Turkish Journal of Agriculture - Food Science and Technology, 12(6): 918-923, 2024
DOI: https://doi.org/10.24925/turjaf.v12i6.918-923.6734

Turkish Journal of Agriculture - Food Science and Technology

Available online, ISSN: 2148-127X | www.agrifoodscience.com | Turkish Science and Technology Publishing (TURSTEP)

Investigation of the Allelopathic Effects of Different Faba Bean (*Vicia faba* L.) Genotypes Against Various Weeds

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A R T I C L E I N F O

Research Article

Received : 21.02.2024
Accepted : 23.03.2024

Keywords:
Allelopathy
Vicia faba L.,
In-vitro
Weeds
Ecological conditions

A B S T R A C T

Many allelopathic crops are cultivated in agricultural fields, and these plants can influence the growth of other plants in the cultivation environment with their phytotoxic compounds. One of these plants is the faba bean. In this study conducted under the ecological conditions of Sakarya/Arifiye, the allelopathic effects of Eresen-87, Salkim, Bilecik, and Sakarya faba bean genotypes on weeds such as Johnson grass (*Sorghum halepense* L.), curly dock (*Rumex crispus* L.), purslane (*Portulaca oleracea* L.), and wild mustard (*Sinapis arvensis* L.) were investigated. Weed seeds used in the experiment were collected from agricultural fields in the Sakarya province. Extracts from dried plant parts of faba bean genotypes were prepared and applied to petri dishes containing weed seeds at concentrations of 5% and 10%, with four replications. At the end of the research, it was observed that all faba bean genotypes at all application doses caused a decrease in germination rate (%), root length (cm), and shoot length (cm) parameters in the four weed species tested. The best results were determined as Eresen-87 and Bilecik at 10% concentration. When the activities of fresh and dry extracts of faba bean genotypes was compared, it was determined that dry application had a higher allelopathic effect.

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Introduction

Sustainability in agriculture involves establishing a balance through reduced chemical use in the control of diseases, pests, and weeds, employing biological and cultural control methods. However, the increasing preference for herbicides in the management against weeds, due to their ease of application, rapid results, and labour efficiency, raises concerns about intensive chemical usage. Improper and excessive use of herbicides negatively impacts environmental and human health (Kayin & Kizil Aydemir, 2023; Tiryaki et al., 2010). Therefore, alternative control methods, including biological control, are becoming increasingly important. Harnessing the allelopathic effects of plants, which are part of the ecosystem, stands out as an environmentally friendly approach within the scope of biological control. This facilitates the support of desired plant growth in a competitive environment and natural weed control (Chon et al., 2005).

The focus of this study is on the faba bean (*Vicia faba* L.), a leguminous plant with high adaptability to various climatic conditions, rich in protein, and a cool-season legume crop. Although specific information about its consumption dates is limited, the history of faba beans traces back to ancient civilizations. In addition to being used as a food source in various forms such as fresh, dried, canned, and in appetizers, its rich content also leads to its continued use in traditional medicine. Faba beans play a crucial role in sustainable agriculture due to their allelopathic effects, inclusion in crop rotations within the legume group, use as green manure, improvement of soil structure, and the ability to fix biological nitrogen (N). The plant can combat weeds by employing cultivation methods and its cover crop properties. Moreover, incorporating allelopathic chemicals such as β-alanine, camphor, cineole, camphene, diephentene, esculin, coumarin, and psoralen into the soil through the breakdown of faba bean residues can negatively affect weed emergence (Ozturk, 2006; Torun & Uygur, 2019). In a study examining the effects of certain plants, including faba beans, on broomrape (*Orobanche* spp.) for control purposes, Ozturk (2006) found that incorporating faba beans into the soil suppressed the emergence of broomrape through allelopathic effects.

Weeds compete with crops for essential environmental factors such as water, nutrients, area, and light, leading to decreased yields, increased susceptibility to diseases and pests, and a decline in local plant species, resulting in reduced biodiversity. Specifically, in the case of faba beans, weeds during the seedling stage cause leaf drying, stunting during flowering, weakening of the plant, decreased fruit formation, and shortened vegetation periods. A study on the control of weeds reported an 80% reduction in grain yield in faba beans (El-Metwally et al., 2017; Mohamed et al., 2004). In a study investigating the effects of field dodder (*Cuscuta campestris* Yunck) on the phenological and morphological characteristics of faba beans, it was observed that field dodder negatively affected plant height, flower and branch numbers, harvest frequency, fruit size, fruit weight, fruit number, and faba bean yield. Despite its robust taproot system and rapid growth, faba beans can succumb to weeds early in their growth, resulting in plant death (Ustuner, 2023).

