Anadolu, J. of AARI
ISSN:1300-0225 (Print)
E-ISSN: 2667-6087 (Online)
2024, 34 (1):82-89
DOI: 10.18615/anadolu.1494763

Determination of In Vitro Allelopathic Effect of Field Bindweed (Convolvulus arvensis L.) on Some Weeds and Test Plants

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Received (Geliş tarihi): 03.06.2024 Accepted (Kabul tarihi): 24.06.2024

***ABSTRACT**: As the damage caused by weeds to agricultural crops increases, the use of herbicides is rapidly rising. The importance of allelopathy, one of the most environmentally friendly strategies in weed control, is growing day by day, making it one of the heavily researched topics in this field. Field bindweed (**Convolvulus arvensis**) is a weed causing considerable damage in agricultural areas. In this study, the in vitro allelopathic effect of field bindweed (**C. arvensis**) on weeds such as **Sorghum halepense** and **Xanthium strumarium** and on seed germination of crops such as cress (**Lepidium sativum**), cucumber (**Cucumis sativus**) and grass (**Lolium perenne**) was investigated. The studies were conducted in the Laboratory of Plant Protection, Faculty of Agriculture, Sakarya University of Applied Sciences* in *2023. Water and methanol extracts derived from the green parts of field bindweed were applied to seeds in Petri dishes at concentrations of 1, 3, and 5%. According to the results obtained, it was observed that 5% methanol extract prevented seed germination in all plants. It was also concluded that 5% water extract prevented the germination (0% germination) of hogweed (**X. strumarium**) and cress (**L. sativum**) plants. Promising data were obtained from this laboratory study against the germination of various plant seeds of field ivy (**C. arvensis**), which is an agriculturally problematic plant, and the results will be further confirmed by conducting greenhouse and field trials.*

***Keywords:** Convolvulus arvensis, water extract, alcohol extract, germination, alternative control.*

Tarla Sarmaşığı (Convolvulus arvensis L.)'nın Bazı Yabancı Otlar ve Test Bitkileri Üzerinde In Vitro Allelopatik Etkisinin Belirlenmesi

***ÖZ:** Yabancı otların tarımsal ürünlere verdiği zararın artmasıyla birlikte herbisitlerin kullanımı da hızla artmaktadır. Yabancı ot kontrolünde en çevre dostu stratejilerden biri olan allelopatinin önemi her geçen gün daha da artmakta ve bu alan, yoğun şekilde araştırılan konular arasında yer almaktadır. Tarla sarmaşığı (**Convolvulus arvensis**) tarım alanlarında hemen her yerde görülen önemli zararlara neden olan bir yabancı ot olarak karşımıza çıkmaktadır. Bu çalışmada Tarla sarmaşığı (**C. arvensis**) bitkisinin in vitro allelopatik etkisini belirlemek amacıyla yabancı otlardan kanyaş (**Sorghum halepense**) ve domuz pıtrağı (**Xanthium strumarium**)'na, kültür bitkilerinden ise tere (**Lepidium sativum**), hıyar (**Cucumis sativus**) ve çim (**Lolium perenne**) bitkilerinin tohum çimlenmeleri üzerine etkileri araştırılmıştır. Çalışmalar 2023 yılında Sakarya Uygulamalı Bilimler Üniversitesi Ziraat Fakültesi Bitki Koruma Bölümü Laboratuvarında yürütülmüştür. Tarla sarmaşığının yeşil aksamından elde edilen su ve methanol ekstraktları %1, 3 ve 5 konsantrasyonlarda petri kapları içerisinde bulunan tohumlara uygulanmıştır. Elde edilen sonuçlar doğrultusunda %5'lik methanol ekstraktının tüm bitkilerde tohum çimlenmesini engellediği gözlemlenmiştir. Ayrıca %5'lik su ekstraktınında domuz pıtrağı (**X. strumarium**) ve tere (**L. sativum**) bitkilerinin çimlenmesini (% 0 çimlenme) engellediği sonucuna varılmıştır. Buna karşın kullanılan su ekstraktlarının tüm dozlarının kanyaş (**S. halepense**) ve çim (**L. perenne**) bitkilerinde kök gelişimini teşvik ettiği gözlemlenmiştir. Tarımsal açıdan sorun oluşturan Tarla sarmaşığı (**C. arvensis**) bitkisinin çeşitli bitki tohumlarının çimlenmesine karşı ümitvar veriler alınan bu laboratuvar çalışması sonrası sera ve tarla denemeleri de yapılarak sonuçlar daha da doğrulanmış olacaktır.*

