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Research Article

Allelopathic Effect of Jimson Weed (*Datura stramonium* L.) on Germination of Redrooted Pigweed (*Amaranthus retroflexus* L.), Lamb's Quarters (*Chenopodium album* L.) and Sugar Beet (*Beta vulgaris* L.) Seeds[a]

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Abstract

In this study the effect of jimson weed (*Datura stramonium* L.), which has known with its allelopathic effects, on germination of two weeds, redrooted pigweed (*Amaranthus retroflexus* L.) and lamb's quarters *(Chenopodium album* L.), which cause significant crop losses in crops, with a crop, sugar beet (*Beta vulgaris* L.). The study was conducted in Plant Protection department of Van Yuzuncu Yil University in 2019. Aqueous extracts of *D. stramonium* leaves that are collected on flowering stage were applied at rates of 5, 15, 30, 40, 50 and 60%. Germination of sugar beet inhibited 89% by 5 % aqueous extract and redrooted pigweed 55%. There was not observed any germination in all remaining concentration values, and 100% germination inhibition occurred. Although the effect was high against sugar beet, it's considered that the results obtained with new studies by different crop will contribute to the weed control, the use and development of biopreparats that are more sensitive to human health and the environment.

Keywords: Allelopathy, *Datura* spp., germination, management, weed

Kırmızı Köklü Horozibiği (*Amaranthus retroflexus* L.), Sirken (*Chenopodium album* L.) ve Şeker Pancarı (*Beta vulgaris* L.) Tohumlarının Çimlenmesi Üzerine Şeytan Elması (*Datura stramonium* L.)'nın Allelopatik Etkisi

Öz

Bu çalışmada allelokimyasal etkiye sahip olduğu bilinen şeytan elması (*Datura stramonium* L.)'nın kültür alanlarında önemli verim kayıplarına yol açan kırmızı köklü horozibiği (*Amaranthus retroflexus* L.), sirken (*Chenopodium album* L.) yabancı otları ile şeker pancarı (*Beta vulgaris* L.) kültür bitkisinin çimlenmesi üzerine etkisinin belirlenmesi amaçlanmıştır. Çalışma Van Yüzüncü Yıl Üniversitesi Bitki Koruma Bölümü'nde 2019 yılında yürütülmüştür. *Datura stramonium* L.'un çiçeklenme döneminde toplanan yapraklarının su ekstraktı %5, 15, 30, 40, 50 ve 60 konsantrasyonlarında uygulanmıştır. Denemede su ekstraktının %5'lik konsantrasyonunda şeker pancarında %89, kırmızı köklü horozibiği bitkisinde ise %55 oranında çimlenme inhibisyonu gözlenmiştir. Geri kalan bütün konsantrasyon değerlerinde çimlenme gözlenmemiş olup %100 çimlenme inhibisyonu gerçekleşmiştir. Şeker pancarına karşı yüksek inhibisyon gözlenmesine rağmen farklı kültür bitkilerinde yapılacak yeni çalışmalar ile birlikte elde edilen sonuçların özellikle yabancı otlarla entegre mücadeleye, insan sağlığı ve çevreye daha duyarlı olan biyopreparatların kullanılmasına, geliştirilmesine katkı sağlayacağı düşünülmektedir.

Anahtar Kelimeler: Allelopati, *Datura* spp., çimlenme, mücadele, yabancı ot

Introduction

Jimson weed (*Datura stramonium* L.) is a single or perennial herb that can be scaled 1-1.5 m, belonging to the Solanaceae family. *Datura* spp. is quite common in the flora of our country (Ceylan and Kaya, 1997). Since it is not very selective in terms of soil requirements, it grows as weeds on roadsides, abandoned areas and fields (Tepe, 2014).

Datura stramonium L. contains high levels of atropine, hyoscyamine and scopolamine. The alkaloid ratio in the plant varies according to the development period and organs of the plant. While the highest alkaloid rate in the leaf is in the beginning and in full flowering phases, this rate becomes the highest again in the development phase in the stem and root, and the alkaloid rates in these two organs decrease as the vegetation progresses. The total alkaloid amount in the leaves has been reported as 0.20-0.45% (Kırımer et al., 1991). Generally, the scopolamine ratio in the young period of the plant is higher than the rate of hyoscyamine. However, the rate of scopolamine decreases rapidly, and the rate of hyoscyamine increases until the full flowering period. In general, the ratio of hyoscyamine to scopolamine in this period is 1/2. The active substances of *Datura* species, atropine and scopolamine, are provided by import. Jimson weed has an important place in the pharmaceutical industry due to its active ingredients and is in the first place in terms of participating in drug production (Esendal et al., 2000).

