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Research Article
Allelopathic Effect of *Calotropis procera, Hyoscyamus muticus* and *Pulicaria undulata* Extracts on Seed Germination of *Portulaca oleracea* and *Chenopodium murale*

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Abstract

Background and Objective: The use of herbicides leads to severe damage, especially to the environment. The aim of this investigation was operated to study the allelopathic effect of *Calotropis procera, Hyoscyamus muticus* and *Pulicaria undulata* aqueous extracts on the seed germination of *Portulaca oleracea* and *Chenopodium murale*. **Materials and Methods:** The aerial parts of the plants (*Calotropis procera, Hyoscyamus muticus* and *Pulicaria undulata*) washed well in distilled water and were dried in room temperature then ground to fine powder. Aqueous extract was prepared using distilled water. **Results:** In this study, different concentrations of plant extracts (1, 3 and 5%) were used to illustrate which of these concentrations have the potential to inhibit seed growth of *Portulaca oleracea* and *Chenopodium murale*. Concentration of 5% for all plant extracts used to inhibited the growth of all seeds of *Chenopodium murale* while, concentration of 5% for *Pulicaria undulata* extract only inhibited the growth of all seeds of *Portulaca oleracea*. **Conclusion:** This work dealt with the use of allelopathy strategy in preventing the growth of some weeds to be one of the safest alternative ways of using herbicides. The results showed the effective effect of plant extracts for both *Calotropis procera*, *Hyoscyamus muticus* and *Pulicaria undulata* on the seed germination of *Portulaca oleracea* and *Chenopodium murale*.

Key words: Allelopathic, weed control, *Calotropis procera, Hyoscyamus muticus, Pulicaria undulata, Portulaca oleracea, Chenopodium murale*

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Competing Interest: The author has declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Weeds are a component of agroecosystems, but the presence of weeds leads to a huge loss of agricultural crops[1-8] up to 36%. The presence of weeds has a strong relationship with the type of crops, as well as soil properties[9].

Many methods can be used to control weed growth, such as; chemical, mechanical and biological methods. However, the expansion of herbicides use has been prevalent in the past decades (about 3 million t of herbicides/year was used in agro ecosystems)[10,11]. Many herbicides can be used to eliminate weeds and increase crop productivity[12-15], but the continuous use of herbicides has many harmful effects on the environment, human health concerns, water resources contaminated, soil inefficiency, developing weed resistance and increase natural enemies[16-21].

Also, most herbicides are very expensive[22]. So, it was very important to use beneficial and safer materials on the environment and not expensive such as natural herbicides[23-25].

Rice[26], Gatti *et al.*[27] and Fritz *et al.*[28] defined allelopathy as "any indirect or direct harmful effect of specific plant on the growth of microorganism or another nearby plant through production of allelopathic materials into the environment". Allelopathy plays essential role in crop protection, weed control and crop re-establishment. Many weeds have allopathic efficacy on the growing of other weeds[29-33]. Allelopathic materials are found in many plant parts (roots, stems, leaves, fruits and flowers) as secondary metabolites such as; phenolic acids, flavonoids, alkaloids, terpenoids, isoprenoids, cyanogenic, glycosides, tannins, saponins, cyanohydrins, polyacetylenes, benzoic, unsaturated lactones and coumarins[34-40].

Many plant extracts showed allelopathic effects on the growth of many weeds[41-43]. The most successful allelopathic materials prevent the germination of the most weeds and at the same time do not affect the germination of crops[44-62].

The flora of Saudi Arabia includes many native plants which have allelopathic effects on the growth of several weeds[45,46,63,64]. Several authors have studied the allelopathic effect of *Calotropis procera, Hyoscyamus muticus* and *Pulicaria undulata* on different plants[47-53].

The present study aimed to assess the allelopathic effect of *Calotropis procera, Hyoscyamus muticus* and *Pulicaria undulata* aqueous extracts on the seed germination of *Portulaca oleracea* and *Chenopodium murale*.

MATERIALS AND METHODS

Plants and seeds collection: The studied allelopathic plants and the seeds of *Portulaca oleracea* and *Chenopodium murale* were collected from Tayma city and surrounding it at the flowering period during Spring of 2018. All plant species were identified according to Migahid[54] and Collenette[55].