In faba bean cultivation areas, annual weeds such as broomrape (*Orobanche crenata* Forsk.), hemp-nettle (*Galeopsis tetrahit* L.), cockspur grass (*Echinochloa crus-galli* (L.) P. Beauv.), black bindweed (*Fallopia convolvulus* (L.) A. Löve), purslane (*Portulaca oleracea* L.), lamb's quarters (*Chenopodium album* L.), field dodder (*Cuscuta campestris* Yunck), pigweed (*Amaranthus* spp.), pale persicaria (*Persicaria lapathifolia* L.), wild mustard (*Sinapis arvensis* L.), wild oat (*Avena fatua* L.), and common speedwell (*Veronica arvensis* L.) have been observed. Perennial weeds in faba bean fields include field horsetail (*Equisetum arvense* L.), sow thistle (*Sonchus arvensis* L.), Johnson grass (*Sorghum halepense* L.), dandelion (*Taraxacum officinale* F. H. Wigg.), Canada thistle (*Cirsium arvense* L.), curly dock (*Rumex crispus* L.), couch grass (*Elytrigia repens* L.), and broadleaf plantain (*Plantago major* L.) (Grenz et al., 2005; Guncan & Karaca, 2023; Ozalp, 2008; Romaneckas et al., 2021; Ustuner, 2023).

Given the absence of registered herbicides for faba bean weed control and the growing emphasis on sustainability, there is a trend towards biological control as an alternative approach in faba bean cultivation. This study aims to explore the allelopathic effects of plant extracts obtained from the stems and leaves of faba beans on Johnson grass (*Sorghum halepense* L.), curly dock (*Rumex crispus* L.), purslane (*Portulaca oleracea* L.), and wild mustard (*Sinapis arvensis* L.) as part of the biological control of weeds.

Materials and Methods

Material

Four different faba bean (*Vicia faba* L.) genotypes were used in the study, including two registered varieties (Eresen-87 and Salkim) and two local populations (Bilecik and Sakarya). Registered varieties were obtained from the Aegean Agricultural Research Institute. Local faba bean populations were collected from villages in Bilecik and Sakarya provinces. When examining the characteristics of the registered faba bean varieties involved in the study, Eresen-87, a commercial variety, exhibits a plant height of 68-91 cm, thousand-seed weight of 1.350-1.600 g, and grain yield of 200-500 kg ha^{-1}, being tolerant to anthracnose. Another commercial variety, Salkim, has a plant height of 37-70 cm, thousand-seed weight of 1.310-1.530 g, and grain yield of 350-450 kg ha^{-1} (AARI, 2020). Four different weed plants, including Johnson grass (*Sorghum halepense* L.), curly dock (*Rumex crispus* L.), purslane (*Portulaca oleracea* L.), and wild mustard (*Sinapis arvensis* L.), were collected from nature to be used in the study.

Method

The study was conducted in two stages: field and laboratory work. Fieldwork took place at the Agricultural Sciences and Technologies Education, Application, and Research Center of Sakarya University of Applied Sciences. The faba bean varieties and populations used in the experiment were planted on a total area of 676 m^2, and the same cultural practices were applied to each faba bean variety.

Laboratory work for the experiment was carried out at the Plant Protection and Field Crops Laboratories of the Faculty of Agriculture at Sakarya University of Applied Sciences. Two registered faba bean varieties (Eresen-87 and Salkim) and two local populations (Bilecik and Sakarya) were used in the study. Weed seeds were collected from agricultural fields in Sakarya province between 2022 and 2023. Four different weed seeds; curly dock, Johnson grass, purslane, and wild mustard were used in the experiment. Johnson grass and wild mustard seeds were subjected to dormancy-breaking treatment before being included in the experiment.

The experiment was conducted using extracts obtained from the stems and leaves of two different broad beans (fresh and dry) and two different concentrations (5% and 10%). The study was carried out with four replications.

