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Allelopathic effects of syrian bean caper (*Zygophyllum fabago* L.) on seed germination and seedling growth of eastern dodder (*Cuscuta monogyna* Vahl.)

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Key words: Allelopathy, Eastern dodder, Germination, Seedling growth, Syrian bean caper.

Abstract

Eastern dodder (*Cuscutamonogyna*Vahl.) is a parasitic weed of woody species. The objective of the research was to study allelopathic effects of above ground parts of Syrian bean caper (*Zygophyllumfabago* L.) on eastern dodder(*Cuscutamonogyna*Vahl.) seed germination and seedling growth. Water extracts from leaf, fruit and stem dry powder in five concentrations (0, 2.5, 5, 7.5 and 10 g/100ml) were tested on germination and seedling growth in factorial experiment in completely randomized block design with three replications.The results indicatethereduction of seed germination up to 90.6%. Leaf extract showed higher inhibition impact on seed germination and seedling growth.Also, fruit and stem extracts inhibition on seed germination seedling growth of eastern dodder was significant. By increasing of allopathic plant concentration, seed germination and seedling growth of this parasitic weed was decreased significantly. In all concentrations of all plant parts, seedling growth of eastern dodder was more sensitive thanseed germination.Therefore, allelopathic potential of Syrian bean caper could be used for this parasitic weed management, in order to achieve the goals of sustainable agriculture and environmental conservation.

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Introduction

Allelopathy refers to the beneficial or harmful effects of one plant on another plant; both crop and weed species, by the release of secondary plant metabolites (such as alkaloids, isoprenoids, phenolics, flavonoids, terpanoids and gluconolates) from plant parts by leaching, root exudation, volatilization, residue decomposition, and other processes in both natural and agricultural systems (Gibson and Liebman, 2003) as one of the most controversial of ecological interactions. In addition, environmental conditions and genetic characteristics are the most effective agents in enhancing synthesis and exudation of allelochemicals. It is interesting to note that many of the weed species demonstrated to have powerful allelopathic effects as well. If some of those compounds are released to the environment, from leaching, litter decomposition, root exudation, or direct volatilization, they could affect germination and growth of other species (Ebana *et al.*, 2001).

Germination is an important stage in plant growth that is affected by allelopathic compound. These compounds can regulate such interactions within and between species in plant communities (Fernandez *et al.*, 2008). This stage includes several phases, which is included water imbibitions, catabolic and anabolic phases. Irregularities in the respiration rate reduced metabolic energy (ATP) and resulted in seed germination and growth reduction. Allelopathic compounds not only reduced germination, but also delayed germination that affect seedling (Escudero*et al.*, 2000).

Weed management during growing season has been a serious problem for many years. Worldwide, a 10% loss of agricultural products can be attributed to competitive effect of weeds, despite their intensive control. The application of herbicides has been a major factor enabling the intensification of agriculture in past decades. There has been increasing herbicide resistance in weeds and widespread concern about adverse environmental effects from herbicide use (Stephenson, 2000). For this reason, the use of allelopathic varieties may provide an alternative to minimize the risk towards agroecosystems by serving in a complementary way with herbicides (Alam*et al.*, 2001).

The Syrian bean caper (*Zygophyllumfabago* L.) is a member of the*Zygophyllaceae* Family. The plant is a succulent, perennial and multi-branched shrub that found in disturbed sites and waste areas. This plant can be found in Mediterranean region, central Asia, Australia and southern, northern and north-eastern Africa (Lefevre*et al.*, 2010).

Phytochemical investigation of the genus *Zygophyllum* shows that it's very rich in saponins (Smati*et al.*,2007) and quinovic acids(Hassanean*et al.*, 1993). Beside this compounds, several others such as flavonoids (Sameh*et al.*, 2011)and alkaloids (Alam, 2011) are also identified from this plant.

The genus *Cuscuta* is composed of approximately 150 tiny herbaceous obligatory parasitic species. Some species invade more than one host and some others are hostspecific and all are detrimental. Eastern dodder (*Cuscutamonogyna*Vahl.) as a parasitic plant infests mainly woody species such as grapevine, olive, citrus,pomegranate, etc (Lanini*et al*, 2010). It has no chlorophyll and cannot make its own food by photosynthesis. Instead, it grows on other plants, using their nutrients for its growth and weakening the host plant (Karimi, 2001).