***Anahtar kelimeler: Convolvulus arvensis**, su ekstraktı, alkol ekstraktı, çimlenme, alternatif mücadele.*

INTRODUCTION

Weeds are unwanted plants of agricultural areas. Having an aggressive growth habitat, weeds are able to grow rapidly and dominate crop plant growth. Weeds compete with crops for nutrient, space, sunlight, and water. A common method of weed control is the application of herbicides such as 2.4 D. But most of the herbicides were banned due to hazardous effects on enivronment, animals and humans (Uddin et al., 2012). Allelopathy is a direct or indirect harmful or beneficial effect of a plant, fungus or microorganism on other living things by producing and secreting various allelochemicals (Rice, 1974; Özer et al., 2003). Allelopathy between plants occurs when a plant secretes chemicals that affect surrounding plant species (Rice, 1984). Chemical secretions with allelopathic effects are called allelochemicals (Cheng and Cheng, 2015). These chemicals are found in all plant parts, including leaves, flowers, fruits, stems, roots, rhizomes, seeds, and pollen and are released into the environment in different ways (Zeng et al., 2008).. Exposure to allelochemicals affects plant growth and development. Inhibition of germination, decrease in photosynthetic rate, chlorosis and distortion, darkening and swelling of seeds, development and shortening of root shoots and coleoptiles, lesions on root tips, lack of root hair formation, curling of root tips, decrease in dry weight, and decrease in plant reproductive ability are observed (Benyas et al., 2010) Plants on Earth secrete more than 10,000 allelochemicals, which vary in their effects. These allelochemicals have also been identified in weeds, and glucosinolates, saponins, limonoid triterpenes, essential oil, polyphenols, alkaloids, phenolics, flavonoids, and tannins are the most important in these plants (Şin and Öztürk, 2021).

Convolvulus arvensis L., known as field bindweed, is one of the 250 plants of the family Convolvulaceae. The weed is perennial, each plant producing 30-300 seeds that survive 50 years. (Timmons, 1949; Weaver and Riley, 1982). It is commonly found on 32 crops in 44 countries worldwide (Holm et al., 1977). This weed chokes young crops, covers them, proliferates, and reduces yield by competing for the nutrients, water, and sunlight needed for plants to develop. *C. arvensis* is a common weed that can rapidly grow, wrap, and overwhelm other plants. Due to its climbing ability, it can affect plants of all sizes, including trees. It competes highly with other species for sunlight, moisture, and nutrients (Berca, 2004). Annual crop plants are susceptible to *C. arvensis* damage and 20-80% yield loss can occur in these plants (Black et al., 1994). In addition, *C. arvensis* is reported to host several viruses including potato virus X disease, and tomato spotted wilt virus (DiTomaso and Healy, 2007).

Field bindweed is reported to have an allelopathic effect on crop plants such as wheat, barley, lentils, and weeds (Om et al., 2002; Yarnia, 2010; Shahrokhi et al., 2011; Rahimzadeh et al., 2012). For instance, Obaid and Qasem (2005) found that volatiles extracted from *C. arvensis* shoots reduced the growth of cabbages, cucumbers, carrots onions, pumpkins, peppers, and tomatoes. Compounds such as caffeic, ferulic acid, amino acids, amides, sugars, aliphatic acids, aromatic acids, ethylene, vitamins, peptides, proteins, enzymes, plant hormones, alcohols, ketones, olefins, urea, phytoalexins-coumaric acid, p-Hydroxybenzoic acid, and syringic have been detected as allelochemicals released by roots of field bindweed (Hegab and Ghareib, 2010; Balah, 2015).

The objective of this research was to study the *in vitro* allelopathic effects of ethyl alcohol and water extracts from field bindweed on Johnson grass (*Sorghum halepense*) and cocklebur (*Xanthium strumarium*), as well as on cultivated plants such as cress (*Lepidium sativum*), cucumber (*Cucumis sativus*), and perennial ryegrass (*Lolium perenne*).