Samples randomly taken from the cultivated faba bean genotypes were harvested by cutting them from the root region, and stems and leaves were obtained. Harvested plant samples were brought to the laboratory for the extraction of fresh and dry extracts. For the preparation of extracts from fresh plants, the plants were first chopped into small pieces. For the preparation of dry extracts, plant samples were dried at 65 °C for 72 hours. The dried plants were ground into small pieces. For extract preparation, 100 grams of crushed plant parts were mixed with distilled water to create a 20% stock solution. The mixture was then shaken at 120 rpm at room temperature for 72 hours using an orbital shaker. The obtained extracts were filtered through Whatman filter papers (Kadioglu & Yanar., 2004; Onaran & Yilar, 2012). Prepared stock solutions were diluted to concentrations of 5% and 10%, which were the concentrations applied to the weed plants. Two filter papers were placed at the bottom of 9 cm diameter sterile Petri dishes, and 5 ml of extract was applied to each Petri dish, with 20 weed seeds on top. Sterile distilled water was used for the control group. Daily counts were made from the beginning of the study, and the experiment was terminated after 15 days, followed by harvesting the plants. Parameters such as germination rate (%), root length (cm), shoot length (cm), fresh weight (g), and dry weight (g) were examined in the study. Seeds with a radicle length reaching 1 mm were considered germinated. The analysis of the obtained data was conducted using the SPSS statistical package program.

Results

The data regarding the germination parameters of curly dock, Johnson grass, purslane, and wild mustard seeds treated with extracts at concentrations of 5% and 10%, prepared from fresh and dry faba bean samples, are presented in the tables below and have been evaluated.

When the effect of extracts obtained from faba bean stems and leaves on the germination of wild mustard (*Sinapis arvensis*) was examined, in control plants treated with pure water, the germination rate was observed to be 83.25%, root length 4.399 cm, shoot length 2.663 cm, fresh weight 0.1640 g, and dry weight 0.0040 g.

When the impact of extracts from different concentrations (5% and 10%) of faba bean genotypes on the germination rate of wild mustard was investigated, the highest germination rate was observed in the application of Sakarya faba bean population with a 5% concentration using fresh samples (81.25%). Looking at the data for root length among genotypes, the highest root length was observed in the application of Bilecik faba bean population with a 5% concentration using fresh samples (2.928 cm). Evaluating shoot lengths, the highest values were observed in the applications of Bilecik and Sakarya faba bean populations with a 5% concentration using fresh samples (4.013 and 3.940 cm). According to the fresh weight data, the highest values were found in the applications of Salkim and Eresen-87 faba bean varieties (0.2015 and 0.1800 g) and Bilecik faba bean population (0.1828 g) with a 5% concentration using fresh samples. In dry weight data, the highest values among genotypes were obtained from the applications of Bilecik and Sakarya faba bean populations with a 5% concentration (0.0020 and 0.0015 g). The lowest germination rate, root length, shoot length, fresh weight, and dry weight data were observed in the applications of Eresen-87 and Sakarya genotypes with a 5% concentration using no germination and dry samples, as well as in the applications of Eresen-87, Salkim, Bilecik, and Sakarya faba bean genotypes with a 10% concentration. An increase in concentration resulted in a decrease in germination rate, root length, and fresh weight values in wild mustard.

According to Table 2, in the control group of purslane (*Portulaca oleracea*), the germination rate is 83.50%, root length is 3.200 cm, shoot length is 2.733 cm, fresh weight is 0.1045 g, and dry weight is 0.0010 g. On a genotype basis, the highest germination rate is observed in the application of the Sakarya population with a 10% concentration using fresh samples (93.25%). The highest root length is observed in the applications of the Bilecik faba bean population with 5% and 10% concentrations using fresh samples (1.409 and 1.343 cm). When evaluating shoot length, the highest value is recorded in the application of the Sakarya population with a 10% concentration using fresh samples (3.495 cm). Looking at the fresh weights after the extract applications on weeds, the highest value is measured in the application of the Eresen-87 faba bean variety with a 5% concentration using fresh samples (0.2018 g).

