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Study of Allelopathic Activity of Common Sowthistle Weed (*Sonchus oleraceus* L.)

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ABSTRACT

The present work was conducted to study the allelopathic activity of Common Sowthistle weed (*Sonchus oleraceus* L.) belongs to family Asteraceae growing in agricultural fields in Benghazi using Radish (*Raphanus sativus* L.) as test plant. Flowers, leaves, stems and roots aqueous extracts of *Sonchus oleraceus* L. at 1%,5% and 10% concentrations were applied to determine their effect on seed germination, germination index (GI), speed/rate of germination (SG/RG), seedling vigor index (SVI), root length (RL), hypocotyle length (HL), seedlings fresh weight (FW) and seedlings dry weight (DW) of Radish under laboratory conditions. The aqueous extracts of all plant parts caused inhibitory effects on all measurement, which increased progressively on increasing the concentration of extracts. On the other hand, at low concentration (1%) stimulation of some traits of different plant parts was recorded. These results could be explained in the light of the facts that a higher plants release a diversity of allelochemicals into the environment, which include phenolics, alkaloids, long-chain fatty acids, terpenoids, and flavanoids. The compounds exhibit a wide range of mechanisms of action effect on DNA (alkaloids), photosynthic and mitochondrial function (quinines), phytohorme activity, ion uptake and water balance (phenolics).

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1. Introduction

Allelopathy is derived from the Greek words *allelon* "of each other "and *pathos* "to suffer" (Rizvi et al., 1992). Rice (1974) defines allelopathy as any direct or indirect effect by one plant, including microorganisms, on another through the production of chemical compounds that escape into the environment and subsequently influence the growth and development of neighboring plants. These effects can be harmful or beneficial (Rice, 1984). Allelopathy is an important mechanism of plant interference mediated by the addition of plant-produced secondary products to the soil rhizosphere (Weston, 2005). The beneficial or harmful effects of one plant on anther plant both crop and weed species , take place by the release of chemicals from plant parts by leaching , root exudation, volatilization, residue decomposition and other processes in both natural and agricultural systems (Ferguson & Rathinasabapathi, 2009).

Because of human population increase in recent years, the demand on food has also increased. The weed competition is one of the major constraints in food production due to its inhibition of seed germination and seedling growth of crop species through allelopathy and therefore, reducing yield. On the other side allelopathy offer potential for biological control of weeds, through production and release of allelochemicals from flowers, leaves, stems, and roots of living or decomposing plant materials (Patil, 2007). Under suitable environments, allelochemicals may produce in quantity, which inhibit the growth and development of weed seedlings similar to herbicides (Weston, 1996). Many researchers (Weston, 2005; Khan, 2005 & Patil et. al., 2007), have suggested that, this phenomenon can be employed in weed management programmers, in particular, allelochemicals may used as alternative to synthetic herbicides. Therefore, in this work we will evaluate the ability of extracts of Sowthistle (*Sonchus oleraceus* L.) annual or biennial weed belongs to family Asteraceae growing in agriculture fields in Benghazi, Libya, which have not been tested before to inhibit or suppress the growth and development of other plants.

2. Materials and methods

The experiments were conducted in the Main Research Laboratory, University of Benghazi, Faculty of Science, Botany Department to study the allelopathic effect of Common sow thistle (*Sonchus oleraceus* L.) on Radish (*Raphanus sativus* L.). Seeds of Radish were obtained from local market were kept in the containers, which they were supplied, and stored in the laboratory at room temperature until required for sowing. Common sow thistle was collected from its natural habitats during the flowering stage to test the allelopathic activities of the aqueous extract of flowers, leaves, stems and roots. The collected materials were dried in oven at 60 C° for 24 hours then ground and stored in glass jars until used. To obtain different concentrations (W/V) of flowers, leaves, stems and roots; 1, 5 and 10 grams of Common sow thistle were soaked in 100 ml distilled water for 24 hours at room temperature and stored in the refrigerator at 4°C until used. Growth chamber conditions for germination were 25 C°, in dark, and relative humidity 65 %. Radish was used as the recipient. Twenty seeds surface sterilized were sown onto 9 cm Petri-dishes lined with one layer of Whitman No. 1 filter paper. 5 ml from different concentrations of each extract were delivered to Petri-dishes and distilled water (5 ml) was used as control. Germinated seeds with a radical were recorded, root, and shoot lengths and fresh and dry weights of seedling were measured after 5 days of sowing. Several of parameters were used in this work to assess the effects of weed extracts on seed germination and seedlings development of test species. These parameters include:

1. Percent of Seed Germination

$$Germination\ (\%) = \frac{No.\ of\ seeds\ with\ extended\ radicals}{Total\ number\ of\ seeds}$$

2. Seed germination index (SGI)

Seed germination index (SGI) was calculated according to the following equation (Scott et al., 1984).