Although a large number of methods to control this parasitic weed have been proposed including, crop rotation, delay in the sowing date, plant breeding, catch and trap crops, soil solarisation, chemical and biological control, effective management is very difficult to be reached because of its physiological traits and life cycle (Joel *et al.*, 2007).

Consideringthat seed germination is a key phase for parasitic plant developmentand infestation, a further approach proposed for the managementof these weeds has been to use natural metabolites

producedby plants as seed germination inhibitors. Indeed, plants may competeby suppressing the growth of neighboring plants by the production and release of allelopathic compounds (Zeng*et al*., 2008). But, the probable alleloptahic effects of *Zygophyllumfabago* have not been studied yet, especially on the *Cuscutamonogyna*. Thus, the main objective of present study was to determine the probable allelopathic effect of *Z.fabago* on the germination and seedling growth of *C. monogyna*.

Materials and methods

A factorial experiment in completely randomized block design with three replications was conducted under laboratory conditions to evaluate the effects of leaf, stem and fruit of syrian bean caper (*Zygophyllumfabago*L.) on seed germination and seedling growth of eastern dodder (*Cuscutamonogyna*Vahl.), in the University of Tabriz, Iran in 2015.

Different concentration of *Z. fabago*was prepared as 2.5, 5, 7.5 and 10 g powder of that plant soluble in 100 ml distilled water and shaken for 24 hours by a horizontal rotary shaker in room temperature. Eastern dodder seeds were gathered from green space of Basmenj, East Azerbayjan, Iran. They were sterilized with sodium hypo chloride (1%) and washed by distilled water. In this experiment, 25 seeds of eastern dodder were placed on Whatman filter paper in 9 cm petri dishes. Four ml of distilled water (control) and final aqueous extract concentrations of *Z. fabago*were added to each petri dish. The solutions were applied where required during the course of experiment. Then, petri dishes were incubated at 25°C and germinated seeds (protrusion of radicle by 2 mm) were counted every day up to 8 days. Then percentage and rate of seed germination was calculated according to Ellis and Roberts (1981):

$$GR=\frac{\sum N}{\sum D.N}$$

Where n is the number of seeds germinated on day D, D is the number of days from the beginning of the test and GR is the mean germination rate. Percentage of germination was also determined.

At the end of the test, length and fresh weight of seedling were measured. Seedlings of each sample were dried in an oven at 75°C for 24 hours (Perry, 1977) and mean dry weight of seedling for each treatment at each replication was determined. All the data were analyzed on the basis of experimental design, using SPSS-16 software. The means of each trait were compared according to Duncan multiple range test at P≤0.01 and standard error values. Excel software was used to draw figures.

Results and discussion

Results of analysis of variance (ANOVA) showed the significant effect of extract concentration on the germination percent (*P*≤0.01), significant effect of plant parts on the germination percent (*P*≤0.01).

Interaction effect between concentration and plant parts of *Z. fabago*were significant on the germination rate (*P*≤0.05), seedling length, seedling fresh weight and seedling dry weight (*P*≤0.01) of *C monogyna* (Table 1).

Table 1. Effect of extract concentration of plant parts on germination and seedling growth of *Cuscutamonogyna* Vahl.

Source of Variation	df	Mean of Squares (MS)				
		Germination Percent	Germination Rate	Seedling Length	Seedling Fresh Weight	Seedling Dry Weight
Replication	2	233.156	6.602×10^{-5}	0.674	1.220×10^{-5}	1.136×10^{-7}
Plant Parts (A)	2	187.822 **	3.459×10^{-4} **	1.121 **	1.866×10^{-5} **	2.562×10^{-7} **
Extract Concentrations (B)	4	8449.422 **	0.014 **	166.654 **	0.002 **	7.369×10^{-6} **
A×B	8	18.489 ns	3.096×10^{-5} *	0.063 **	3.567×10^{-6} **	2.344×10^{-8} **
Error	28	13.156	1.028×10^{-5}	0.018	6.869×10^{-7}	6.889×10^{-9}

ns,* and ** non significant, Significant at *P*≤0.05 and *P*≤0.01, respectively.

