THE ALLELOPATHIC EFFECTS ON DIFFERENT CULTIVATED PLANT OF *CARDARIA DRABA* (L.) DESV. PLANT WATER EXTRACTS

Melih YILAR

Ahi Evran University, Faculty of Agriculture, Department of Plant Protection, Kirsehir, Turkey

Corresponding author: melih.yilar@ahievran.edu.tr

ABSTRACT

In this study, the allelopathic effects of water extract obtained from ground parts of *Cardaria draba* (L.) Desv. plant on seed germination and seedling growth of different cultivated plant species were investigated. For this purpose, *C. draba* plants were collected in 2016 from Kirsehir province. After drying them the shadows, the plants were pulverized with a grinder. A 20% stock solution was prepared by placing 200gr plant sample in 1 lt water. *Lactuca sativa* L., *Lepidium sativum* L. and *Triticum vulgare* L. seeds (25 piece) were homogeneously distributed in two layers of fitler paper in 9 cm diameter petri dishes placed and the filter papers were thoroughly moistened using distilled water(control) for 1%, 5%, 10% and 20% extract doses. The petri dishes were tightly wrapped with parafilm and petri dishes were incubated at 12 hours dark -12 hours light periods with an average temperature of 24 ^{o}C±1 for two weeks. At the end of this period, seed germination rates, root and shoot lengths of the test plants were determined. Plant extracts of *C. draba* were completely inhibited seed germination, root and shoot development with 5% dose of *L. sativum* and 10% dose of *L. sativa*. The extracts of *C. draba* inhibited seed germination, root and shoot growth of *T. vulgare* significantly compared to control To conclude, *C. draba* plant which is naturally distributed in our country was found phytotoxic on cultivated plants.

Keywords: *Cardaria draba* (L.) Desv., Kirsehir, allelopathic effects, water extract

INTRODUCTION

Weeds compete with culture plants for CO_2, O_2, light, and nutrients and some release phytotoxic compounds and negatively affect the growth of plants (Shah et al., 2017). Through these secondary compounds with allelopathic effects, some plants may negatively affect the germination and other developmental processes of plants (Taiwo and Makinde, 2005).

These compounds are called allelochemicals and affect other plants, inhibit their growth, and thereby negatively affect yields (Alam and Islam, 2002). Phytotoxins inhibit or slow the growth and development of other plants and are found in the leaves, shoots, fruits, seeds, and rhizomes of plants (Zeng et al., 2008). They are released into the environment and soil through volatilization, root secretions, wash-off from aerial organs, and decomposition of plant residue (Fujii et al., 2004; Arıkan and Elibüyük, 2015). In addition to their detrimental effects on culture plants due to the competition stemming from their broad distribution across culture areas, the phytotoxic effects of weeds on culture plants reduce yields.

Cardaria draba (L.) Desv. is a perennial and highly competitive weed that causes problems in natural habitats and agricultural lands (AI-Ahmed, 1982; Qasem, 2004). *C. draba* is distributed in almost every region of Turkey (Anonymous, 2018). The *C. draba* plant contains toxic compounds with allelopathic properties called glucosinolates in its shoots and roots (McInnis et al., 1993; Kiemnec and McInnis, 2002). The hydrolytically decomposed products of these chemicals were determined to have seed germination and plant growth-inhibiting bioactivity (Brown and Morra, 1997).

Different researchers have reported the phytotoxic or allelopathic effects of some common weeds on culture plants (Qasem, 2001; Obaid and Qasem, 2002; Obaid and Qasem, 2005). In light of previous studies, this study investigates the allelopathic effect of *C. draba* water extract, which is an important weed species, on the *Lactuca sativa* L., *Lepidium sativum* L., and *Triticum vulgare* L. culture plants.

MATERIAL AND METHODS

Plant materials

The *Cardaria draba* plants were collected from Kırşehir Province in 2016 vegetation period. Plants were collected in the flowering stage. The plants were dried and kept in the shade.

The preparation of the plant water extracts

The dried plant material was ground and powdered in a plant grinding mill. A 20% stock solution was prepared by adding 200 g of the plant material to 1 L pure water. The solution was shaken in an orbital shaker at 120 rpm for 24 hours and, then, solid wastes were removed using filter paper. The extracts were kept at +4 ^{o}C until use (Yılar et al., 2014).