SGI = [SIGMA] TiNi / S

Where,

Ti*= is the number of days after sowing,*

Ni*= is the number of seed germinated on day I,*

S*= is the total number of seeds planted.*

3. Speed of germination/ Rate of germination:

Speed or rate of germination was computed by using the following formula, (Patil, 2007).

$$SG/RG = N1/D_1 + N_2/D_2 + N_3/D_3 + \ldots\ldots\ldots + N_n/Dn$$

Where,

SG*=Speed of germination*

RG*=Rate of germination*

N_1, N2, N3…….N_n*= Number of seedling emerged on D_1, D2, D3…….D_n days after sowing.*

4. Seedling Vigor Index (SVI)

The seedling vigor index was calculated by using Abdul-Baki and Anderson (1973) formulae.

SVI = (Shoot length + Root length)×Germination percentage.

5. Root Length:

Length of roots, were measured in cm using a ruler

6. **Shoot Length**:

Length of shoots, were measured in cm using a ruler

7. Fresh Weight:

The fresh weight of the whole seedling was recorded by weighing small tins empty after drying for a few minutes at 80 C° in an oven and then with the amount of fresh sample.

8. Dry Weight:

Samples were dried for 24 hours in an oven at 80 C°, the tins were removed from the oven closed allowed to cool, weighed and put back in the oven for further 24 hours periods until constant weight was reached.

9. Inhibition of Growth:

Relative reduction or stimulation of seed germination, root length , shoot length and fresh weight and dry weight as affected by the allelopathic substance were calculated according to the general equations, (Nesrine et al., 2011).

$$\left[1 - \left(\frac{allelopathic}{control}\right) \times 100\right]$$

Statistical Treatment of Data:

Data were subjected to standard one-way analysis of variance (ANOVA) using the COSTAT, 2.00 statistical analysis soft were manufactured by CoHort Software Company (1986).

3. Results and discussion

1. Percent of Germination

Different extracts of plant parts of S. oleraceus L. at 1% concentration had no significant effect on seed germination of radish except root extracts significantly reduced seed germination to (94%) compared to control (99%). At 5% concentration, significant decrease in germination percentage for flowers and leaves extracts especially leaves extracts (93%) compared to control (99%). While roots and stems extracts had no significant effect on seed germination. Extracts of all plant parts at 10% concentration significantly reduced seed germination in radish. The highest reduction recorded for leaves extracts (92%) compared to control (99%). Meanwhile root extracts increased germination percentage significantly (100%) compared to control (99%), Fig. 1.

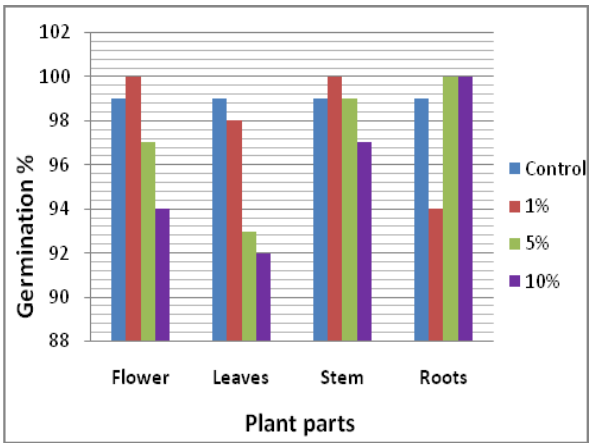

Fig.1: Allelopathic effect of *Sonchus oleraceus* L. aqueous extracts at different concentrations of different plant parts on seed germination.

Germination Index (GI)

Extracts of all plant parts at 1% concentration had no significant effect on GI at 5% concentration however, extracts of leaves only reduced GI significantly (2.52) compared to control (2.82). Extracts of all plant parts of S. oleraceus L. at 10% concentration significantly decreased GI especially flowers extract (2.08) compared to control (2.82). Meanwhile root extracts at 10% concentration had no significant effect on GI Fig. 2.

