Bioherbicidal Actions of Common Purslane on Seed Germination and Growth of Some Crop and Weed Species

Saber W. Hamad

Department of Field Crops Production, College of Agricultural Engineering Sciences, Salahaddin University, Iraq.

Email: saber.hamad@su.edu.krd

Abstract

This study was conducted to examine allelopathic actions of Common Purslane Portulaca oleracea L. aqueous shoot and root extracts on germination of seeds and some growth parameters of wheat (Triticum aestivum) and rapeseed (Brassica napus). The experiment was performed in sterilized Petri dishes for one week at 22 °C. The experiment was arranged for completely randomized design. The concentrations were chosen for this study as (0%, 3%, 6% and 9%). The results indicated that the higher concentrations (6% and 9%) of both shoot and root extracts of common purslane caused significant reduction in seed germination whereas the lowest concentration caused the least negative impact on seed germination. Other growth polarimeters such as shoot and root length and shoot and root oven dry weight were significantly inhibited by the application of both Common Purslane aqueous shoot and root extracts at concentrations (6% and 9%) in wheat T. aestivum and rapeseed B. napus. However, dicot B. napus turned out to be more effected than monocot T. aestivum. The findings of this study suggest that common purslane aqueous shoot and root extracts can be recommended to utilize as bio-herbicide to suppress seed germination and growth of weeds.

Keywords: Allelopathy, Common purslane, Bioassay, Weed management, Bio-herbicide.

1. Introduction

The definition of allelopathy is any direct or indirect suffer or advantageous effect of a plant or the effect of a microorganism on other plants by releasing allelochemicals to the environment [1-3]. The phenomenon of plants which have influence on other nearby plants through delivering chemicals was originally addressed by Theophrastus in 370 BC [4]. Molisch [5] was the first who mentioned the term Allelopathy. According to previous scientific research, there are significant numbers of secondary metabolite of plants that are considered to have allelopathic influences. For instance, some plant natural products, for example, phenolics and alkaloid compounds play crucial role in natural activities of plants for instance, seed germination development and plumule growth [2,6-8]. Plants, which are able to have phytochemical activities, must have ability to produce bio-compounds called allelochemicals, that must be delivered into the neighbouring plants which must be reachable for the process of transportation in order to be taken by another plant [3]. Allelopathic compounds are delivered into environment through various of mechanisms as they involve root exudation process, leaching, plant leaf volatile as well as decomposition of plants [3, 9].

Based on some recent scientific investigations, utilizing chemical herbicides causes many risks to environment which negatively affect human health and reduces quality of water, as well as it has the negative influence on soil microorganisms [10]. In addition, there are about 470 genotype weeds which application of synthetic herbicides to them are no longer effective. (Heap, 2017). Therefore, to escape from these expecting issues, plants which have capability of producing bio-active compounds might be useful to utilize them as bioherbicides for terminating unwanted plants, to such an extent that allelopathy may be considered to be a possible implement to reduce weed existence and increase crop production [11-14]. Shehata [15] examined the allelopathic activities of P. oleracea L. seed extracts on germination and growth of Cichorium endivia L., Lactua sativa L., Echinochloa crus-galli L., and Brassica tournefortii. The results illustrated that the extracts caused a significant reduction in germination and seedling growth with the increase of concentration. Another study by Rashidi, Reza Yousefi [16] indicated that seeds of P. oleracea L. has inhibitory allelopathic reduction in growth parameters of some crop species such as common bean onion, sugar beet, broad bean, and pea.

Portulaca oleracea L. (purslane) belongs to family of Portulacaceae, is one of well-known common weed worldwide. Although it is considered to have poor competition, it has fast capability to regenerate vegetative growth [17]. Even though purslane is a common weed, there is still not much information available about its allelopathic activities in weed
management. Thus, the present experiment aimed at assessing the allelopathic actions of shoot and root extracts of purslane on germination and seedling growth of monocot and dicot plants.

2. Materials and Methods

2.1 Sample Collection

Purslane plants were collected in Erbil-Khabat at the maturity stage in Summer-2020. The plants were separated into two roots and shoot parts. They were cut into 5 cm pieces. The chopped plants then left air-dried for 14 days. The air-dried samples were delivered to Agriculture Lab at Salahaddin University-Erbil, where they were ground into fine particles and were getting ready for the test.

2.2 Aqueous extract preparation

Shoot and root water extracts of dried purslane plants were prepared via mixing 10 g of each purslane shoot and roots with 100 ml deionised water separately and then put into a shaker then left overnight. The shoot and root extracts were centrifuged (1000 rpm) for 10 min after filtration using filter paper. The supernatant was filtered through a micropore filter (0.45 µm). The resultant extracts were stored at 4°C until required for the germination tests.

2.3 Experiment of seed germination

For this experiment, seeds of wheat (Triticum aestivum) and rapeseed (Brassica napus) were utilized. The seeds were obtained from College of Agricultural and Engineering Sciences, Salahaddin University-Erbil. To avoid contamination, sodium hypochlorite (10%) was used for seed sterilization and washed for 15 min and then rinsed 3 times in deionized water. This process was performed to prevent contamination with pathogens during their germination.

2.4 Bioassay

Ten seeds of wheat and rapeseed were separately placed in 9 cm diameter petri dishes lined with filter paper. Five ml of three different Portulaca oleracea shoot and root extracts were applied to the petri dishes of both seed samples as these were the treatment petri dishes. The non-treatment petri dishes (control) received 5 ml distilled water only. There were 3 replications of each seed species (wheat and rapeseed) including test and control treatments. Petri dishes were incubated in a growth chamber at 22°C. After one week, seed germination percentage, shoot length, root length, shoot dry weight and root dry weight of germinated seedlings were recorded.

