Evaluation of *Convolvulus arvensis* For allelopathic activities

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Abstract

During 2012-2013 screening of *Convolvuls arvensis* L weed growing in agricultural fields in Benghazi for allelopathic activity was conducted, using Radish (*Raphanus sativus*) for the assay of the allelochemicals. The assay experiment was carried out under laboratory conditions in the Botany Department, Faculty of Science, University of Benghazi. Several traits including percentage of seed germination (SG), seed germination index (GI), seedling vigor index (SVI), speed of germination/rate of germination (SG/RG), root and hypocotyle length (RL&HL), fresh and dry weight (FW& DW) of seedlings and percentage of growth inhibition were measured. The results showed that the aqueous extracts from dry biomass of flowers, leaves, stems and roots at 1, 5 and 10% concentrations contain growth inhibiters or stimulators substances. These substances distributed over all plant organs (flowers, leaves, stems, and roots). The effects of different extracts of plant parts were varied according to the concentration used. With inhibitory effects at high concentration and stimulatory or no effects at low concentration. The results also revealed that all extracts of different plant parts screened for allelopathic effects at 1% concentration had no significant effects on germination present (G%), germination index (GI), hypocotyle length (HL) and fresh weight (FW). Meanwhile speed germination/rate germination (SG/RG), seedling vigor index (SVI), root length (RL) and dry weight (DW) most extracts recorded stimulatory effects in comparison with controls. At 5% concentration had no significant effect of seed germination (SG) and germination index (GI). On the other hand SG/RG, SVI, RL, HL and FW was significantly reduced by most of extracts. In contrast the highest effects were recorded for all extracts of all plant parts at 10% concentration. Most traits at this concentration were significantly reduced by extracts of all plant parts. Percentage of seed germination (SG) was for leaves extract (12%) compared to controls (100%). Regarding germination index the highest effect recorded for leaves extract (0.48) compared to control (2.92). Speed/Rate of germination (SG/RG) reduced significantly by extract of C. arvensis leaves to the highest levels (3.8) compared to control (41.9). The highest inhibition of seedling vigor index (SVI), root length (RL), hypocotyle length (HL) and fresh weight (FW) however, was for Leaves extract (100 %) there was no recorded growth for radish seedlings after germination (zero). Finally the obtained results reported in this search suggest that the screened bindweed can cause grate losses in crop yield through its release of allelochemicals that can inhibit seed germination and seedling development. On the other hand allelochemicals produced by this weed may be used as natural pre- emergence herbicides to control many weeds in crop fields.

Keywords: Allelopathic activity, *Convolvuls arvensis,* Radish, germination

1 Introduction

Allelopathy is derived from the Greek words *allelon* "of each other "and *pathos* "to suffer" (Rizvi, Haque, Singh& Rizvi, 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). As a result of human population increase in recent years, the demand on food has also increased. The weed compaction 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 produced in quantity which inhibit the growth and development of weed seedlings similar to herbicides (Weston, 1996). Many researchers (e.g. 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 project we will evaluate the ability of extracts of some weed species growing in agriculture fields in Benghazi, Libya, which have not been tested before to inhibit or suppress the growth and development of other plants.

This paper aimed to study the allelopathic effect of *Convolvuls arvensis* L. and to study the potential of different organs extracts of *Convolvuls arvensis* L.phytoxicity on test plant.

2.Material and Methods

Laboratory experiments were conducted during 2012-2013 to investigate the allelopathic activity of bindweed. The experiments were conducted in Main Research Laboratory, Benghazi University, Faculty of Science, Botany Department**.** Laboratory experiments were conducted to study the allelopathic effect of bindweed (*Convolvuls arvensis* L.) on *Raphanus sativas* L. The experiments consist of one test plant (*Raphanus sativas* L.) and one of weed species. The details of test plant and weed species used are presented as below. Seeds of *Raphanus sativas* were obtained from local market. Seeds were kept in the containers which they were supplied, and stored in the laboratory at room temperature until required for sowing. One weed species were collected from its natural habitats during the flowering stage to test the allelopathic activities of the aqueous extract of flowers, leaves, stems and roots on *Raphanus stivus* L. The collected materials were ried in oven at 60C° 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 bindweed 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 *(Raphanus sativas)* was used as the receiver. Twenty seeds (surface sterilized of ryegrass were sown onto 9 cm petri-dishes lined with one layer of whitman No. 1 filter paper. 5 ml of each extract from different concentrations were delivered to each peters-dish and distilled water (5ml) was used as control. Germinated seeds with a radical were recorded and root and shoot lengths and fresh and dry weights of seedling were measured after 5 days of sowing. A variety of parameters were used in this study to assess the effects of weed extracts on seed germination and seedlings development of test species. These parameters include:

$$\% \text{ Germination} = \frac{No.of\ seeds\ with\ extened\ radicals}{Total\ number\ of\ seeds} \times 100$$