MATERIAL AND METHODS

Material

The study was conducted in the Plant Protection Laboratory, Faculty of Agriculture, Sakarya University. The main material of the study was the green part (leaves) of field bindweed (*Convolvulus arvensis*), which is known to have allelopathic effects. To determine the allelopathic effect of the prepared extracts on germination, the following plants were used: hogweed (*Xanthium strumarium*), perennial ryegrass (*Lolium perenne*), Johnson grass (*Sorghum *halepense*), cucumber (*Cucumis sativus*), and cress (*Lepidium sativum*). The weeds used in the experiment were selected from the weeds that cause significant problems in agricultural areas of Sakarya province (Çal and Kara, 2020). Weed seeds were collected from agricultural areas where crops were grown in Sakarya in 2022 and 2023. The collected seeds were cleaned and stored in glass jars at +21°C and in the dark. Before setting up the experiments, hogweed (*X. strumarium*) seeds were removed from the fruits and undamaged large seeds were included in the experiments. In order to break the dormancy of Johnson grass (*S. halepense*), sulfuric acid was applied for 30 min. Seeds were then rinses by passing through pure water three times and were then used in the experiment (Şin et al., 2019). The cultivated plants seeds (perennial ryegrass, cucumber and cress) used in the study were obtained from an agricultural dealer.

Method

The leaves of field bindweed (*C. arvensis*) were collected from cultivated fields in Sakarya province. They were first sorted and dried by mixing and periodically turning in the shade. The dried plants were then ground into powder. Then, 450 ml of solvent (distilled water and methanol) was added per 50 g weighed plant samples. The mixture was shaken at 180 rpm in an orbital shaker at room temperature for 48 hours. The solvent obtained was filtered through a 4-ply cheesecloth and then filtered twice through filter paper. Evaporation was used to remove the alcohol in the methanol extract, and the pure extract was obtained. The prepared extracts were stored in the refrigerator at +4℃ until use (Ashrafi et al., 2008; Abbasi, 2012; Al-Malki, 2014). In the experiment, the stock solutions were adjusted to 1%, 3%, and 5% doses and used.

Sterile 9 cm diameter plastic petri dishes were used for germination studies. Two layers of Whatman filter paper were used in the Petri dishes. Twenty Johnsongrass, perennial grass, cress, cucumber and Hogweed seeds were added to each petri dish. The experiment was arranged as randomised block design with 4 replicates. Five ml of the prepared extract solutions were added to each petri dish. Sterile pure water was used in the control group. The experiments were monitored for 15 days at an optimal temperature of 24±2°C. The experiment was checked every other day and germination was counted. When the radicle reached a length of 0.5 cm, the seed was considered as germinated. At the end of the 15th day, the root and shoot lengths of the germinated seedlings were measured with a digital calliper. The fresh weight of the seedlings was measured, the seedlings were kept in an oven at 72°C for 48 h and the dry weight was measured and recorded (Üremiş & Uygur, 1999; Şin et al., 2017).

The Duncan test was applied using the SPSS (20.0) package program to reveal the statistical differences between the data obtained from the research.

RESULTS AND DISCUSSION

When water and alcohol extracts were prepared from field bindweed and applied at various concentrations (1%, 3%, 5%) against Johnson grass (*Sorghum halepense*), cocklebur (*Xanthium strumarium*), cress (*Lepidium sativum*), cucumber (*Cucumis sativus*), and perennial ryegrass (*Lolium perenne*) seeds, the results presented in Tables 1 to 5 were obtained.

Table 1.The effect of extracts on the germination of cocklebur (*Xanthium strumarium* L.) and growth parameters.
Çizelge 1. Ekstraktların domuz pıtrağı (*Xanthium strumarium* L.) çimlenmesi ve büyüme parametreleri üzerine etkisi.

Extract-Dose	Germination rate (%)	Root length (cm)	Shoot length (cm)	Fresh weight (mg)	Dry weight (mg)
Control	70.00^{a}	3.28±0.88^{a}	3.93±0.73^{a}	1310.00±72.90^{a}	268.00±53.00^{a}
Water %1	50.00^{b}	1.80±0.62^{ab}	2.50±1.84^{ab}	303.00±55.10^{b}	30.00±11.80^{c}
Water %3	17.50^{c}	1.67±0.59^{b}	2.21±0.84^{ab}	350.00±58.50^{b}	35.00±15.60^{c}
Water %5	0.00^{d}	0.00^{c}	0.00^{c}	0.00^{c}	0.00^{d}
Alcohol %1	47.50^{b}	1.99±0.34^{ab}	3.68±0.35^{a}	367.00±55.20^{b}	67.00±10.90^{b}
Alcohol %3	15.00^{cd}	1.06±0.22^{bc}	3.14±0.69^{b}	241.00±55.20^{c}	55.00±16.30^{c}
Alcohol %5	0.00^{d}	0.00^{c}	0.00^{c}	0.00^{c}	0.00^{d}

*p<0.05

Table 1 presents the parameters of the control group, which were as follows: germination rate (70%), root length (3.28 cm), shoot length (3.93 cm), fresh weight (1310 mg) and dry weight (268 mg).