2.5 Statistical Analysis

Results of experiments were analyzed using ANOVA general linear model (Minitab software, version 17) for a completely randomized design (CRD) with three replications. Tukey’s test (P ≤ 0.05) was used to calculate significant differences between means.

3. Results

3.1 Effect of common purslane on seed germination

Figure 1 shows the effects of various concentrations of purslane shoot and root aqueous extracts on germination of wheat (Triticum aestivum) and rapeseed (Brassica napus). Results indicate that shoot and root aqueous extracts of common purslane significantly inhibited seed germination of both T. aestivum and B. napus (Figure 6 and 7). The highest reduction turned out to be at concentrations (6% and 9%).
Figure 1. Effect of purslane shoot and root aqueous extract on seed germination of *Brassica napus* and *Triticum aestivum*. The results are means of three replications. Error bars stand for standard errors. Tukey’s test (P ≤ 0.05) was used to calculate significant differences between means.

3.2 Effect of common purslane on shoot length

The results from Figure 2 shows that purslane ground shoot and root aqueous extract at all concentrations (3%, 6% and 9%) significantly reduced shoot length of dicot *B. napus* and monocot *T. aestivum*. Shoot length of *B. napus* was more significantly affected by the highest concentrations of purslane shoot and root extracts at higher concentrations (Figure 6 and 7).

Figure 2. Effect of purslane shoot and root aqueous extract on shoot length of *Brassica napus* and *Triticum aestivum*. The results are means of three replications. Error bars stand for standard errors. Tukey’s test (P ≤ 0.05) was used to calculate significant differences between means.

3.3 Effect of common purslane on root length

Root length of *B. napus* and *T. aestivum* were significantly reduced by the application of purslane shoot and root aqueous extracts (Figure 3) at all concentrations (3%, 6%, 9%). In addition, shoot length of *B. napus* was more significantly reduced compared with *T. aestivum*. 
3.4 Effect of common purslane on shoot dry weight

Figure 4 shows the effects of different concentrations of purslane aqueous shoot and root extract on shoot dry weight of *Brassica napus* and *Triticum aestivum*. *B. napus* at concentrations (6% and 9%) completely affected by the application of aqueous shoot and root extract (P < 0.001) of purslane in comparison with *T. aestivum* which had less significant reduction. In addition, shoot dry weight of *T. aestivum* was more sensitive by the influence of purslane aqueous shoot extract compared to purslane aqueous root extract.

3.5 Effect of common purslane on root dry weight

Root dry weights of *B. napus* and *T. aestivum* were significantly (P < 0.001) inhibited by 6% and 9% concentrations of aqueous shoot and root extracts of common purslane. Also, the results indicate that root growth of *B. napus* dicot turned out to have more growth reduction than *T. aestivum* monocot plant (Figure 5).
Figure 5. Effect of purslane shoot and root aqueous extract on root dry weight of *Brassica napus* and *Triticum aestivum*. The results are means of three replications. Error bars stand for standard errors. Tukey’s test (P ≤ 0.05) was used to calculate significant differences between means.

Figure 6. Effect of common purslane aqueous shoot extract (3%, 6%, 9%) on seed germination and early growth of *B. napus* and *T. aestivum*.

Figure 7. Effect of common purslane aqueous root extract (3%, 6%, 9%) on seed germination and early growth of *B. napus* and *T. aestivum*. 
4. Discussion

The allelopathic actions of common purslane shoot and root extracts at different concentrations (0%, 3%, 6% and 9%) on germination and early growth of *B. napus* and *T. aestivum* were examined. The reduction of seed germination and growth, shoot and root length, and shoot and root oven dry weight of the examined plant species may be due to the effect of biochemicals present in common purslane extracts [18]. The response of germinating seeds and early growth to phenolic compounds have been reported in previous studies which illustrates that phenolic compounds contribute with the plant growth system and could affect seedling growth of plants through affecting plant hormones [19]. The results are in agreement with Wang, Zhang [18] who isolated 12 organic acids and 3 phenolic compounds from common purslane extracts which they play a crucial role in allelopathy [20, 21].

The findings about the allelopathic activities of different concentrations (3%, 6% and 9%) of common purslane extracts on seed germination and early growth of *B. napus* and *T. aestivum* showed that the negative impact increased with increasing concentration of the extract. 6% and 9% aqueous shoot and root extracts recorded the most allelopathic influence on seed germination and early growth of the plants. These results are similar to the findings obtained by Sharma and Satsangi [22], who indicated that higher concentrations (50-100%) of sunflower aqueous shoot extracts had more negative impacts than extracts with low concentrations on *Amaranthus viridis* and *Parthenium hysterophorus*.

The reduction of seed germination and growth parameters of *B. napus* and *T. aestivum* may be because of allelochemicals present in purslane extracts which could have negative impacts on cell division and physiological activities. Additionally, during the seed germination process, biochemicals may be the reason for changing in cell membrane permeability of the examined plant and weed species [23]. They may change respiration and reduce the concentration of RNA and ATP or disturb the secondary messengers functions that are required for germination of seeds and growth development [24].

The findings of this study has indicated that purslane aqueous shoot extracts have more allelopathic influences on germination, shoot and root length and shoot and root oven dry weight than aqueous root extract [25, 26]. Moreover, our findings are similar with Turk and Tawaha [27], who showed that for black mustard the greater allelopathic effects can be released through leaf extracts. This might be because water soluble allelochemicals have greater inhibitory effect from shoot extracts than root extracts. It is concluded that both shoot and root aqueous extracts from purslane plant have inhibitory allelopathic effects on seed germination and growth of both monocot and dicot studied species which could lead to be alternative to using of herbicides and it can be a production of natural herbicides in the future.

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