Seed germination index (SGI) was calculated according to the following equation (Scott, S.J. *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.*

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

$$SG/RG = N_1/D_1 + N_2/D_2 + N_3/D_3 + \ldots\ldots\ldots\ldots + N_n/Dn$$

Where,

SG*=Speed of germination*

RG*=Rate of germination*

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

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

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

Length of shoots and roots, were measured in cm. The fresh weight of the whole Seedling was recorded by weighing small tins empty after drying for a few minutes at 80C° in an oven and then with the amount of fresh sample. 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. 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).

Relative reduction or stimulation = [1- (allelopathic/control) × 100]

Data of the present study 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

3.1.1. Percent of Germination:

The results in fig.(1) showed that at 1% concentration of all extract from different plant parts had no significant effect on final germination percentage of radish compared to control. At 5%& 10% concentrations the extracts of leaves only decreased germination percent significantly (73% & 21%) in comparison with control.

3.1.2. Germination Index (GI):

Regarding GI Fig. (2) Showed no significant differences between all extracts and the control. In contrast extracts of leaves at 5 & 10% concentrations decreased GI significantly (1.86 & 0.48 respectively) compared to controls (2.9) and other concentrations of different plant parts.

3.1.3. Speed /Rate of Germination (SG/RG):

According to data in fig.(3) there was significant difference between different bindweed parts extracts at 1% concentration compared to the controls. At this concentration stimulation of rate germination was observed. Extractions of leaves at 5% concentrations however, slow down the rate of seed germination (16.4) in radish compared to control (41.9). Mean while at 10% concentration extracts of all plant parts lowered rate of germination, the highest effect was for leaves extracts (3.8).

3.1.4. Seedling Vigor Index (SVI):

Seedling vigor index in radish seedlings was stimulated by extracts of flowers and roots at 1% concentration (1252 & 1267) compared to controls (1200) fig. (4). In contrast leaves extract concentration 1% reduced significant decrease seedling vigor index of radish (900) comparison with control (1200). While stems extract had no significant effect on SVI. At 5% concentration flowers extraction increased SVI (1231) compared to control (1200). Mean while extracts of leaves and roots reduced SVI significantly of radish seedlings in comparison with controls (197, 837, and 1200 respectively). Extracts of all plant parts at 10% concentration reduced SVI significantly compared controls particularly extract of leaves (zero),

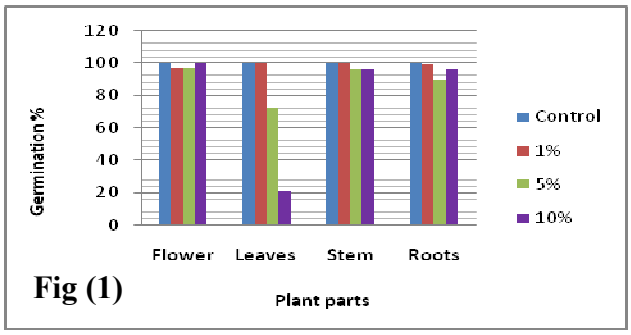


Fig (1)

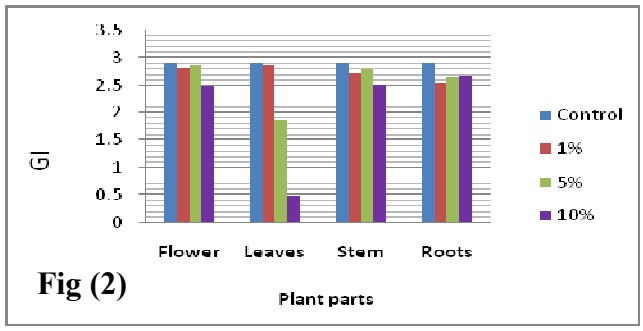


Fig (2)