According to the dry weights, the highest values, except for the 0.0013 and 0.0010 g in the Salkim variety's 5% and 10% applications with no germination and using dry samples, are obtained in the other treatments. The lowest germination rate, root length, shoot length, fresh weight, and dry weight data were observed in the applications of Eresen-87, Bilecik, and Sakarya faba bean genotypes with a 10% concentration using no germination and dry samples.

According to Table 3, in the control group of Johnson Grass (*Sorghum halepense*) using plants for control, the germination rate is 72.75%, root length is 2.333 cm, shoot length is 4.270 cm, fresh weight is 0.1870 g, and dry weight is 0.0190 g.

When evaluating the genotype×concentration interactions for germination rates, the highest germination rate is observed in the application of the Sakarya population with 5% and the Bilecik population with 10% concentrations using fresh samples (89.00% and 81.00%). The lowest germination rate is observed in the applications of Eresen-87 and Bilecik genotypes with 10% concentrations using dry samples (10.25% and 8%).

Table 1. Effect of Extracts Obtained from Faba Bean Genotypes on the Growth of Wild Mustard (*Sinapis arvensis* L.) ($p<0.05$)

C	F/D	Genotypes	Germination rate (%)	Root length (cm)	Shoot length (cm)	Fresh weight (g)	Dry weight (g)
		Control	83.25^{a}	4.399^{a}	2.663^{de}	0.1640^{bc}	0.0040^{a}
5%	Fresh	Eresen-87	69.00^{b}	1.556^{de}	2.821^{cd}	0.1800^{ab}	0.0010^{c}
		Salkim	73.00^{b}	1.726^{d}	3.179^{b}	0.2015^{a}	0.0010^{c}
		Bilecik	67.00^{b}	2.928^{b}	4.013^{a}	0.1828^{ab}	0.0020^{b}
		Sakarya	81.25^{a}	1.997^{c}	3.940^{a}	0.1513^{cd}	0.0015^{bc}
	Dry	Eresen-87	0^{g}	0^{h}	0^{h}	0^{h}	0^{d}
		Salkim	23.00^{e}	0.617^{g}	2.321^{f}	0.0463^{fg}	0.0010^{c}
		Bilecik	10.25^{f}	0.503^{g}	1.858^{g}	0.0313^{g}	0.0010^{c}
		Sakarya	0^{g}	0^{h}	0^{h}	0^{h}	0^{d}
10%	Fresh	Eresen-87	44.00^{d}	0.976^{e}	2.415^{ef}	0.0593^{f}	0.0010^{c}
		Salkim	46.00^{d}	1.044^{f}	3.082^{bc}	0.0923^{e}	0.0010^{c}
		Bilecik	56.25^{c}	1.356^{e}	3.245^{b}	0.1313^{d}	0.0010^{c}
		Sakarya	58.25^{c}	0.984^{f}	3.028^{bc}	0.1088^{e}	0.0010^{c}
	Dry	Eresen-87	0^{g}	0^{h}	0^{h}	0^{h}	0^{d}
		Salkim	0^{g}	0^{h}	0^{h}	0^{h}	0^{g}
		Bilecik	0^{g}	0^{h}	0^{h}	0^{h}	0^{d}
		Sakarya	0^{g}	0^{h}	0^{h}	0^{h}	0^{d}

C: Concentration

Table 2. Effect of Extracts Obtained from Faba Bean Genotypes on the Growth of Purslane (*Portulaca oleracea* L.) ($p<0.05$)