When the effects of 1%, 3% and 5% doses of water, and alcohol extracts of the field bindweed on the growth of the cocklebur (*Xanthium strumarium*) were examined, it was observed that germination was not possible with increasing doses of water and alcohol extracts, especially at 5% doses. Furthermore, comparable outcomes were observed at 1% and 3% doses of the water extract. The 3% dose resulted in a reduction in the developmental parameters in comparison to the control. Nevertheless, the results indicated that the growth parameters were enhanced relative to the 1% dose. The growth parameter data decreased when alcohol extracts were applied in increased doses.

Table 2 demonstrates that when field bindweed extracts were applied to the grass plants , the 1% and 3% doses of water extract increased germination compared to the control, both in terms of germination percentage and statistically. However, germination decreased significantly as the dose of water extract increased, as shown in Table 2. In alcohol extracts, the germination rate at a 1% dose was 91.25%, which was statistically different from the control and water extracts, and the germination completely stopped when the doses were increased to 3 and 5%. As a result of the experiment, the maximum root length was observed in the control group (11.08 cm), while the shoot length was observed in the 3% water extract (12.09 cm). The highest wet weight was found in the control group, while the highest dry weight was found in the 1% alcohol extract (60.5 mg). Notably, although the 1% alcohol extract showed the highest dry weight, there was no statistically significant difference in dry weight between the 1% and 3% water extracts.

Table 2. The effect of extracts on the germination and the growth of perennial ryegrass (*Lolium perenne* L.).
Çizelge 2. Ekstraktların çim (*Lolium perenne* L.) çimlenmesi ve büyüme parametreleri üzerine etkisi.

Extract-Dose	Germination rate (%)	Root length (cm)	Shoot length (cm)	Fresh weight (mg)	Dry weight (mg)
Control	93.75^{bc}	11.08±0.67^{a}	9.51±0.48^{b}	536.00±29.00^{a}	49.50±1.90^{ab}
Water %1	98.75^{a}	7.71±0.46^{b}	10.52±0.31^{b}	365.70±22.00^{bc}	55.30±1.80^{a}
Water %3	97.5^{ab}	3.37±0.48^{c}	12.09±0.31^{a}	429.50±31.00^{ab}	54.50±1.90^{a}
Water %5	81.25^{d}	1.97±0.36^{d}	7.83±1.03^{c}	257.00±75.00^{c}	41.00±8.00^{b}
Alcohol %1	91.25^{c}	4.07±0.45^{c}	4.10±1.06^{d}	399.80±49.00^{b}	60.50±2.80^{a}
Alcohol %3	0.00^{e}	0.00^{e}	0.00^{e}	0.00^{d}	0.00^{c}
Alcohol %5	0.00^{e}	0.00^{e}	0.00^{e}	0.00^{d}	0.00^{c}

*p<0.05

As given in Table 3, when extracts were applied to the *Sorghum halepense* seeds, the germination rate was determined as 90% in the control group, whereas it was found as 65% both in the 1% alcohol and water extracts. When comparing the 3% and 5 % water and alcohol extract treatments, it was found that the germination rate was decreased both in the 3% water and alcohol extracts. In addition, the germination rate was observed as 0% when 5 % alcohol extract was applied. The highest root length was found in 1 % water extract treatment, while the highest shoot lengths were determined in 1% and 3% extracts. In wet weight, 1% alcohol extract was the highest after the control group and statistically in the same group as the control group. The highest value was found in 1% water extract in dry weight.

Table 3. The effect of water and alcohol extracts prepared from field bindweed plant at 1%, 3%, and 5% doses on the germination and growth of Johnsons grass (*Sorghum halepense* (L.) Pers.).
Çizelge 3. Tarla sarmağı bitkisinin %1, %3 ve %5 dozlarında hazırlanan su ve alkol ekstraktlarının Kanyaş (*Sorghum halepense* (L.) Pers.) çimlenmesi ve büyümesi üzerine etkisi.