Preparation of extracts: The aerial parts of the plants (*Calotropis procera, Hyoscyamus muticus* and *Pulicaria undulata*) washed well in distilled water and were dried in room temperature then ground to fine powder. Aqueous extract was prepared by soaking 100 g air-dried plant powder in 1 L of distilled water at 20-25°C for 1 day with shaker. The mixture was filtered by using filter paper then kept at 5°C until used. From aqueous extracts different concentrations 0, 1, 3 and 5% were prepared, in addition to control (distilled water). The laboratory experiment was done in Petri dish. The experiment was left for 18 days to allow germination of all seeds and finally germination percentage of all seeds, radicle length and plumule length were calculated for each extract. The laboratory experiments were conducted at the laboratory of Biology Department, University College of Tayma, Tabuk University, KSA .

Statistical analysis: Data were statistically analyzed with the aid of CoStat 6.311[56] software of analysis of variance[57]. The means were compared using Duncan at $p \leq 0.05$.

RESULTS

Radicle and plumule length: The radicle and plumule length of *Portulaca oleracea* and *Chenopodium murale* were affected by extracts of *Calotropis procera*, *Hyoscyamus muticus* and *Pulicaria undulata* in most test concentrations (Table 1). There is an inverse relationship between increased concentrations of *Calotropis procera* and *Hyoscyamus muticus* extracts and the radicle and plumule length of *Portulaca oleracea* and *Chenopodium murale* (Fig. 1, 2). Concentration of 5% for all plant extracts inhibited the growth of all radicles and plumule of *Chenopodium murale*. While, only concentration of 5% for *Pulicaria undulata* extract inhibited the growth of plumule and radicle of *Portulaca oleracea*. The results showed that *Pulicaria undulata* extract for all concentration has more extracts to prevent the growth of both radicle and plumule of *Chenopodium murale* (Fig. 3).

Table 1: Different extracts effect on the radicle and plumule length of *Portulaca oleracea* and *Chenopodium murale*

			Concentrations of extract			
Extract type	Length (cm)	Plant name	0%	1%	3%	5%
Calotropis procera	Radicle	*Portulaca oleracea*	3.1^{a}	1.8^{b}	1.3^{c}	1.0^{d}
		Chenopodium murale	3.2^{a}	0.9^{d}	0.5^{e}	0.0^{f}
	Plumule	*Portulaca oleracea*	2.9^{a}	2.0^{b}	1.8^{b}	1.5^{c}
		Chenopodium murale	3.0^{a}	1.7^{b}	1.4^{c}	0.0^{f}
Hyoscyamus muticus	Radicle	*Portulaca oleracea*	3.1^{a}	1.33	1.0^{d}	0.8^{d}
		Chenopodium murale	3.2^{a}	2.9^{a}	1.5^{c}	0.0^{f}
	Plumule	*Portulaca oleracea*	2.9^{a}	1.9^{b}	1.7^{b}	1.5^{c}
		Chenopodium murale	3.0^{a}	3.0^{a}	2.0^{b}	0.0^{f}
Pulicaria undulata	Radicle	*Portulaca oleracea*	3.1^{a}	0.5^{e}	0.2^{e}	0.0^{f}
		Chenopodium murale	3.2^{a}	0.0^{f}	0.0^{f}	0.0^{f}
	Plumule	*Portulaca oleracea*	2.9^{a}	0.5^{e}	0.3^{e}	0.0^{f}
		Chenopodium murale	3.0^{a}	0.0^{f}	0.0^{f}	0.0^{f}

Percentage followed by different letters in the column are significantly different (high) while similar letters indicates small significance according to Duncan's multiple range test at p = 0.05

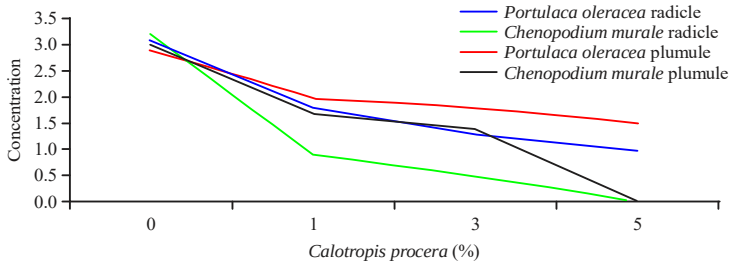

Fig. 1: Different extracts effect of *Calotropis procera* on the radicle and plumule length of *Portulaca oleracea* and *Chenopodium murale*