C	F/D	Genotypes	Germination rate (%)	Root length (cm)	Shoot length (cm)	Fresh weight (g)	Dry weight (g)
		Control	83.50^{b}	3.200^{a}	2.733^{c}	0.1045^{b}	0.0010^{a}
5%	Fresh	Eresen-87	81.75^{b}	1.041^{c}	2.430^{de}	0.2018^{a}	0.0010^{a}
		Salkim	71.75^{c}	1.061^{c}	2.244^{ef}	0.0615^{b}	0.0010^{a}
		Bilecik	81.75^{b}	1.409^{b}	2.323^{def}	0.0538^{b}	0.0010^{a}
		Sakarya	78.25^{bc}	0.905^{d}	2.977^{b}	0.0079^{b}	0.0010^{a}
	Dry	Eresen-87	8.50^{fg}	0.190^{f}	1.237^{g}	0.0018^{b}	0.0010^{a}
		Salkim	1.75^{gh}	0.042^{g}	$0.075^{\imath}$	0.0048^{b}	0.0003^{b}
		Bilecik	43.50^{e}	0.100^{fg}	0.545^{h}	0.0133^{b}	0.0010^{a}
		Sakarya	11.50^{f}	0.200^{f}	2.101^{f}	0.0165^{b}	0.0013^{a}
10%	Fresh	Eresen-87	85.00^{b}	0.884^{d}	2.112^{f}	0.0583^{b}	0.0010^{a}
		Salkim	61.50^{d}	1.106^{c}	2.519^{cd}	0.0463^{b}	0.0010^{a}
		Bilecik	78.25^{bc}	1.343^{b}	2.333^{def}	0.0515^{b}	0.0010^{a}
		Sakarya	93.25^{a}	0.650^{e}	3.495^{a}	0.0963^{b}	0.0010^{a}
	Dry	Eresen-87	0^{h}	0^{g}	$0^{\imath}$	0^{b}	0^{b}
		Salkim	1.75^{gh}	0.03^{g}	$0.075^{\imath}$	0.0010^{b}	0.0003^{b}
		Bilecik	0^{h}	0^{g}	$0^{\imath}$	0^{b}	0^{b}
		Sakarya	0^{h}	0^{g}	$0^{\imath}$	0^{b}	0^{b}

C: Concentration

Table 3. Effect of Extracts Obtained from Faba Bean Genotypes on the Growth of Johnson Grass (*Sorghum halepense* L.) ($p<0.05$)

C	F/D	Genotypes	Germination rate (%)	Root length (cm)	Shoot length (cm)	Fresh weight (g)	Dry weight (g)
		Control	72.75^{bc}	2.333^{b}	4.270^{f}	0.1870^{cd}	0.0190^{a}
5%	Fresh	Eresen-87	56.25^{de}	1.744^{c}	7.020^{c}	0.1458^{e}	0.0138^{bc}
		Salkim	73.00^{bc}	2.005^{bc}	8.219^{a}	0.2183^{c}	0.0188^{a}
		Bilecik	46.00^{f}	3.119^{a}	7.354^{bc}	0.1718^{de}	0.0130^{cd}
		Sakarya	89.00^{a}	2.278^{b}	6.987^{c}	0.2750^{b}	0.0193^{a}
	Dry	Eresen-87	27.00^{gh}	0.225^{fg}	3.212^{g}	0.0500^{f}	0.0015^{e}
		Salkim	50.00^{ef}	0.366^{fg}	4.563^{ef}	0.1413^{e}	0.0133^{cd}
		Bilecik	35.50^{g}	0.582^{ef}	5.542^{d}	0.0271^{fg}	0.0043^{e}
		Sakarya	64.75^{cd}	0.958^{de}	5.151^{de}	0.1370^{e}	0.0203^{a}
10%	Fresh	Eresen-87	69.00^{c}	1.142^{d}	6.965^{c}	0.1618^{de}	0.0193^{a}
		Salkim	58.25^{de}	2.261^{b}	8.078^{ab}	0.1923^{cd}	0.0090^{d}
		Bilecik	81.00^{ab}	3.058^{a}	7.660^{abc}	0.3208^{a}	0.0175^{ab}
		Sakarya	50.00^{ef}	2.113^{bc}	5.700^{d}	0.1470^{e}	0.0180^{a}
	Dry	Eresen-87	10.25^{i}	0.120^{g}	1.550^{h}	0.0143^{fg}	0.0010^{e}
		Salkim	$14.75^{\imath i}$	0.200^{fg}	4.437^{ef}	0.0400^{fg}	0.0015^{e}
		Bilecik	8.00^{i}	0.112^{g}	2.225^{h}	0.0083^{g}	0.0010^{e}
		Sakarya	$21.00^{h\imath}$	0.144^{fg}	4.331^{f}	0.0523^{f}	0.0103^{cd}

C: Concentration

Regarding the root length data of Johnson Grass, the highest value is observed in the applications of the Bilecik population with 5% and 10% concentrations using fresh samples (3.119 and 3.058 cm). The lowest root length is observed in the applications of Eresen-87 and Bilecik genotypes with 10% concentrations using dry samples (0.120 and 0.112 cm).