Extract-Dose	Germination rate (%)	Root length (cm)	Shoot length (cm)	Fresh weight (mg)	Dry weight (mg)
Control	90.00^{a}	1.11±0.28^{b}	3.23±0.72^{c}	123.30±18.80^{a}	10.20±1.38^{b}
Water %1	65.00^{b}	2.07±0.21^{a}	5.48±0.41^{ab}	37.70±13.40^{b}	27.20±11.27^{a}
Water %3	55.00^{c}	0.48±0.06^{cd}	5.73±0.75^{a}	53.00±8.20^{b}	12.50±11.30^{b}
Water %5	37.50^{d}	0.21±0.04^{d}	2.95±0.67^{c}	37.80±11.70^{bc}	9.30±2.10^{b}
Alcohol %1	65.00^{b}	0.89±0.16^{bc}	3.68±0.39^{bc}	120.00±18.30^{a}	8.50±2.90^{b}
Alcohol %3	25.00^{e}	0.38±0.12^{d}	2.71±1.04^{c}	33.80±11.20^{bc}	1.00±4.00^{b}
Alcohol %5	0.00^{f}	0.00^{d}	0.00^{c}	0.00^{c}	0.00^{b}

*p<0.05

Based on the results recorded in Table 4, which contains data about the germination of cucumber plants, the highest germination rate, with a 95% success rate, was observed in control plants, and this was followed by the 1% alcohol extract, which exhibited a 90% germination rate. Although the germination rate in the 1% water extract remained at 60%, the highest root and shoot length (10.29 and 7.11 cm) was determined after the control group (14.47 and 9.07 cm). Although the root and shoot length was less than that of the water extract, the wet weight of the 1% alcohol extract was higher. The statistical evaluation revealed a statistically significant difference between the two groups.

Table 5 presents the germination and growth data of cress plants. Cress plants are known to be sensitive to extracts, as evidenced by the results of our experiment. While the germination rate was 83.75% in the control group, it decreased to 23.75% at 1% and 12.5% at 3% water extract concentration. No germination was observed in extracts made using 5% water extract and alcohol. Similar results were observed in root length and wet and dry matter content. In particular, a significant decrease (18.8 and 17.2 mg) was observed in water extracts compared to the control group (179.5 mg) in plant wet weight. Among the parameters, only shoot length exhibited an increase in the 1% water extract compared to the control group. However, this increase diminished with increasing doses and ultimately disappeared.

Table 4. The effect of water and alcohol extracts prepared from field bindweed plant at 1%, 3%, and 5% doses on the germination and growth of cucumber (*Cucumis sativus* L.).
Çizelge 4. Tarla sarmağı bitkisinin %1, %3 ve %5 dozlarında hazırlanan su ve alkol ekstraktlarının hıyar (*Cucumis sativus* L.).çimlenmesi ve büyümesi üzerine etkisi.

Extract-Dose	Germination rate (%)	Root length (cm)	Shoot length (cm)	Fresh weight (mg)	Dry weight (mg)
Control	95.00^{a}	14.47±1.25^{a}	9.07±0.41^{a}	3002.00±124.00^{a}	81.30±8.30^{d}
Water %1	60.00^{b}	10.29±1.10^{b}	7.11±0.41^{b}	771.30±299.00^{bc}	123.50±23.46^{ab}
Water %3	57.50^{b}	4.30±1.31^{c}	5.79±0.48^{c}	540.90±438.00^{c}	109.30±13.70^{bc}
Water %5	37.50^{c}	2.13±0.92^{d}	2.69±0.72^{e}	370.00±86.00^{d}	94.30±29.04^{cd}
Alcohol %1	90.00^{a}	3.84±0.61^{c}	4.60±0.53^{d}	1586.00±156.00^{b}	106.00±9.58^{bc}
Alcohol %3	65.00^{b}	0.81±0.10^{e}	1.57±0.15^{f}	560.00±133.00^{d}	140.00±25.69^{a}
Alcohol %5	0.00^{d}	0.00^{f}	0.00^{g}	0.00^{d}	0.00^{e}

*p<0.05

Table 5. The effect of water and alcohol extracts prepared from field bindweed plants at 1%, 3%, and 5% doses on the germination and growth of cress (*Lepidium sativum* L.).

Çizelge 5. Tarla sarmağı bitkisinin %1, %3 ve %5 dozlarında hazırlanan su ve alkol ekstraktlarının tere (*Lepidium sativum* L.). çimlenmesi ve büyümesi üzerine etkisi.