Means comparison revealed that the highest germination percent (48.8%) was obtained from stem extract treatment and the lowest germination percent (41.7%) was obtained from leaf extract (Fig 1). This result is in accordance with previous study reporting thatall parts of plants (leaf, stem, root and fruit) have different allelopathic potentials (Alam and Islam, 2002; Tinnin and Muller, 2006).

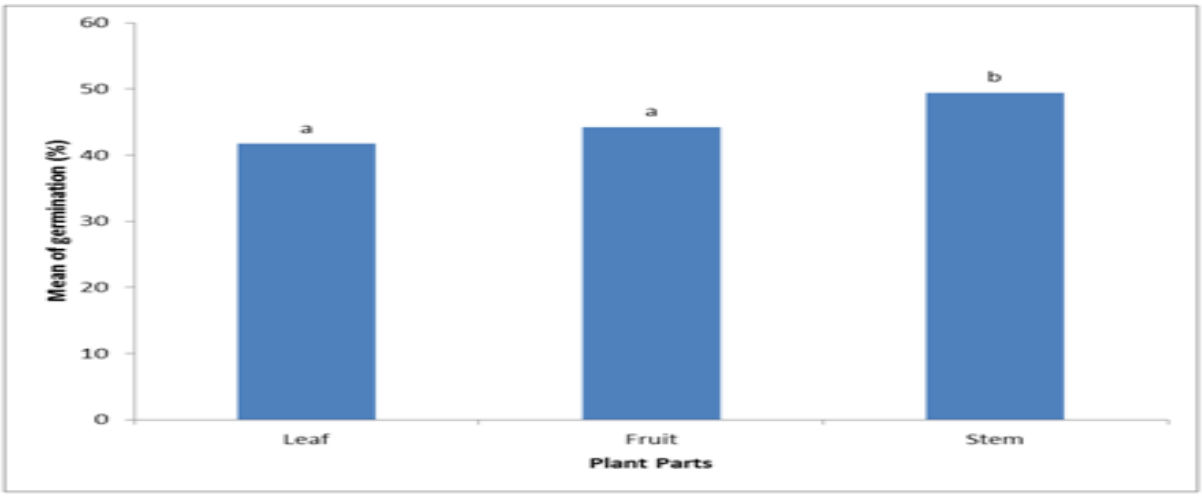

Fig. 1. Effect of *Zygophyllumfabago* L. parts extracts on the germination percentage of *Cuscutamonogyna*Vahl. The same letters show non-significant differences at $P \leq 0.01$.

The results were shown that the maximum germination percent (80%) were obtained from control treatment. Increasing the extract concentration caused in descending trends of germination percent. So, the minimum germination percent (7.5 %) were obtained from 10 g/100ml extract concentration (Fig 2). This result confirms the findings of Agarwal *et al.* (2002), Iqbal *et al.* (2003), Fateh*et al.* (2012), Nouri*et al.* (2012), and Shang and Xu (2012) showing that allelochemicals have an inhibitory and/or lethal effects on seed germination of plants. According to these authors, lower concentrations inhibit germination to different degrees, which is probably due to the lower contents of allelochemicals in them, while higher concentrations induce lethal effects on seed germination.