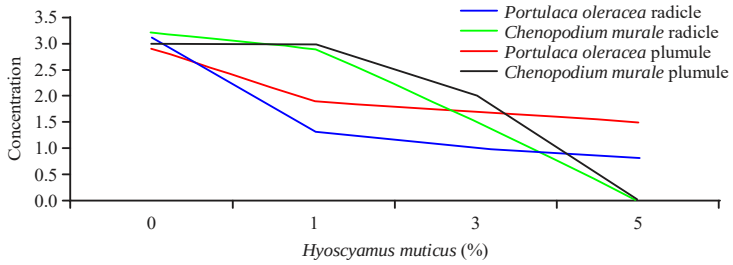

Fig. 2: Different extracts effect of *Hyoscyamus muticus* on the radicle and plumule length of *Portulaca oleracea* and *Chenopodium murale*

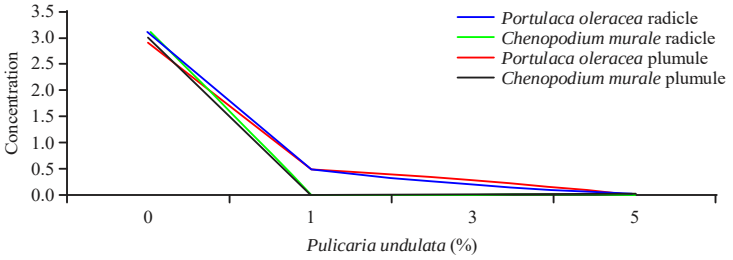

Fig. 3: Different extracts effect of *Pulicaria undulata* on the radicle and plumule length of *Portulaca oleracea* and *Chenopodium murale*

Table 2: Different extracts effect on the seed germination (%) of *Portulaca oleracea* and *Chenopodium murale*

	Calotropis procera extract		*Hyoscyamus muticus* extract		*Pulicaria undulata* extract	
Concentrations (%)	*Portulaca oleracea*	*Chenopodium murale*	*Portulaca oleracea*	*Chenopodium murale*	*Portulaca oleracea*	*Chenopodium murale*
0	100^{a}	89^{a}	98^{a}	95^{a}	90^{a}	80^{b}
1	83^{b}	60^{c}	83^{b}	60^{c}	83^{b}	0^{g}
3	83^{b}	20^{f}	83^{b}	40^{e}	33^{f}	0^{g}
5	66^{c}	0^{g}	50^{c}	0^{g}	0^{g}	0^{dg}

Percentage followed by different letters in the column are significantly different (high) while similar letters indicates small significance according to Duncan's multiple range test at p = 0.05

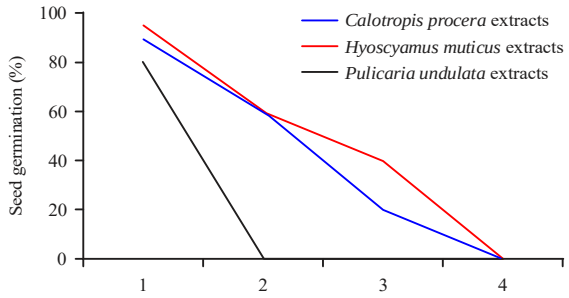

Fig. 4: Different extracts effect of *Calotropis procera, Hyoscyamus muticus* and *Pulicaria undulata* on the seed germination (%) of *Chenopodium murale*

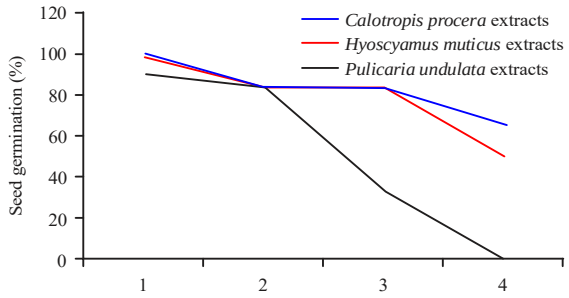

Fig. 5: Different extracts effect of *Calotropis procera*, *Hyoscyamus muticus* and *Pulicaria undulata* on the seed germination (%) of *Portulaca oleracea*

