% physical control method. Do you apply chemicals for control of weeds?" 62% of the answers given to the question stated that they said yes and 38% said they said no. "Who do you consult with the herbicide you use in your field?" 30% of the answers given to the question of pesticide dealers, 15% stated that they asked the provincial and district directorates of agriculture, 5% stated that they decided by myself and 12% stated that they asked other producers. When we look at the herbicides they used in the previous year, 31 of them stated that they used 284 g L^{-1} Diclofop-methyl, 17 of them used 75% Tribenuron-methyl and 14% of them stated that they used 50% Thifensulfuron methyl + 25% Tribenuron methyl.

When we asked about the effectiveness of herbicides, 27 of the farmers stated that they were very effective, 20 of them moderately effective, 7 of them completely effective, 5 of them very little effective and 3 of them not effective at all. 29% of the farmers stated that A. albus, 20% *C. arvensis* and 13% *E.repens* weeds were not affected by herbicides. To the question we asked about whether they paid attention to the cleaning and maintenance of the spraying equipment before and after the herbicide spraying, % 22 of the farmers stated that often clean, % 13 rarely clean, % 11 Ialways clean, % 9 sometimes clean and %7 of them never clean. "Do you follow the necessary spraying rules when applying herbicides?" 81 of the answers given to the question yes and 19 no stated that they did not comply with the spraying rules. It is concerning to see that a significant percentage of farmers do not always follow the necessary spraying rules when applying herbicides, as this can have serious consequences for human health, the environment (Rani et al., 2021) and crop productivity.

5. Conclusions

The survey detected 31 weed species, with broad-leaved weeds being the most common, and the Asteraceae and Brassicaceae families having the highest number of species. While similarities were found between weed species in wheat and barley fields, there were also differences in families and specific species of weeds. The most common and problematic weed species in wheat and barley fields were *C. arvensis* and *C. draba*. The survey also revealed that many farmers lacked knowledge of plant protection measures and that weeds were the most significant plant protection problem. Effective and sustainable weed control measures should be implemented to minimize negative impacts on crop production. These findings can help inform weed management practices, improve productivity, and increase profitability in agriculture in the region. Therefore, effective and sustainable weed control measures should be implemented to minimize the negative impacts of weeds on crop production.

Declaration of Author Contributions

Conceptualization, Investigation, Data Curation, Visualization, Writing-Original Draft Preparation, Writing-Review & Editing, *H. SAVCI*; Conceptualization, Material, Methodology, Investigation, Data Curation, Formal Analysis, Visualization, Supervision, Writing-Original Draft Preparation, Writing-Review & Editing, *R. GÜRBÜZ*. All authors declare that they have seen/read and approved the final version of the article ready for publication.

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