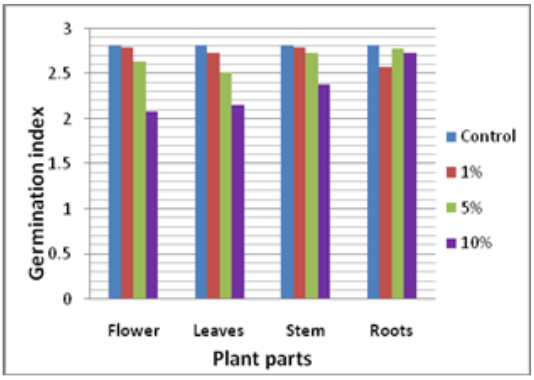

Fig.2: Allelopathic effect of *Sonchus oleraceus* L. aqueous extracts at different concentrations of different plant parts on germination index.

Speed /Rate of Germination (SG/RG)

Data of speed/rate of germination indicated that all extracts of different plant parts of S. oleraceus L. at used concentrations reduced rate of seed germination of radish. At 1% concentration, roots extracts recorded significant decrease in rate of seed germination (23.70) compared to control (27). Extract of leaves at 5% concentration also showed significant reduction in rate of germination (21.60) in comparison with control (27). In addition, extracts of all plant parts at 10% concentration significantly reduced rate of seed germination in radish. The highest reduction recorded for flowers extracts (15.20) compared to control (27), Fig. 3.

2. Seedling Vigor Index (SVI)

Seedling vigor index in radish seedlings was stimulated by extracts of flowers, stems and roots at 1% concentration. The highest increase recorded for flowers extracts (750) compared to control (534). Meanwhile extract of leaves recorded significant decrease in SVI of radish (401) compared to control (534). At 5% and 10% concentrations of all plant parts extracts significantly reduced SVI of radish seedling with the highest effect for stems

extracts (232) at 5% and flowers extracts (159) at 10% concentration compared to control (534) except extract of roots showed significant increase in SVI (730 & 810 respectively) compared to control (534), Fig. 4.

Fig.3: Allelopathic effect of *Sonchus oleraceus* L. aqueous extracts at different concentrations of different plant parts on speed/rate of germination.

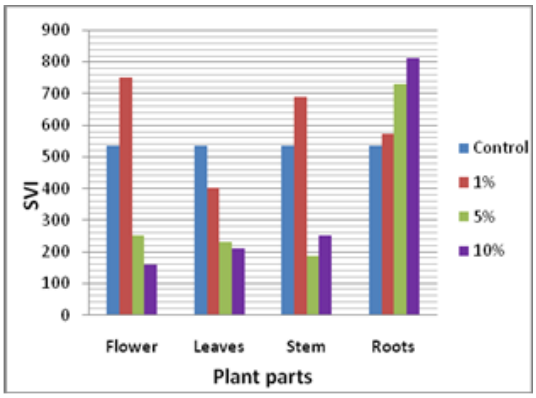

Fig.4: Allelopathic effect of *Sonchus oleraceus* L. aqueous extracts at different concentrations of different plant parts on seedling vigor index.

Allelopathic effect of *Sonchus oleraceus* L. aqueous extracts at different concentrations of different plant parts on seed germination (Fig. 1), germination index (Fig. 2), speed/rate of germination (Fig. 3), and seedling vigor index (Fig. 4) of Radish (*Raphanus sativus* L.) 5 days after planting.

5. Root Length:

Data concerning root elongation in radish seedlings showed in Fig. 4 & 5.

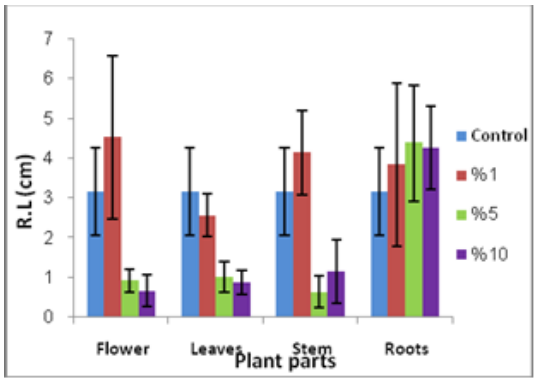

Fig.5: Allelopathic effect of *Sonchus oleraceus* L. aqueous extracts at different concentrations of different plant parts on root length.

Significant stimulation of root length was recorded for all extracts at 1% concentration especially extracts of flowers showed significant increase in root length (43%) compared to control. Meanwhile extracts of leaves recorded significant decrease in root length of radish (19%) compared to control. At 5% and 10% concentrations of all plant parts extracts significantly reduced root length of radish seedling with the highest effect for stems and flowers extracts (79%) compared to control. Extracts of roots however, showed significant increase at 5% and 10% concentrations in root length (38% & 34% respectively) compared to control.