The Effect of The Plant Extracts on The Seed Germination and Seedling Growth of The Test Plants

The phytotoxic effects of the plant extracts on the seed germination and seedling growth of the test plants were observed in 9 cm-diameter petri dishes. Two layers of blotting paper were placed in petri dishes and the seeds of the test plants were homogeneously distributed in the dishes (25 seeds each). Using pure water, doses of 1%, 5%, 10%, and 20% were prepared from the previously prepared stock solution (20%). The petri dishes were thoroughly moistened with the plant extracts at different concentrations and pure water for control (5ml/petri dish). The petri dishes were incubated at an average temperature of 24^{o}C±1 for two weeks. At the end of this period, the germination rates and radicle and shoot lengths of the test plants were determined (Yılar et al., 2014). The experiments were carried out in three replicates and two repetitions.

Data Analysis

The significance levels of the differences between the treatments were determined using variance analysis (ANOVA) and the mean results were compared using the DUNCAN test. The statistical analyses were carried out using the SPSS 13 software.

RESULTS

The tables and figures given below show the results for the allelopathic effects of the *Cardaria draba* plant water extract, which is a commonly distributed weed species in the agricultural lands in Turkey, on three culture plants as *L. sativum*, *L. sativa*, and *T. vulgare*.

The results showed that the test plants were negatively affected by the *C. draba* water extract. However, the level of its effects on the test plants varied depending on the species. The *L. sativum* plant was the most susceptible species to the extract, followed by *L. sativa* and *T. vulgare*, respectively. Moreover, the negative effect of the extract increased with increasing doses. At the dose of 5%, the *C. draba* extract completely inhibited the seed germination and root and shoot development of garden cress (Table 1, Figure 1,2,3).

Table 1. The effects of the *Cardaria draba* plant water extract on the seed germination and seedling growth of *L. sativum.*

Doses	Germination(%)	Root Length(mm)	Shoot Length(mm)
Control	100.0a* ±0.00	28.9a±6.44	13.9a±1.48
1%	97.3b±1.33	13.1b±1.98	10.4b±1.13
5%	0.0c±0.00	0.0c±0.00	0.0c±0.00
105	0.0c±0.00	0.0c±0.00	0.0c±0.00
20%	0.0c±0.00	0.0c±0.00	0.0c±0.00

* Means in the same column with the same letter were not significantly different by ANOVA (a = 0.05)

Furthermore, albeit the most tolerant plant to the *C. draba* extract, the seed germination and root and shoot development of *T. vulgare* were reduced when compared with the control group. The seed germination of *T. vulgare* was inhibited by 33.4% along with 92.53% inhibited root development and 87.88% inhibited shoot development compared with the control group (Table 2; Figure 1,2,3). As another test plant in the trial, *L. sativa* was also negatively affected by the *C. draba* plant water extract. The seed germination and root and shoot development of *L. sativa* was completely inhibited by the *C. draba* extract at the dose of 10% (Table 3; Figure 1,2,3).

Table 2. The effects of the *Cardaria draba* plant water extract on the seed germination and seedling growth of *T. vulgare*

Doses	Germination(%)	Root Length(mm)	Shoot Length(mm)
Control	100.0a* ±0.00	45.5a±0.35	49.5a±0.30
1%	97.3a±2.66	30.8b±0.16	44.1b±0.10
5%	94.6a±3.52	11.4c±0.02	10.8c±0.07
105	82.6b±2.66	9.5d±0.20	7.7d±0.04
20%	66.6c±3.52	3.4e±0.28	6.0e±0.02

* Means in the same column with the same letter were not significantly different by ANOVA (a = 0.05)

Table 3. The effects of the *Cardaria draba* plant water extract on the seed germination and seedling growth of *L. sativa*

Doses	Germination(%)	Root Length(mm)	Shoot Length(mm)
Control	100.0a* ±0.00	4.9a±0.07	2.9a±0.02
1	85.3b±2.66	4.2b±0.04	2.9a±0.05
5	36.0c±4.61	1.0c±0.01	2.2b±0.03
10	0.0d±0.00	0.0d±0.00	0.0c±0.00
20	0.0d±0.00	0.0d±0.00	0.0c±0.00

* Means in the same column with the same letter were not significantly different by ANOVA (a = 0.05)