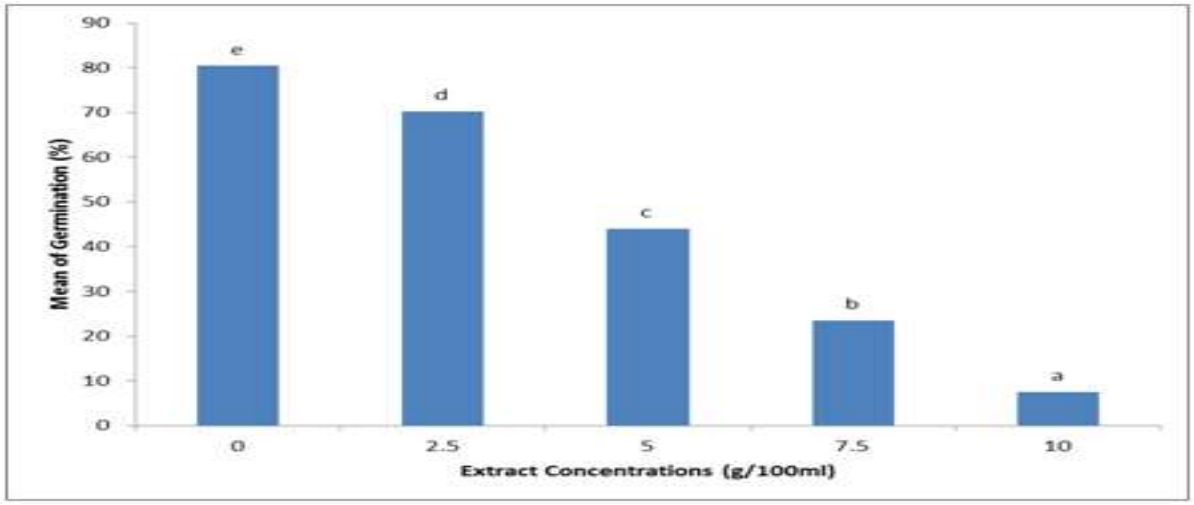

Fig. 2. Effect of *Zygophyllumfabago* L. extract concentration on germination percentage of *Cuscutamonogyna* Vahl. The same letters show non-significant differences at $P \leq 0.01$.

The highest germination rate (0.22 day^{-1}) belonged to controltreatment and the lowest germination rate (0.12day^{-1}) was obtained from leaf extract in 10 g/100ml concentration (Fig 3). These results correlate with the findings that stopping of germination during germination period may also be because of changing in enzyme activities which restricted the conversion of nutritive compounds (El-Khatib*et al.*, 2004).

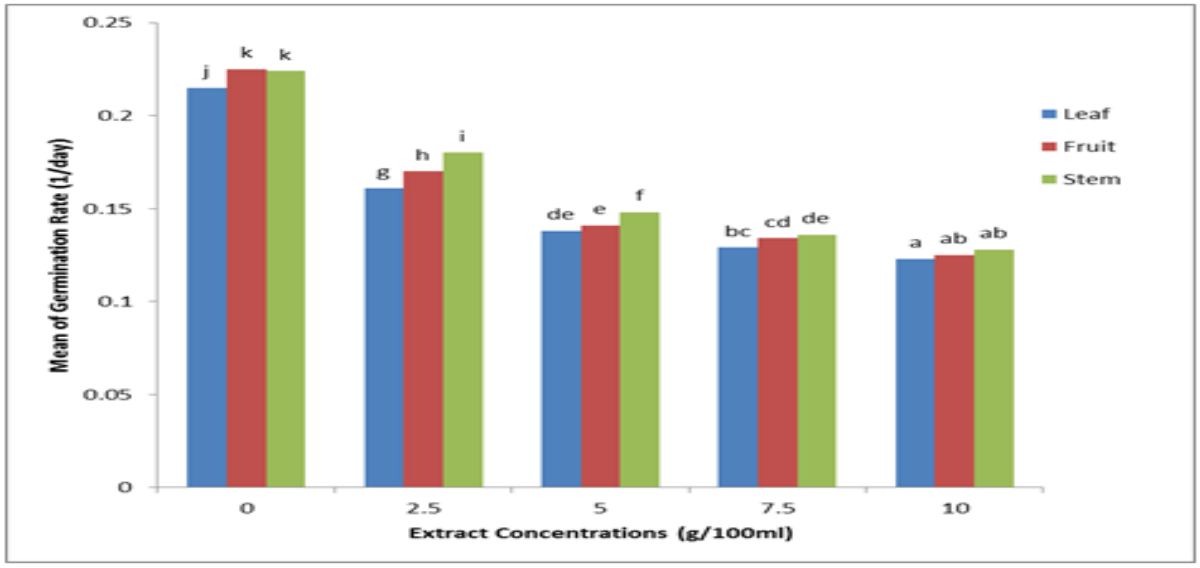

Fig. 3. Interaction effect between *Zygophyllumfabago* L. partsand their extract concentration on germination rate of *Cuscutamonogyna* Vahl.. The same letters show non-significant differences at $P \leq 0.05$.