6. Hypocotyle Length:

Hypocotyle length in radish seedlings was stimulated by extracts of flowers and stems at 1% concentration. The highest increase recorded for flowers extracts (33%) compared to control. Meanwhile extracts of leaves recorded significant decrease in hypocotyle length of radish (31%) compared to control. At 5% and 10% concentrations of all plant parts extracts significantly reduced hypocotyle length of radish seedling with the highest effect for stems extracts (40%) at 5% for flowers extracts (66%) at 10% concentration compared to control. Extracts of roots however, showed significant increase at 5% and 10% concentration in hypocotyle length (28% & 69% respectively) compared to control, Fig. 7 & 8.

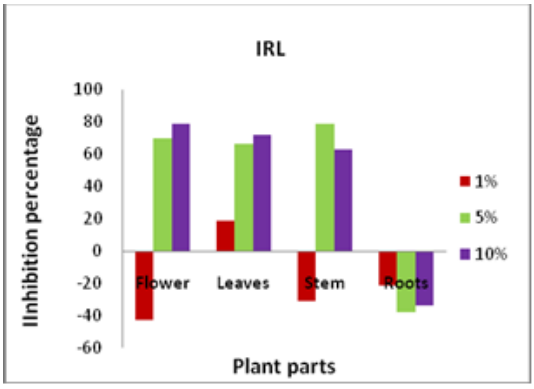

Fig.6: Allelopathic effect of *Sonchus oleraceus* L. aqueous extracts at different concentrations of different plant parts on inhibition of root length.

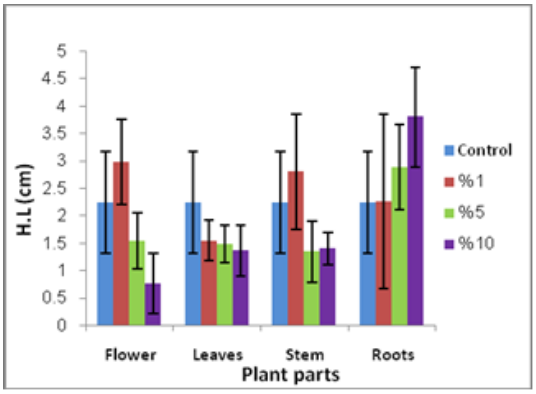

Fig.7: Allelopathic effect of *Sonchus oleraceus* L. aqueous extracts at different concentrations of different plant parts on hypocotyle length.

7. Fresh Weight:

The data in Fig. (9 & 10) shows that all concentrations of different plant parts had marked effect on seedlings fresh weight in comparison with control. In contrast, stems extracts at 1% concentration showed stimulated effect on fresh weight of seedlings (15%). Meanwhile extracts of leaves significantly reduced seedlings fresh weight of radish (25%) in comparison with control. The extract of flowers at 1% concentration had no effect on fresh weight. Extracts of all plant parts at 5% and 10% concentrations however, recorded significant reduction in fresh weight of radish seedling. The highest reduction recorded for flowers extracts at 10% concentration (68%).

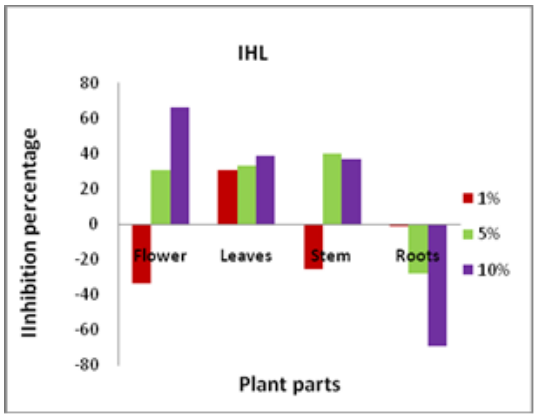

Fig.8: Allelopathic effect of *Sonchus oleraceus* L. aqueous extracts at different concentrations of different plant parts on inhibition of hypocotyle length.

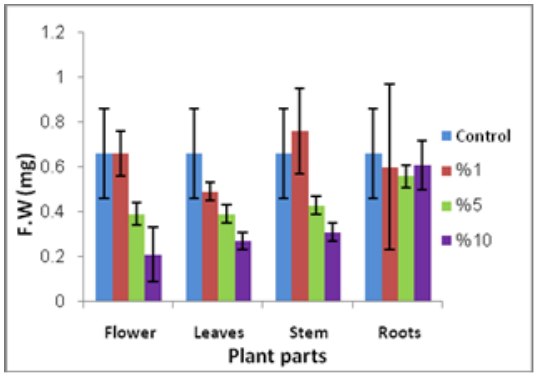

Fig.9: Allelopathic effect of *Sonchus oleraceus* L. aqueous extracts at different concentrations of different plant parts on fresh weight.