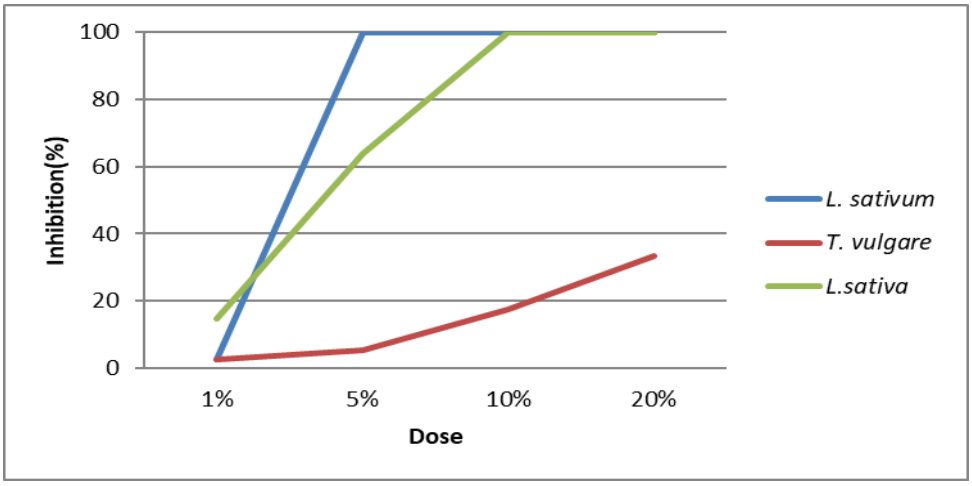

Figure 1. The inhibition% of the *Cardaria draba* plant water extract on the seed germination of the test plants

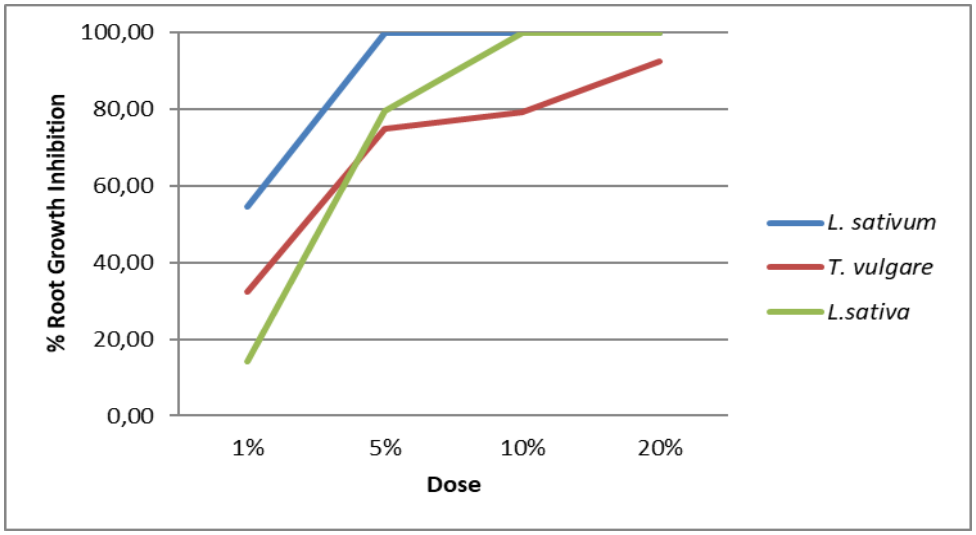

Figure 2. The inhibition% of the *Cardaria draba* plant water extract on the root growth of the test plants