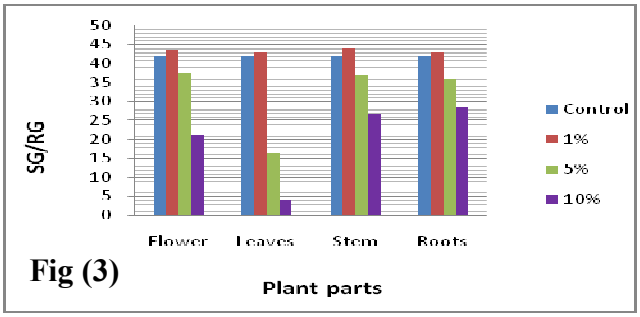


Fig (3)

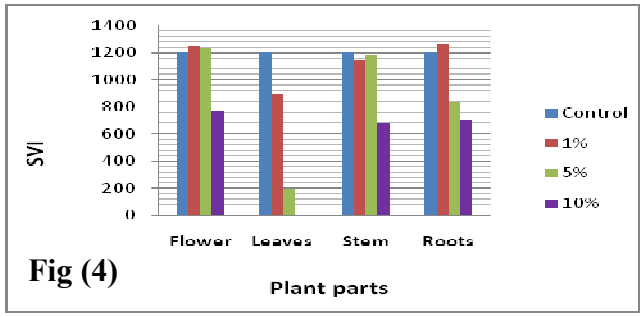


Fig (4)

Allelopathic effect of *Convolvuls arvensis* L . aqueous extracts at different concentrations of different plant (Fig.3),and seedling vigor index(Fig.4) of Radish (*Raphanus sativus* L.) 5 days after planting.

3.1.5. Root Length:

The data on the effect of bindweed allelochemicals on root length (cm) presented in fig.(5). At 1% concentration all plant parts extracts stimulated elongation of radish roots except extraction of leaves which reduced the elongation of roots (19%) compared to control fig. (6). In contrast at 5% concentration all plant parts extracts reduced root length of radish seedling with the highest inhibition caused by extracts of leaves (86%) compared to control except stem extracts which stimulated root elongation (5%) compared to control. At 10% concentration all plant parts extracts reduced root elongation of radish seedlings the highest effect was for leaves extract which inhibited root elongation completely.

3.1.6. Hypocotyle Length:

Results presented in fig. (7 & 8) showed the effect of bindweed aqueous extracts of all plant parts on hypocotyle elongation in radish seedlings. The data revealed that at 1% concentration all extracts of plant parts had no significant effect on hypocotyle elongation except extract of leaves which reduced the length of hypoctyle significantly compared to control (30%) in contrast at 5% concentration the extract of flowers significantly increased hypocotyle length compared to control (17%). While extracts of leaves and roots recorded significantly decrees in hyppcotyle length the highest effect for leaves extract (69 %) compared to control. At 10% concentration the obtained data recorded significant reduction in hypocotyle length for all plant parts extracts, particularly the extract of leaves which completely inhibited the growth of hypocotyle.

3.1.7. Fresh Weight:

Data on the effect of bindweed aqueous extracts on fresh weight of radish seedlings showed that extract of leaves at 1% concentration recorded significant decrease (26%) in fresh weight in comparison with control. At 5% concentration stems extract increased fresh weight of radish seedlings by (12%). On other had leaves extracts at 5% decreased fresh weight significantly (74%). Extracts of all plant parts at 10% concentration however, recorded significant reduction in fresh weight of radish seedlings in particular leaves extract in which no growth recorded.

3.1.8. Dry Weight:

Dry weight of radish seedlings recorded significant increase for all plant parts extracts at all concentrations except leaves extract at 10% concentration recorded complete inhibition of growth compared control. The highest increase recorded for flowers extracts at 10% concentration (44%) followed by stems extracts at 5% concentration (35%). Fig. (11 & 12).