The shoot length is highest in the applications of the Salkim variety with 5% and 10% concentrations (8.219 and 8.078 cm) using fresh samples, and in the Bilecik population with a 10% concentration (7.660 cm). The lowest shoot length is observed in the applications of Bilecik and Eresen-87 genotypes with 10% concentrations using dry samples (2.225 and 1.550 cm).

For the fresh weight data of Johnson Grass (*S. halepense*), the highest value is 0.3208 g in the applications of the Bilecik population with a 10% concentration using fresh samples, while the lowest value is 0.0083 g in the applications using dry samples.

The dry weight values are highest in the applications of Sakarya and Salkim faba bean populations with 5% concentrations using fresh samples (0.0193 and 0.0188 g, respectively), and in the applications of Eresen-87, Sakarya, and Bilecik faba bean genotypes with 10% concentrations using fresh samples (0.0193, 0.0180, and 0.0175 g, respectively). The lowest dry weight values are observed in the applications of Bilecik and Eresen-87 populations with high 5% concentrations using dry samples (0.0043 and 0.0015 g, respectively), and in the applications of Salkim, Eresen-87, and Bilecik genotypes with 10% concentrations using dry samples (0.0015, 0.0010, and 0.0010 g, respectively). An increase in concentration results in a decrease in germination rate and fresh weight in applications using dry samples.

Table 4. Effect of Extracts Obtained from Faba Bean Genotypes on the Growth of Curly Dock (*Rumex crispus* L.) ($p<0,05$)

C	F/D	Genotypes	Germination rate (%)	Root length (cm)	Shoot length (cm)	Fresh weight (g)	Dry weight (g)
		Control	94.00^{a}	1.518^{a}	2.164^{h}	0.0975^{ab}	0.0050^{a}
5%	Fresh	Eresen-87	69.00^{b}	0.879^{c}	5.367^{b}	0.2050^{a}	0.0010^{cd}
		Salkim	56.50^{cd}	1.404^{b}	5.661^{a}	0.1163^{ab}	0.0010^{cd}
		Bilecik	22.25^{gh}	0.721^{d}	2.812^{f}	0.1690^{a}	0.0010^{cd}
		Sakarya	28.25^{fg}	0.725^{d}	3.575^{e}	0.0133^{b}	0.0010^{cd}
	Dry	Eresen-87	28.25^{fg}	0.175^{h}	1.752^{ıi}	0.0180^{b}	0.0010^{cd}
		Salkim	34.75^{f}	0.300^{g}	2.451^{g}	0.0360^{b}	0.0015^{c}
		Bilecik	37.75^{ef}	0.190^{h}	1.492^{i}	0.0375^{b}	0.0010^{cd}
		Sakarya	34.75^{fg}	0.132^{hı}	1.150^{j}	0.0023^{b}	0.0010^{cd}
10%	Fresh	Eresen-87	63.00^{bc}	0.784^{d}	5.023^{c}	0.0958^{ab}	0.0010^{cd}
		Salkim	47.00^{de}	0.770^{d}	5.113^{bc}	0.0485^{b}	0.0010^{cd}
		Bilecik	37.50^{ef}	0.39^{f}	3.985^{d}	0.0263^{b}	0.0010^{cd}
		Sakarya	34.75^{f}	0.525^{e}	3.575^{e}	0.0340^{b}	0.0010^{cd}
	Dry	Eresen-87	3.25^{ı}	0.050^{ı}	0.025^{l}	0.0005^{b}	0.0010^{cd}
		Salkim	69.00^{b}	0.158^{h}	1.881^{ı}	0.0400^{b}	0.0025^{b}
		Bilecik	13.00^{hı}	0.200^{h}	0.675^{k}	0.0020^{b}	0.0010^{cd}
		Sakarya	69.00^{fg}	0.148^{hı}	1.179^{j}	0.0248^{b}	0.0010^{cd}

C: Concentration

According to Table 4, the parameters of the control group are as follows: germination rate is 94.00%, root length is 1.518 cm, shoot length is 2.164 cm, fresh weight is 0.0975 g, and dry weight is 0.0050 g. In the applications of genotype extractions, the highest germination rate is observed in the application of the Eresen-87 faba bean variety with a 5% concentration using fresh samples (69.00%), and in the application of the Salkim faba bean variety with a 10% concentration using dry samples (69.00%).