The maximum seedling length, seedling fresh weight and seedling dry weight (11.1cm, 0.0374g and 0.0026g respectively) was obtained from control treatment. But the minimum seedling length, seedling fresh weight and seedling dry weight (0.6cm, 0.0022 and 0.0002g respectively) belonged to leaf extract in 10 g/100ml concentration (Fig 4, 5 and 6). Obviously, the degree of inhibition increased as the concentration increased. A number of previous studies have suggested that the degree of inhibition increases with increasing extract concentrations (Laosinwattana*et al.*, 2009; Teerarak*et al.*, 2010).

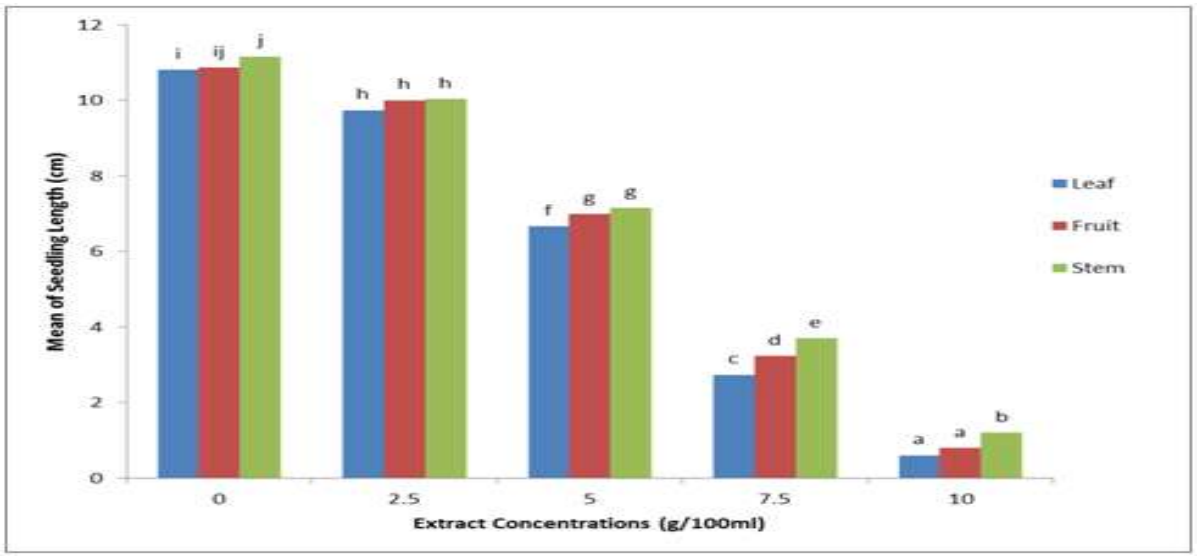

Fig. 4. Interaction effect between *Zygophyllumfabago* L. parts, and their extract concentration on seedling length of *Cuscutamonogyna* Vahl. The same letters show non-significant differences at $P \leq 0.01$.

These observations conform to Hegazy and Fadl-Allah (1995) who reported that the impact of allelopathic plant extracts on seedling growth is more important than seed germination. Similarly Smith and Martin (1994) and Ben-Hammouda*et al.* (1995) found aqueous extracts of several species have suppressed seedling growth in target plants more than seed germination.