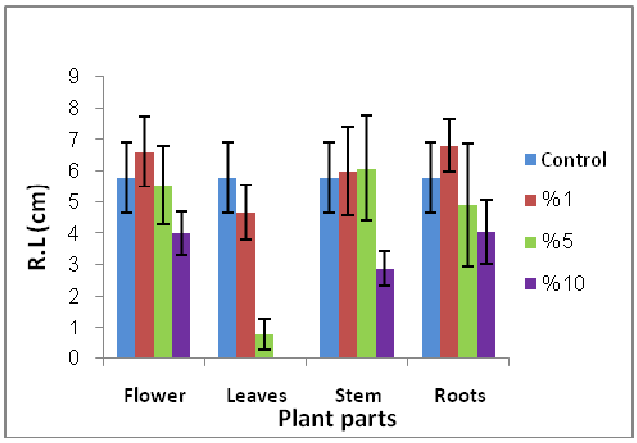


Fig (5)

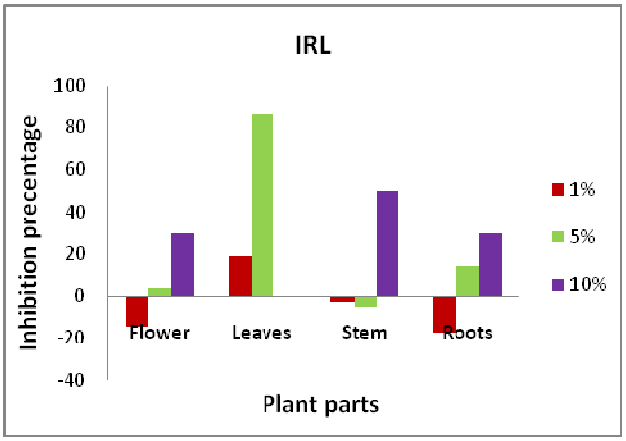


Fig (6)

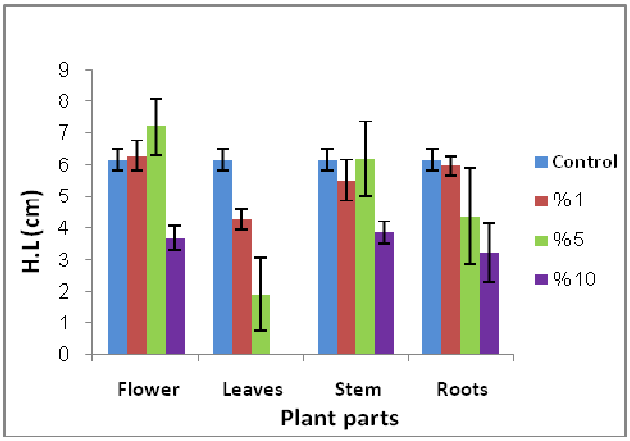


Fig (7)

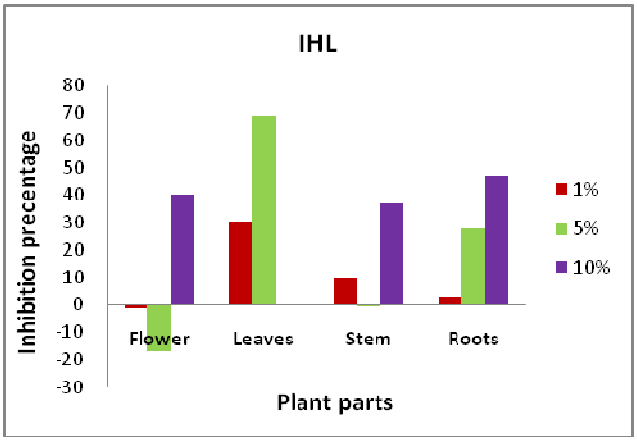


Fig (8)

Allelopathic effect of *Convolvuls arvensis* 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

