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Allelopathic Effects of Aqueous Extracts of *Solanum muricatum* and *Eichhornia crassipes* on Seed Germination and Seedling Growth of Sunflower

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ABSTRACT

In this study; the allelopathic potential of Solanum muricatum and Eichhornia crassipes were examined on seed germination and seedling growth of sunflower (Helianthus annuus L.). Solutions in different concentrations were prepared from the leaf extracts of both plants (0%, 5%, 10%, 20%, 40%). It was determined that the leaf extracts of Solanum muricatum and Eichhorni acrassipes do not have any significant impact on the germination of the sunflower seeds. It was determined that all concentrations of Solanum muricatum have significant effects on the water uptake capacity of the sunflower seeds when compared to the control, whereas it was detected that only some concentrations of Eichhornia crassipes had important effect. It was found that high concentrations of these two plants cause to decreases in the root and shoot length, root and shoot wet weight, and root dry weight of the sunflower seedlings.

Key words: *Allelopathy, Eichhornia crassipes, Germination, Helianthus annuus, Seedling growth, Solanum muricatum*

INTRODUCTION

The allelochemicals released by plants may trigger or inhibit the growth of the same or different species of plants in different concentrations[1,2]. It is considered that allelopathic chemicals have an important potential as herbicide in the control of the weeds or as a resource for the new herbicides[3,4]. It has been determined that high concentrations of *Daturastramonium* L. extracts have decreased the primary root elongation and lateral root development, root hair length and intensity in the soybean, and prevented the cellular division in the root tips, but increased the chromosomal aberration index and micronucleus index[5]. Allelochemicals may change the amounts and contents of plant growth regulators, so they may inhibit the growth and development of the plants[6,7]. Allelochemicals are synthesized from the different parts of the plant such as root, trunk, leaf, pollen, seed and flower and excreted to their surroundings with different ways such as root leakage, percolation from the parts above the ground, evaporation and decay[3].

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Allelopathic chemicals could regulate respiration, photosynthesis, transpiration, biochemical metabolism and even the protein and nucleic acid synthesis[8]. Sunflower (*Helianthus annuus* L.) is an important plant in terms of agriculture. In previous studies, it has been determined that it has allelopathic impacts[9,10]. Previous studies have also reported that *Eichhornia crassipes* has allelopathic effects[11,12]. The main aim of this study was to determine the allelopathic effects of *Solanum muricatum*, which is a tropical or semi-tropical plant and whose allelopathic effects have not been studied before, and *Eichhornia crassipes*, which is an aquatic plant and known to have allelopathic impact on the sunflower seeds having an economical importance. Searching and finding plant-based herbicides in the control of the weeds instead of synthetic chemicals as herbicide will increase the importance of these kinds of studies due to the fact that it is economic and not a threat for human health. In the current study, the effects of the leaf extracts of *Solanum muricatum and Eichhornia crassipes* in various concentrations (0%, 5%, 10%, 20%, 40%) were examined on the germination and water uptake capacities of seeds, root and shoot length, and wet and dry weights in seedlings of sunflower.

MATERIAL AND METHODS

The leaves of *Solanum muricatum* and *Eichhornia crassipes* were dried at 25 °C in room temperature within a period of 4-5 weeks. Five gram was taken from the dried leaf samples of each plant, put into 100 mL distillate water, and were shaken in darkness at 25 °C for 48 hours. Aquatic extracts were filtered and centrifuged at 9000 rpm at 4 °C for 15 minutes. Their final volumes were adjusted to 100 mL[12,13]. Solutions in different concentrations were prepared from prepared stocks (0%, 5%, 10%, 20%, 40%). The sunflower seeds used in the study were Sirena cultivars. The seeds were sterilized for 15 minutes with 2% sodium hypochlorite and after that, they were washed with distiled water for 4 times. The filter papers were placed to the upper and lower parts of the sterilized petri plates and 20 sunflower seeds were placed in each one. The seeds were wetted by extract solutions taken from different concentrations of *S. muricatum* and *E. crassipes* in equal volumes (4 mL). The seeds were left for germination in a climate cabinet at 23±2°C, in humidity ratio between 60-65%, and under 12 hours of daylight and 12 hours of darkness. The germination percentage of the seeds, root and shoot lengths, and root and shoot wet weights were determined at the end of trials. Root and shoot dry weights were determined after they have been dried at 70°C for 48 hours.