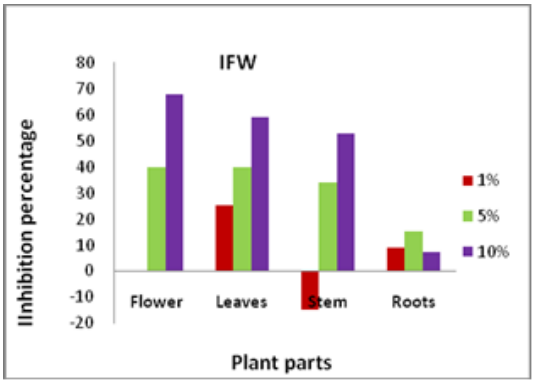

Fig.10: Allelopathic effect of *Sonchus oleraceus* L. aqueous extracts at different concentrations of different plant parts on inhibition of fresh weight.

8. Dry Weight:

Different extracts of all plant parts of S. oleraceus L., at 1% & 5% concentrations significantly reduced seedlings dry weight with the highest effect recorded for roots extracts (29% & 13% respectively). Also 10% concentration of all extracts of plant parts significantly decreased dry weight with the highest effect recorded for flowers and leaves extracts (31%, 18% respectively), Fig. 11 & 12.

Allelopathic effects of aqueous extracts of different parts of Common Sow thistle (*Sonchus oleraceus* L.) on seed germination and seedling development of radish (*Raphanus sativus* L) has been observed in Petri-dish bioassays. As proven by ANOVA test, the results showed that germination percentage, germination index (GI), speed/rate of germination (SG/RG), seedlings vigor index (SVI), root length, hypocotyle length, fresh weight and dry weight.

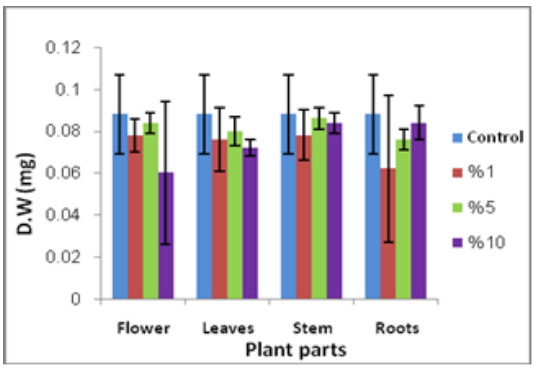

Fig.11: Allelopathic effect of *Sonchus oleraceus* L. aqueous extracts at different concentrations of different plant parts on dry weight.

The results regarding the allelopathic effect of aqueous extracts of annul Sow thistle on seed germination and seedlings development of radish revealed stimulatory and inhibitory effects on all traits. Stimulator at low concentrations and inhibitory at high concentration. Similar results obtained by other workers (Della et. al, 2009; Aljubory et. al. 2010). On the other hand root extracts were found to be more stimulus to all measurements and leaves extracts had more inhibitory effect compared to other extracts and controls. This can be explained by the fact that roots may contain more allelochemicals (Aljubory et. al. 2010).

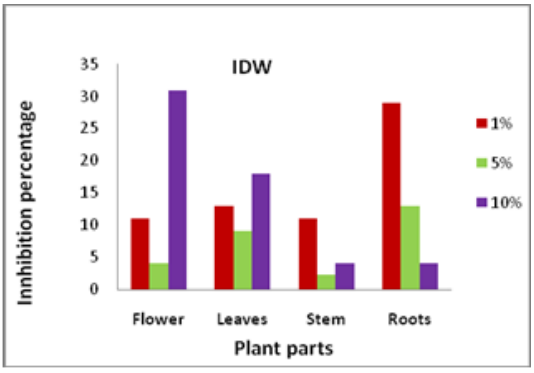

Fig.12: Allelopathic effect of *Sonchus oleraceus* L. aqueous extracts at different concentrations of different plant parts on inhibition of dry weight.

Allelopathic effect of *Sonchus oleraceus* L. aqueous extracts at different concentrations of different plant parts on RL (Fig. 5) ,%IRL (Fig. 6), HL (Fig. 7) and %IHL (Fig. 8) of Radish (*Raphanus sativus* L.) 5 days after planting

Allelopathic effect of *Sonchus oleraceus* L. aqueous extracts at different concentrations of different plant parts on FW (Fig. 9), %IFW (Fig. 10), DW (Fig. 11) and %IDW (Fig. 12) of Radish (*Raphanus sativus* L.) 5 days after planting.

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