All parts of the *Datura stramonium* L., including seeds, show allelopathic effects on many plants (Narwal and Tauro, 1994), preventing the germination and root growth (Zheng et al., 2007; You and Wang, 2011; Mishra, 2015), contain important secondary metabolites such as atropine and meteloidine (Aplin, 1976) as primarily being the scopolamine and hyocyamine. Ahmad et al. (2014) stated that the environmental effects of the plant were very dangerous due to this allelopathic potential that the jimson weed possessed, as well as it can cause great losses in many economically important cultivated plants. It has been stated that the case of 'Spinach Poisoning', that had happened in our country in recent days and mentioned in the press, has actually occurred as a result of mixing the jimson weed into the product (Anonymous, 2019).

In this study, it was aimed at determining the allelopathic effect of germination of cultivated plant of the jimson weed (*Datura stramonium* L.), which leads to significant yield losses in agricultural areas of the *Amaranthus retroflexus* L., *Chenopodium album* L. weeds and *Beta vulgaris* L. It was also aimed that the results would be a step of the integrated weed control systems, to discover new bioherbicides and to contribute to the related literature.

Material and Method

Material

The main material of the study carried out between the years of 2018-2019 is the jimson weed (*Datura stramonium* L.). In determining the effect of this allelopathic plant on germination, the sugar beet (*Beta vulgaris* L.) from the cultivated plants, redrooted pigweed (*Amaranthus retroflexus* L.) and lamb's quarters (*Chenopodium album* L.) seeds which cause significant losses from weeds were used (Tepe, 2014; Tozlu and Zengin, 1997). Weed seeds were obtained from Tusba district of Van in July and August 2018, and the sugar beet seeds were obtained from Agro-tek seed growing firm. The leaves of the jimson weed, which is the main material of the study, were collected from Van, İzmir, Samsun, Manisa and Bursa provinces, where the population of the plant was intense in July and August 2019.

Method

Preparation of extracts

The leaves of the collected jimson weed plant were washed with distilled water, dried in the shade and then stored in paper pouches (Oueslati, 2003). Later on, the dried leaves of the plant were ground into the mill and cut into small pieces, passing through 0.5 mm sieves, the powdered and kept at room temperature.

During the preparation of extracts, 300 grams of the ground material was taken, mixed with 500 ml of distilled water then kept at room temperature at 200 rpm for 24 hours in an "orbital" shaker. The resulting mixture was passed through 4-layer sterile cheesecloth and centrifuged at 3500 rpm for 5 minutes. The mixture was passed through the filter paper then was used by passing through 0.45 µl filters using a sterile syringe (Ashrafi et al., 2008; Abbasi, 2012; Al-Malki, 2014).

Germination experiment

In the applications, 9 cm diameter glass Petri dishes with double layer of dry paper placed at the bottom were used. The trials were carried out by using 5 replicates and in each replication (in Petri dishes) 50 seeds from weeds and 30 seeds from sugar beet were used according to the random parcel trial pattern. The weed seeds, whose dormancies are broken, were first left in 1% sodium hypochlorite for 5 minutes, washed five times with pure water then used (Aydın and Tursun, 2010; Efil, 2012). The obtained aqueous extract was used at concentrations of 5, 15, 30, 40, 50, 60 %. For each petri dish, 5 ml of the prepared extracts were added and pure water was applied to the control Petri dishes at the same rate. The Petri dishes, which were then closed with parafilm, were left in incubators at 25ºC for *Beta vulgaris* L. and at 30ºC for *Amaranthus retroflexus* L. and *Chenopodium album* L. with optimum germination temperatures for 14 days, (Üremiş and Uygur, 1999; Gönen, 1999). Counts were made at the end of 14 days for all applications, and the seeds forming 0.5 cm germ tube were considered as germinated (Efil, 2012).

The inhibition rate of applications on seeds was calculated using the equation below (Ellnain - Wojtaszek et al., 2003).

Inhibition (%) = C-T / C x 100 (Equality. 1)

T: the value obtained from the application

C: the value obtained from the control

Statistical analysis

Duncan multiple comparison test was applied in SPSS package program to compare averages (Anonymous, 2009).