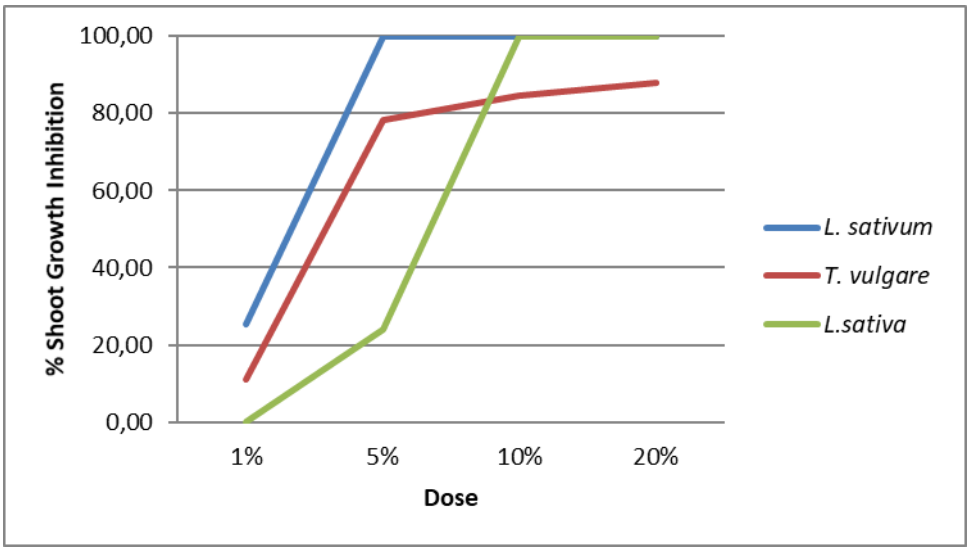

Figure 3. The inhibition% of the *Cardaria draba* plant water extract on the shoot growth of the test plants

DISCUSSION

As shown by the study carried out in a laboratory using petri dish experiments, the *Cardaria draba* plant water extract negatively affected the seed germination and root and shoot lengths of the seedlings of the test plants depending on the application dose and type of the culture plant. Other researchers have also carried out studies investigating the phytotoxic effects of plant extracts and essential oils on culture plants. Yılar M. (2014) reported varying levels of phytotoxicity caused by Salvia *officinalis*, *S. cryptantha*, and *S. tomentosa* essential oils and different plant extracts (*Beta vulgaris* L.) in the pepper (*Capsicum annuum* L.), cucumber (*Cucumis sativus* L.), alfalfa (*Medicago sativa* L.), lettuce (*Lactuca sativa* L.), garden cress (*Lepidium sativum* L.), tomato (*Lycopersicum esculentum* Mill.), common wheat (*Triticum vulgare* L.), and white clover (*Trifolium repens* L.) culture plants. Viecelli and Cruz-Silva (2009) reported that *S. officinalis* inhibited the germination and growth of *Lactuca sativa*. Other researchers showed that the *S. officinalis* water extract reduced the seed germination of *Hordeum vulgare* (barley) and *Portulaca oleracea* (purslane) (Bajalan et al., 2013). It was shown that the water extract derived from the leaves, shoots, and roots of *Calotropis procera* had a phytotoxic effect on the growth of wheat (*Triticum vulgare* L.) (Shah et al., 2017). The phytotoxic effects determined in this and similar studies differed depending both on the plants used to derive the extracts and test plants.

There are also studies investigating the phytotoxic effects and allelopathic activity of the *C. draba* plant. It had allelopathic effects on the seed germination and root and shoot growth of barley (*Hordeum vulgare* cv. Eram), commen bean (*Phaseolous vulgaris* cv. Naz), redroot amaranth (*Amaranthus retroflexus*), and dandelion (*Taraxicum officinalis)* (Miri et al., 2013). Kiemnec and McInnis (2002) reported that the root extract of *C. draba* reduced the seedling growth and root lengths of winter wheat *(Triticum aestivum* L.), alfalfa *(Medicago sativa* L.), crested wheatgrass *(Agropyron cristatum* (L.) Gaertn), and bluebunch wheatgrass *(Pseudoroegneria spicata* (Pursh) A. Love). Again, the shoot water extract and essential oil of *C. draba* significantly inhibited the seed germination and seedling growth of the cabbage, carrot, cucumber, onion, pepper, squash, and tomato test plants (Obaid and Qasem, 2002). The potentially strong allelopathic effects of *Cardaria draba* (L.) Desv. and *Salvia syriaca* L. against the most susceptible vegetable species including cabbage (*Brassica oleracea* L. var

Capitata cv. Pronzwik), onion (*Allium cepa* L. cv. Texas Early Grana), and tomato (*Lycopersicum esculentum Mill cv. Special Back*) were reported (Qasem, 2001). Kaya et al. (2015) showed that, depending on its concentrations, the methanol extract derived from the shoots, roots, and leaves of *Lepidium draba* had phytotoxic effects on the seed germination and growth of corn (Zea mays) and redroot pigweed (*Amaranthus retroflexus*).

CONCLUSIONS

The study showed that the *C. draba* water extract had varying levels of allelopathic effect on different culture plants. The results of the study agree with the results obtained in similar studies and should be supported with the results obtained with future studies carried out using pots and field experiments.

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