In order to determine the water uptake capacities, one gram sunflower seed was weighed and put within the extracts in equal volume and in different concentrations. After 24 hours, their weights were measured. Water uptake capacities were calculated by deducting their weight at the beginning from their weight after 24 hours.Statistical assessments of the study data were conducted by using SPSS 15.0 program. LSD test was used to determine the differences between the averages. The value $P<0.05$ was accepted as significant in the analyses.

RESULTS AND DISCUSSION

It was determined that the water uptake capacities were decreased when compared to the control depending on the increasing concentrations of the *S. muricatum* extracts ($P<0.05$). The lowest water uptake was determined in 40% concentration for 24 hours (Fig. 1). In *E. crassipes* concentrations, it was detected that there was an increase in the 5% concentration and there was a decrease in the other concentrations when compared to the control. It was found that the decrease is significant in the 40% concentration when compared to the control ($P<0.05$) (Fig.1). In the high concentrations of *S. muricatum* and *E. crassipes* (40%), the water uptake was decreased respectively by 15.13% and 9.34% when compared to the control.

In some of the previously conducted allelopathic studies, it was specified that the water uptake capacities of the seeds decreased depending on the increasing concentrations of the plant extracts[13,14]. Likewise, in this study, it was determined that the water uptake capacities of the sunflower seeds were decreased at high concentrations of both plant extracts. It was also detected that the allelopathic effects of *S.muricatum* extracts were more than *E. crassipes* extracts.

It was found that the leaf extracts of *S. muricatum* and *E. crassipes* had a decreased effects on the germination of the sunflower seeds when compared to the control. It was determined that this decrease was not significant (P>0.05). The lowest germination capacity was detected in 10% and 20% concentrations of *S. muricatum* and in the 10% concentration of *E. crassipes* (Fig. 2). Many allelopathic studies reported that there have been negative effects on the germination depending on the concentrations of the plant extracts[15,16,17]. In contrast to these studies, the results of this study indicated that *S. muricatum* and *E. crassipes* extracts do not have any significant effects on the germination of the sunflower seeds when compared to the control. It is known that the allelopathic effects could be changed depending on the concentration of the allelopathic compounds, affection period and the development stage of the plant[8].

It was found that the root length decreased in all the concentrations of *S. muricatum* and *E. crassipes* extracts. While there was a decrease in the root length of *S. muricatum* at 20% and 40% concentrations when compared to the control, similar decrease was determined at 40% concentration in *E. crassipes* (P<0.05) (Fig. 3). Likely, the extracts of *S. muricatum* and *E. crassipes* had a decreasing effect on the shoot lengths depending on the increasing concentrations.The decrease in the shoot length was found to be significant in the 40% concentrations of *S. muricatum* and *E. crassipes* (P<0.05) (Fig. 4). The negative effects in the root length of the extracts of *S.muricatum* and *E. crassipes* were more efficient when compared to their effects on the shoot length. While the decrease in the root length at the 40% concentration of *S. muricatum* was 39.05%, it was determined as 33.48% in the shoot length. At a 40% concentration of *E. crassipes*, a 37.96% decrease in root length and a 24.97% decrease in shoot length were determined. Root wet weights were found to be reduced when compared to the control at the highest concentrations of *S. muricatum* and *E. crassipes* extracts (40%) (P<0.05) (Fig. 5). It was found that the shoot wet weights significantly decreased in the 40% concentrations of both plant extracts when compared to the control (P<0.05) (Fig. 6). Similarly, it was observed that there was a significant decrease at the 40% concentrations of *S. muricatum* and *E. crassipes* when compared to the control in the root dry weights (P<0.05) (Fig. 7). It was detected that the change in the shoot dry weights was not significant when compared to the control (P<0.05) (Fig. 8).