When examining the root lengths of curly dock (*R. crispus*), the highest value is determined in the application of the Salkim faba bean variety with a 5% concentration using fresh samples (1.404 cm). The highest value in shoot length is obtained from the application of Salkim variety with a 5% concentration using fresh samples (5.661 cm).

The highest fresh weight values are obtained from the 5% concentration of fresh samples from Eresen-87, Bilecik, and Salkim genotypes (0.2050, 0.1690, and 0.1163 g) and the 10% concentration of fresh samples from Eresen-87 variety (0.0958 g). In terms of dry weight, the highest value is measured in the application of the Salkim variety with a 10% concentration using dry samples (0.0025 g).

The applications of Eresen-87 faba bean variety with a 10% concentration using dry samples give the lowest values for all parameters, with a germination rate of 3.25%, root length of 0.050 cm, shoot length of 0.025 cm, fresh weight of 0.0005 g, and dry weight of 0.0010 g. with an increase in concentration, root length in curly dock decreases in applications using fresh samples.

Discussion and Conclusion

Ozturk (2006) reported in their study, aiming to determine the effects of some plants on jimsonweed (*Datura stramonium* L.), that as the extract dosage used in the experiment increased, no emergence was observed in the faba bean plant. Álvarez-Iglesıas et al. (2014) examined the effects of faba bean extracts on germination, root length, and shoot length in maize (*Zea mays* L.), soybean (*Glycine max* (L.) Merr.), crabgrass (*Digitaria sanguinalis* (L.) Scop.), barnyard grass (*Echinochloa crus-galli* (L.) P. Beauv.), redroot pigweed (*Amaranthus retroflexus* L.), and lettuce (*Lactuca sativa* L. cv. Great Lakes) plants. According to their findings, while there was a 10% decrease in parameters of maize and soybean among the cultivated plants, they reported a 90% suppression in all weeds.

In a study examining the allelopathic effect of common vetch on different weeds, Kitis et al. (2016) found that common vetch extracts applied at different doses (0%, 25%, 50%, and 100%) almost completely inhibited the germination rates of purslane (*P. oleracea*) and wild mustard (*S. arvensis*) at doses of 50% and 100%. Oueslati et al. (2023) investigated the effects of extracts obtained from different parts of faba bean on the development of durum wheat (*Triticum durum* L.), particularly noting that faba bean leaf extracts significantly reduced wheat root length. These research results are consistent with previous studies.

Upon evaluating all the data, significant differences are observed, especially in germination rate, root length, and shoot length parameters when comparing control and genotypes. Additionally, differences were found in genotype×concentration interactions. As the concentration ratio increased, a decrease in germination rate, root length, and fresh weight values was observed in wild mustard. An increase in the applied concentration in Johnson grass resulted in a decrease in germination rate and fresh weight in dry samples. In the curly dock, an increase in concentration resulted in a decrease in root length in applications using fresh samples. Genotype×concentration-specifically, in applications using dry samples of the two genotypes, the Eresen-87 faba bean variety was found to be significantly effective on wild mustard, purslane, and curly dock weeds at a 10% concentration, yielding the lowest results. In applications with a 10% concentration of Bilecik faba bean population, significant effects were observed on the development of wild mustard, purslane, and Johnson grass, yielding minimum values. When these two genotypes are compared, the Eresen-87 faba bean variety proves itself in terms of yield and yield components. The Bilecik faba bean population stands out in the study by suppressing weeds to this extent, suggesting that improvement of yield parameters can be achieved through breeding studies. The high allelopathic effect of the faba bean plant on weeds has been demonstrated by various research studies and our experiment. As weeds gain resistance to herbicides, alternative applications to reduce resistance problems will become increasingly important. Moreover, excessive and unnecessary use of chemicals poses a danger to natural ecosystems and human health. Herbicides washed away by rain can contaminate essential water sources such as lakes, rivers, reservoirs, and streams, impacting aquatic life and drinking water. In today's world, where the importance of water and conservation is emphasized with climate change, allelopathy studies to reduce the indirect effects of herbicides are expected to be among the topics that will be further investigated in the future. In this context, it is believed that the results of the study will pave the way for pot and field experiments.

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