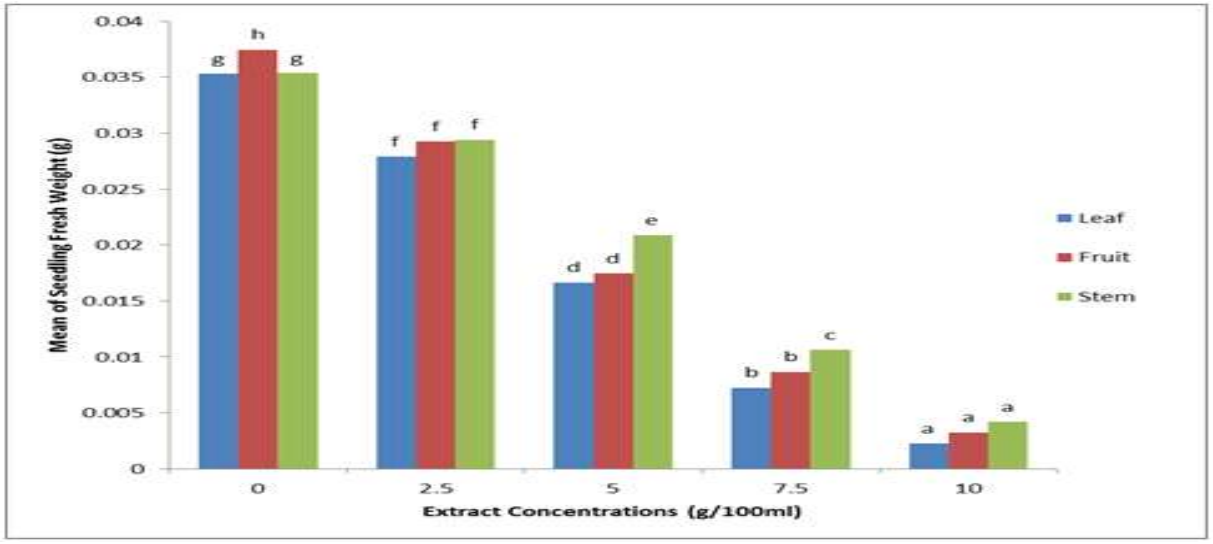

Fig. 5. Interaction effect between *Zygophyllumfabago* L. parts and their extract concentration on seedling fresh weight of *Cuscutamonogyna* Vahl. The same letters show non-significant differences at *P*≤0.01.

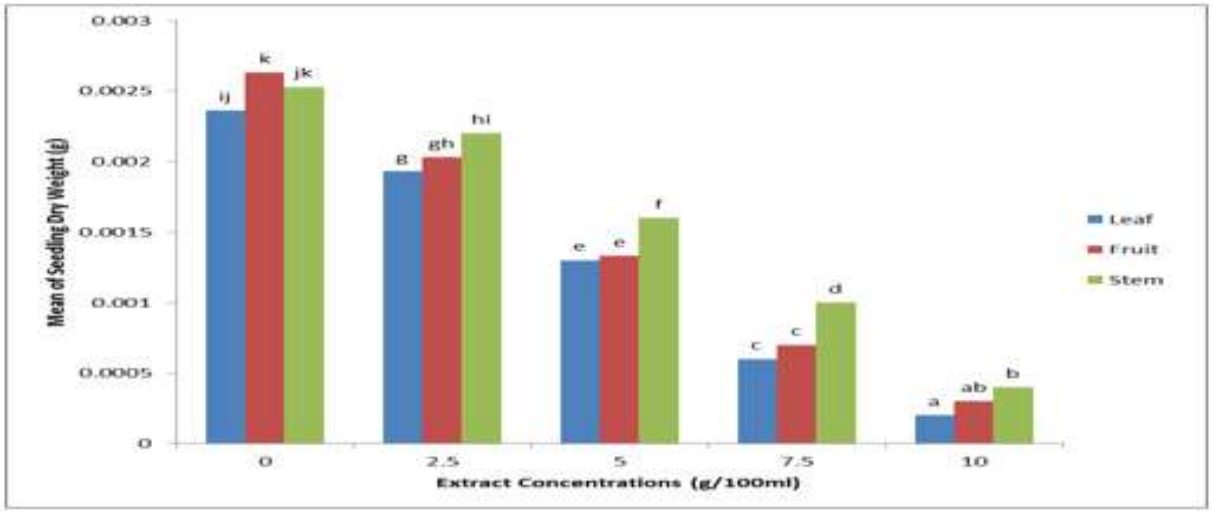

Fig. 6. Interaction effect between *Zygophyllumfabago* L. parts and their extract concentration on seedling dry weight of *Cuscutamonogyna* Vahl. The same letters show non-significant differences at *P*≤0.01.

Conclusion

According to this research *Z. fabago*can damage germination and early seedling growth of*C monogyna*. Due to important of primary growth stage in establishment of plant, it suggested that the mentioned plant extracts must be appliedin early stages of plant growth. This experiment was conducted in laboratory condition therefore it suggests that more research could be carried out in greenhouse condition because in natural condition the results may change as a result of differences in growth conditions.

It also suggested that more investigation about the allelopathic effects of this species should be carried out on the parasitic weeds.

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