In a study in which the allelopathic effects of the *Xanthium strumarium* shoot extracts on lentil was examined, it was specified that the germination, plumule length, and the seedling dry weights are negatively affected at high concentrations[18]. In another study, the allelopathic effects of sunflower examined in barley. They found that the germination and growth of the barley were decreased[19]. *Lavandula angustofolia* leaf extracts inhibited the germination and development of *Lens culinaris,* while its seed extracts inhibited the germination and development of *L. culinaris* and *Zea mays*[20]. Jafariehyazdi and Javidfar researched the allelopathic effects of some *Brassica* species on the germination and growth of the sunflower. The inhibitor effect was determined at the high concentration. It was determined that the root length is more sensitive to the extracts when compared to the hypocotyl length[13]. In accordance with these studies, the present study suggested that the root and shoot length, and root-shoot wet weight, and root dry weight were negatively affected depending on the high concentrations of both *S. muricatum* and *E. crassipes*.

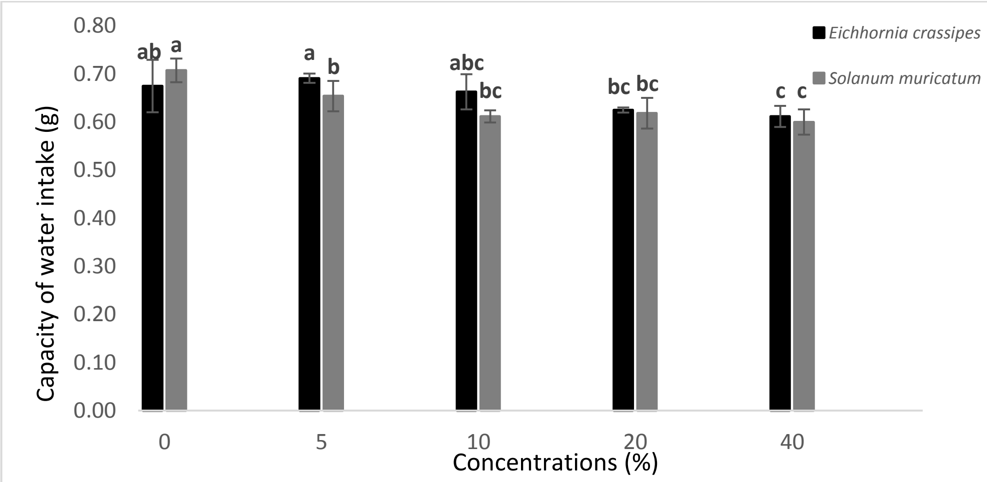

Fig. 1: Water uptake capacities of the sunflower seeds at different concentrations of *Solanum muricatum* and *Eichhornia crassipes* (after 24 hours)

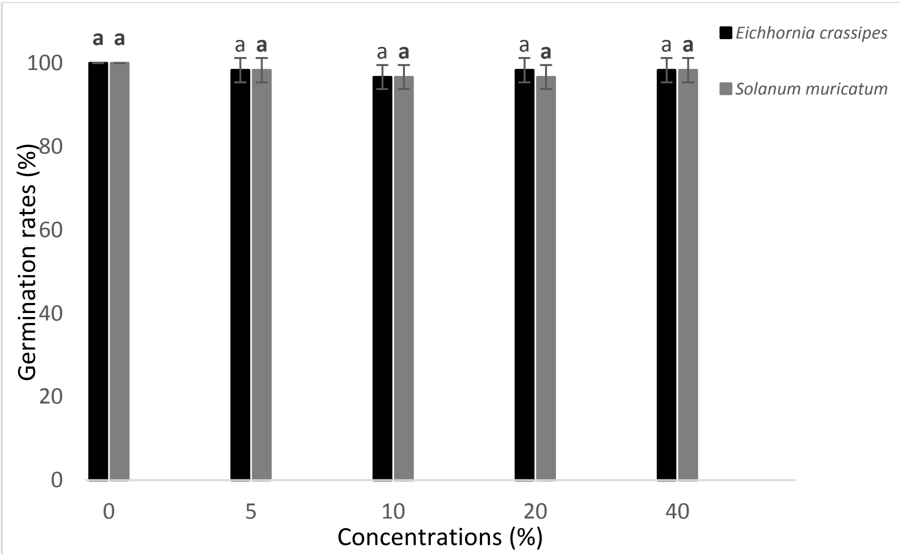

Fig. 2: Germination ratios of the sunflower seeds at different concentrations of *Solanum muricatum* and *Eichhornia crassipes*