Seed germination (%): The seed germination (%) of *Portulaca oleracea* and *Chenopodium murale* were affected by extracts of *Calotropis procera*, *Hyoscyamus muticus* and *Pulicaria undulata* in all test concentrations (Table 2). The results showed an inverse relationship between the concentration of extracts and seed germination (%). It should be noted that, *Chenopodium murale* seed germination (%) was more affected by all concentrations of extracts (Fig. 4). On the other hand, *Portulaca oleracea* seed germination (%) was less affected by all extracts concentrations (Fig. 5). Concentration of 5% for all plant extracts used to inhibited the growth of all seeds of *Chenopodium murale* while, concentration of 5% for *Pulicaria undulata* extract only inhibited the growth of all seeds of *Portulaca oleracea*.

DISCUSSION

Chenopodium murale is worldwide distributed, but it was usually found in saline and xerophytic habitats[58]. While, *Portulaca oleracea* is endemic species in the Mediterranean region and worldwide distributed. In addition to, there are *Chenopodium murale* and *Portulaca oleracea* found as a weeds associated with several crops[59,60]. The presence of weeds in agroecosystems leads to many problems, including reduce crop productivity[61]. The use of herbicides causes many problems so many other strategies for weed control have been proposed. The use of allelopathic plants was safer for the environment.

In this work, the effect of using different concentrations of aqueous extract form three plants (*Calotropis procera, Hyoscyamus muticus* and *Pulicaria undulata*) on the seed germination of *Portulaca oleracea* and *Chenopodium murale* was studied. The results showed that, an inverse relationship between increased concentrations of most plant extracts on the seed germination of *Portulaca oleracea* and *Chenopodium murale.*

Several previous studies have shown the allelopathic effect of *Calotropis procera*, *Hyoscyamus muticus* and *Pulicaria undulata* on the seed germination of many plants. Aslam *et al.*[52] reported the effect of *Calotropis procera* on plant growth of wheat and mustard. Al-Zahrani and Al-Robai[48] pointed to allelopathic effect of *Calotropis procera* leaves extract on seed germination of *Hordeum vulgare, Senna occidentalis, Triticum aestivum, Trigonella foenum graecum* and *Cucumis satirus.* Nenaah and Ahmed[49] indicated that antimicrobial activity of extracts of *Calotropis procera*. Lázaro *et al.*[50] showed the effect of *Calotropis procera* aqueous extract on the reproductive efficiency of bovine tick. Al-Humaid and El-Mergawi[41] pointed to extract of *Pulicaria undulata* had allelopathic significant effect on the seed germination of *Portulaca oleracea*. El-Gawad[51] referred to the effect of *Pulicaria undulata* extract on the germination of *Brassica tournefortii.* El-Gawad and El-Shora[53] reported allelopathic potential of *Hyoscyamus muticus* on antioxidant system and nucleic acids of *Portulaca oleracea*. Furthermore,

there is an effect of *Hyoscyamus muticus* extract on the growth of some fungi as *Botrytis fabae*[47]. The use of herbicides to limit the growth of weeds leads to many problems such as; affecting human and animal health and soil contamination. So, it can be used extracts of many plants that have the ability to prevent weed growth as a safe alternative to herbicides.

CONCLUSION

This work dealt with the use of allelopathy strategy in preventing the growth of some weeds to be one of the safest alternative ways of using herbicides. The results showed the effective effect of plant extracts for both *Calotropis procera, Hyoscyamus muticus* and *Pulicaria undulata* on the seed germination (%) of *Portulaca oleracea* and *Chenopodium murale*.

SIGNIFICANCE STATEMENT

This study focused on the importance of plant extracts as allelopathic effect on unwanted weeds. Aqueous extracts of *Calotropis procera, Hyoscyamus muticus* and *Pulicaria undulata* on the seed germination of *Portulaca oleracea* and *Chenopodium murale*. This paper recommended using natural extracts instead of other chemical uses to rid of unwanted weeds associated with important crops.

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