Extract-Dose	Germination rate(%)	Root length (cm)	Shoot length (cm)	Fresh weight (mg)	Dry weight (mg)
Control	83.75^{a}	$5.10±0.64^{a}$	$2.60±0.08^{b}$	$179.50±17.00^{a}$	$6.50±1.19^{a}$
Water %1	23.75^{b}	$3.49±0.43^{b}$	$3.39±0.45^{a}$	$18.80±12.50^{b}$	$2.30±1.25^{b}$
Water %3	12.50^{c}	$1.08±0.26^{c}$	$2.61±0.45^{b}$	$17.20±5.30^{b}$	$1.00±0.10^{bc}$
Water %5	0.00^{d}	0.00^{d}	0.00^{b}	0.00^{b}	0.00^{c}
Alcohol %1	0.00^{d}	0.00^{d}	0.00^{b}	0.00^{b}	0.00^{c}
Alcohol %3	0.00^{d}	0.00^{d}	0.00^{b}	0.00^{b}	0.00^{c}
Alcohol %5	0.00^{d}	0.00^{d}	0.00^{b}	0.00^{b}	0.00^{c}

*$p<0.05$

Fateh *et al.* (2012) examined the effect of field bindweed extracts on *Pennisetum* sp. and *Ocimum basilicum* plants. Their findings indicated that the allelopathic effect of the 100% dose exhibited the highest suppressive effect on germination for both plants, while the allelopathic effect of the 33% dose exhibited the lowest suppressive effect. The results indicated that germination was suppressed as the extract dose increased. Baličević *et al.* (2014), examining the allelopathic effect of field bindweed dry leaf and root water extracts on two different corn varieties, and they reported that seed germination was reduced by up to 36%. They observed that root extracts had a more suppressive effect on germination and similarly suppressed fresh weight, root, and shoot length. In the experiment, germination and growth parameters decreased with increasing doses. Researchers also concluded that susceptibility to the extract varied depending on corn varieties. Similarly, Yarnya *et al.* (2009) reported that field bindweed extracts had a negative allelopathic effect on germination, growth and yield parameters on wheat seeds *in vivo* conditions.

In another study, Mengal *et al.* (2015), found that the allelopathic effect of field bindweed at 60% concentration gave proven results, and Reynders and Duke (1979) reported that *Convolvulus arvensis* L. had a high allelopathic effect on another weed species, *Amaranthus retroflexus*. Hegab and Ghareib (2010) determined the allelopathic effect of field bindweed methanol extract at different concentrations on wheat growth and some physiological processes. They found that doses at 75, 150, and 300 ppm had stimulating effects on the root, shoot lengths, and dry weights compared to the control and chlorophyll. They concluded that the content of carbohydrates, proteins, and phenolic compounds also increased while the enzyme activities of catalase, peroxidase, phenoloxidase, and superoxide dismutase were gradually stimulated. The gradual suppression of lipid peroxidase and the H_2O_2 content were highest at 300 ppm. They also reported that at the highest concentration of 600 ppm, there was a low level of inhibition of parameters other than lipid peroxidation and H_2O_2 levels. Because of its stimulating potential, they recommended low concentrations of methanol extract from field bindweed that could be used as a fertilizer. Sunar *et al.* (2013) applied *C. arvensis* root, stem, and leaf methanol extracts at 50, 75, and 100 µl concentrations in their study on the examination of field bindweed methanol extracts in terms of genotoxic and inhibitory activity on soluble protein content and genomic template stability on the corn plant. They revealed that especially 100 µl root, stem, and leaf extracts had inhibitory activity on genomic stability, and increasing doses of extracts also increased the total soluble protein content in maize.

Based on the studies conducted by different researchers, it is known that field bindweed has various degree of allelopathic effect on different plants, and our study was compatible with the results of all studies.

CONCLUSION

When comparing all the data, it was observed that field bindweed water and alcohol extracts had varying effects on weeds. Generally, increasing the dose of alcohol and water extracts increased their suppressive effect on parameters compared to the control. A notable finding was that the 5% alcohol extract suppressed plant germination. All water extracts applied to perennial grass and Johnson grass stimulated root development. Additionally, a 5% water dose inhibited germination in cress and hogweed. Given the increasing concern over the harmful effects of chemicals in today's conditions, researchers are exploring alternative weed control methods. Numerous studies have documented the allelopathic effects of many plants. It is crucial to validate such studies and prioritize future research to enable alternative applications under field conditions.

Climate change's detrimental effects vary widely among cultivated plants and weeds, leading to reduced efficacy of conventional chemicals. Consequently, plants with potential allelopathic effects are gaining importance. In this context, allelopathy studies will be increasingly pursued in the future, and our findings will guide greenhouse and field research.

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