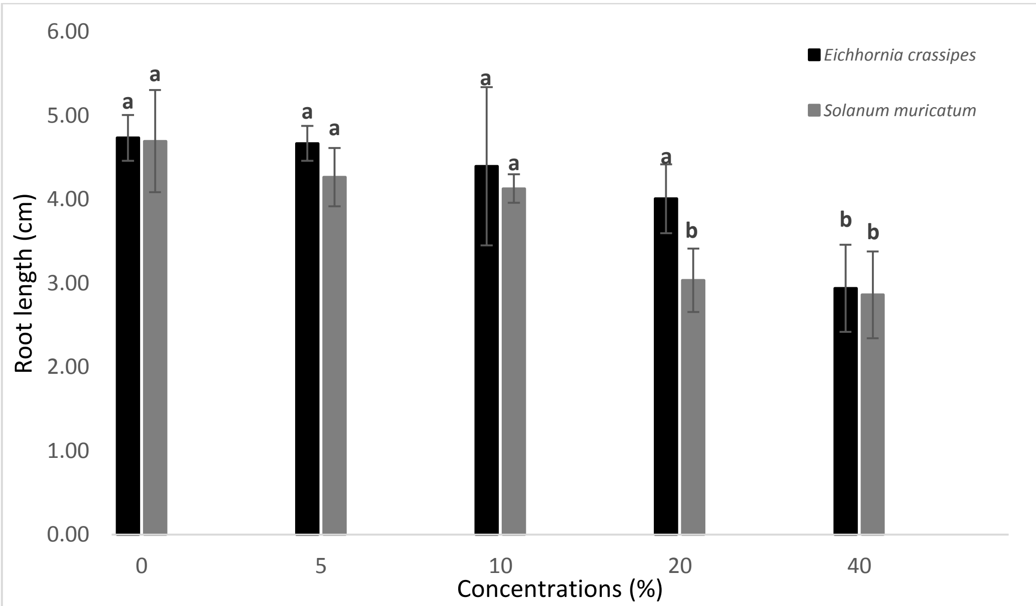

Fig. 3: Root lengths of the sunflower seedlings at different concentrations of *Solanum muricatum* and *Eichhornia crassipes*

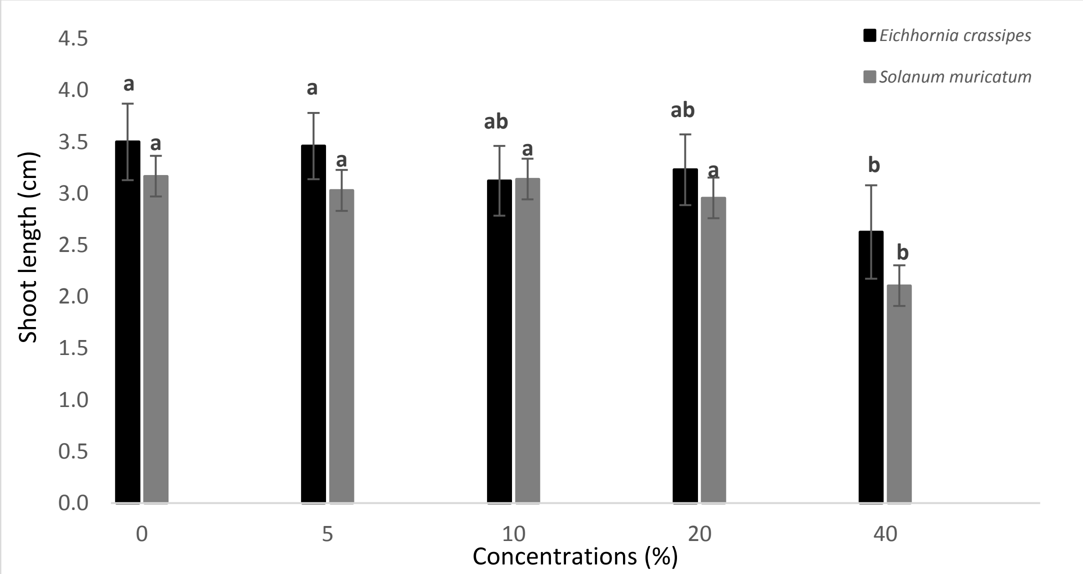

Fig. 4: Shoot lengths of the sunflower seedlings at different concentrations of *Solanum muricatum* and *Eichhornia crassipes*