Results and Discussion

The difference between the applications of aqueous extracts obtained from the leaves of jimson weed (*Datura stramonium* L.) plant was found statistically significant (P<0.05). The 5% application of aqueous extract has a lower effect than the other applications. The remaining concentrations of 15, 30, 40, 50, 60% were found to be extremely effective, and there was not found any statistical difference between the effects of these concentrations. The inhibition rates of concentrations on the seeds as a result of applications were estimated according to Equality 1. The 5% dose among the concentrations has been less effective than other doses. Accordingly, the inhibition rate for *Beta. vulgaris* L, *Amaranthus retroflexus L.* and *Chenopodium. album* L. was found to be as 89, 55 and 100%, respectively. In all other doses administered, the 100% inhibition was obtained (Table 1). It has been observed that *C. album* seeds are very sensitive even to the lowest concentration of aqueous extracts.

Table 1. Results of different concentrations applied to test plants.

Concentrations (%)	***Beta vulgaris*** *	***Amaranthus retroflexus****	***Chenopodium album*** *
	x̄±SE ** (Inhibition rate)	x̄±SE ** (Inhibition rate)	x̄±SE ** (Inhibition rate)
5	2.40±0.24[a] %89	16.8±0.58[a] %55	0.00±0.00[a] %100
15	0.00±0.00[b] %100	0.00±0.00[b] %100	0.00±0.00[a] %100
30	0.00±0.00[b] %100	0.00±0.00[b] %100	0.00±0.00[a] %100
40	0.00±0.00[b] %100	0.00±0.00[b] %100	0.00±0.00[a] %100
50	0.00±0.00[b] %100	0.00±0.00[b] %100	0.00±0.00[a] %100
60	0.00±0.00[b] %100	0.00±0.00[b] %100	0.00±0.00[a] %100
Control	22.00±1.14[c]	38.00±1.58[c]	36.20±2.17[b]

*: The difference between the means indicated by different letters in the same column is important. (p<0.05)

**: x̄: Mean SE: Standard Error

As a result of these studies, it was seen that the utilized concentrations of jimson weed were extremely effective. In a similar study, the allelopathic effect of *Datura stramonium L.* on the seed germination of *Triticum aestivum* L. was studied and treated with concentrations of 1:10, 1:20, 1:30, 1:40. As a result of the treatments, it was stated that *Datura*

stramonuim L.'s concentration of 1:10 had an allelopathic effect on *T. aestivum*. In parallel, it was stated that it increased in the effectiveness due to the increase in concentration (Ahmad et al., 2014). Mishra (2015) used concentrations of 2.5, 5, 10, 15 and 20% in the study of investigating the inhibitory potential of aqueous extracts from *Datura stramonuim* L leaves on seed germination of *Parthenium hysterophorus*. While the most effective result was obtained at 20% in the doses applied to the *D. stramonium* plant, it was stated that the other doses were effective from high dose to low dose, respectively.

Similarly, Javaid et al. (2008) reported that *D. metel*'s root methanol extract reduced seed germination by 31-50% in their study to determine the herbicide activity against the *Phalaris minor*. In another study conducted to determine the allelopathic effect of *D. stramonium* on the seed germination from extracts, 1, 2, 3, 4 and 5% concentrations were used against *Sorghum bicolor*, *Pennisetum glaucum*, *Zea mays* and *Triticum vulgare*. It was determined that 5% concentration dose had been the most effective from the applied doses and *Sorghum bicolor, Pennisetum glaucum, Zea mays* and *Triticum vulgare* germinates at the rate of 65.3, 83.8, 74.5, 54.3% were obtained, respectively (Dafaallah et al., 2017).

Elisante et al. (2013) used the extracts of *D.stramonium* obtained from its seed and leaf extracts against *Cenchrus ciliaris* and *Neonotonia wightii* plants. It was determined that it had an inhibitory effect on the plants tested. This effect was observed to increase as the concentration increased from 0% to 5% in both extract types. In the study in which the effect against *Phaseolus vulgaris*, *Vigna sinensis*, *Cajanus cajan* and *Medicago sativa* was investigated, the concentrations of 1, 2, 3, 4 and 5% of the aqueous extract were used. It was concluded that the 5% concentration had been the most effective dose compared to the control and that the results also had a direct relationship between the concentration and decrease in germination (Dafaallah et al., 2019).

Conclusion

No matter how important the jimson weed (*Datura stramonium* L.) has important alkaloids, it was found that it had caused a quite high inhibition aqueous extract even at low concentration of aqueous extract. When this situation is taken into consideration, it is thought that *D. stramonium* plant will have an important place in the integrated weed control with its ability to prevent damage caused by pesticide use and to support modern agriculture and environmentally friendly practices. However, in order to reach definite judgments, it has been concluded that studies on the subject should be increased and similar studies should be continued in greenhouse or field conditions.

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