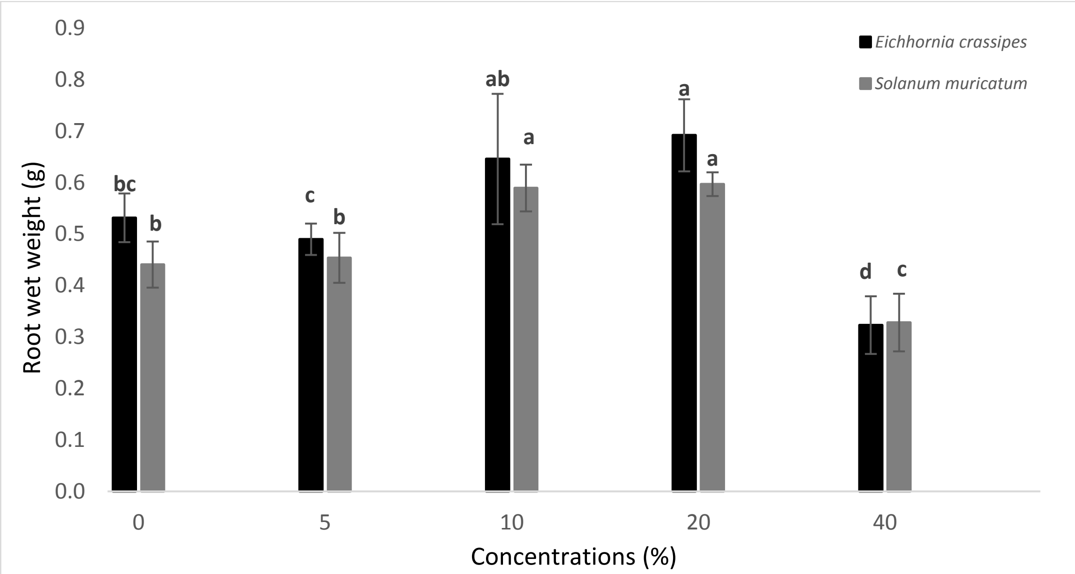

Fig. 5: Root wet weights of the sunflower seedlings at different concentrations of *Solanum muricatum* and *Eichhornia crassipes*

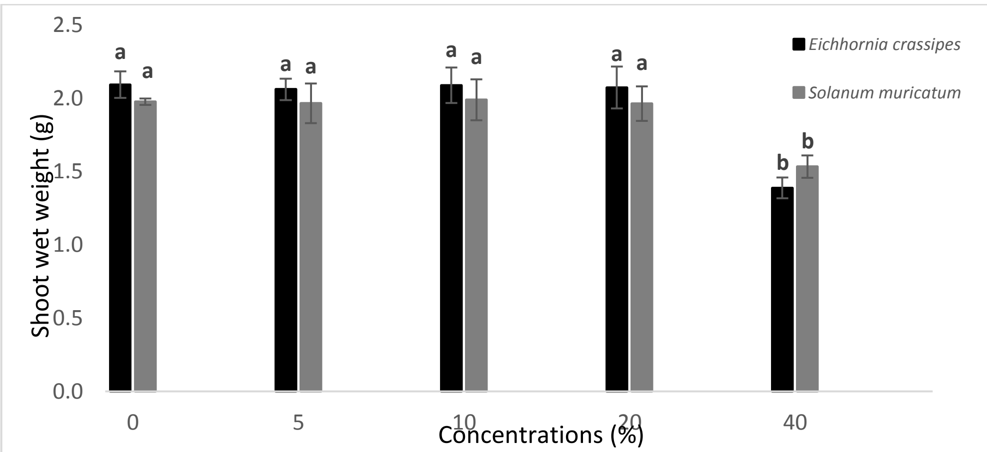

Fig. 6: Shoot wet weights of the sunflower seedlings at different concentrations of *Solanum muricatum* and *Eichhornia crassipes*

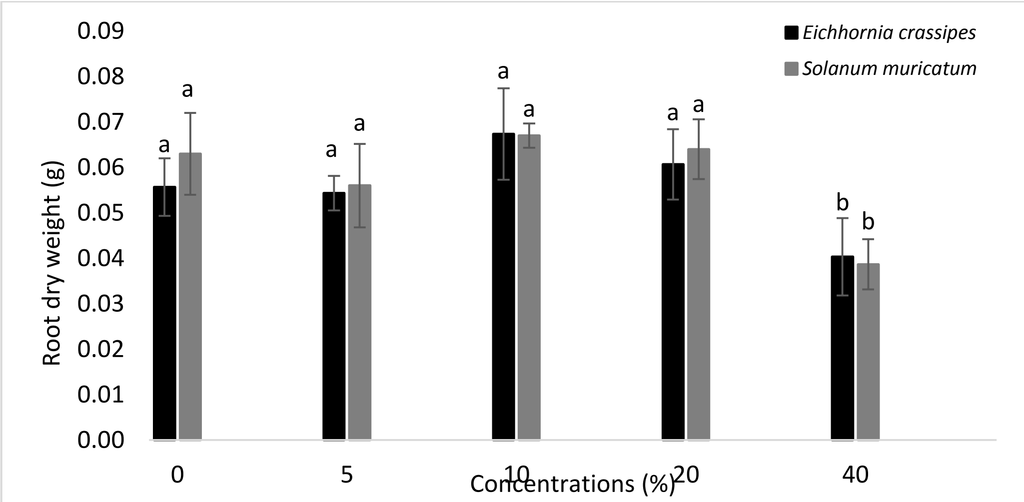

Fig. 7: Root dry weights of the sunflower seedlings at different concentrations of *Solanum muricatum* and *Eichhornia crassipes*

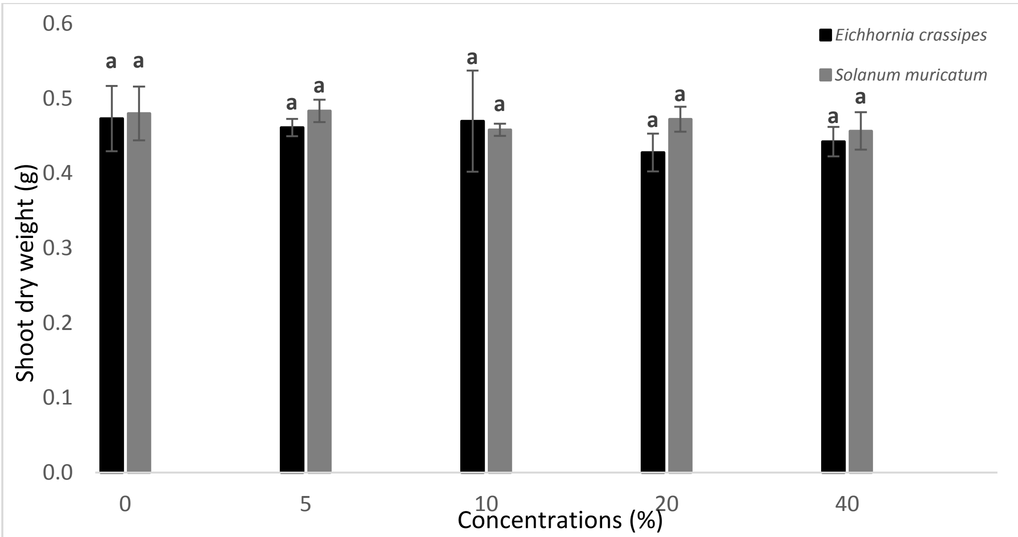

Fig. 8: Shoot dry weights of the sunflower seedlings at different concentrations of *Solanum muricatum* and *Eichhornia crassipes*

CONCLUSIONS

The germination of the sunflower seeds was not influenced by the leaf extracts of *S. muricatum* and *E. crassipes*, while the seedling growth was rather affected negatively. It was found that both plant extracts showed differences in some growth parameters of the sunflower (water uptake capacity, root-shoot length, root-shoot wet weight, and root dry weight). The 40% concentrations of *S. muricatum* and *E.crassipes* may be used allelopathic inhibitory for seedling growth except for the germination in sunflower.

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