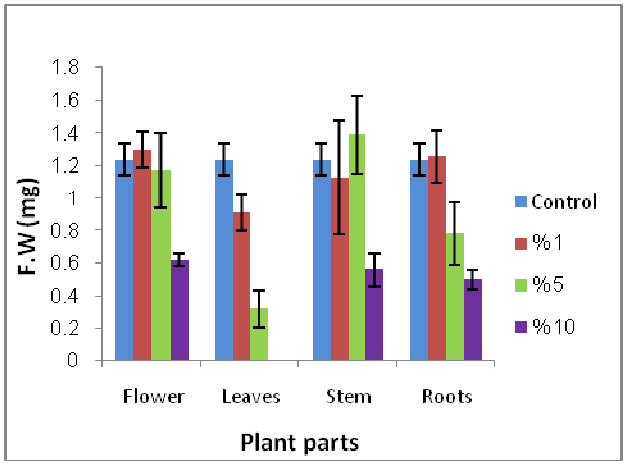
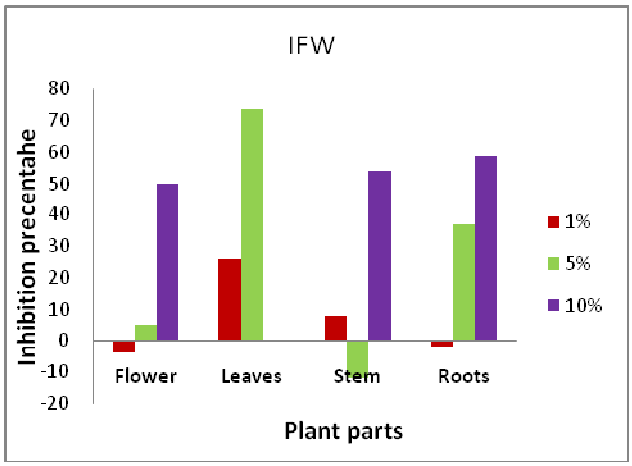


Fig (9)



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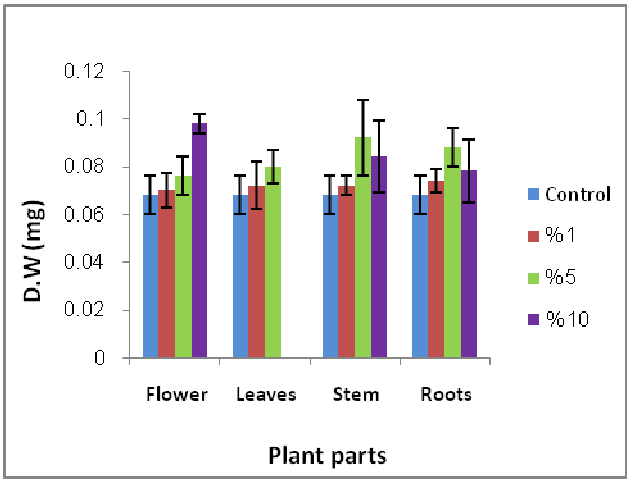


Fig (11)

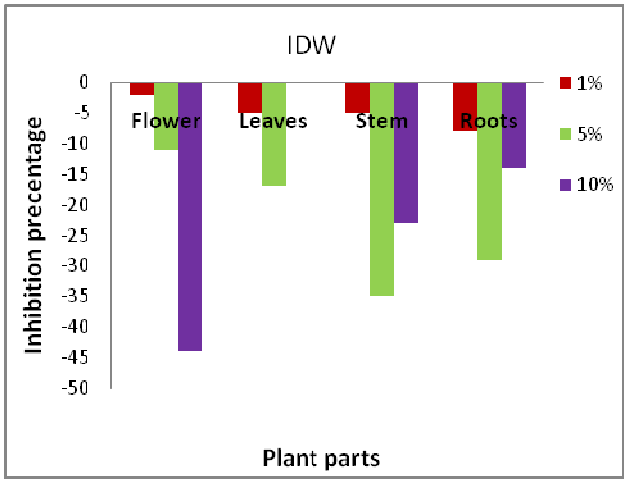
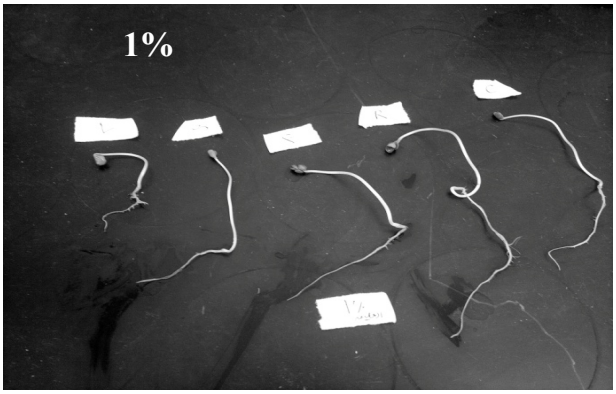
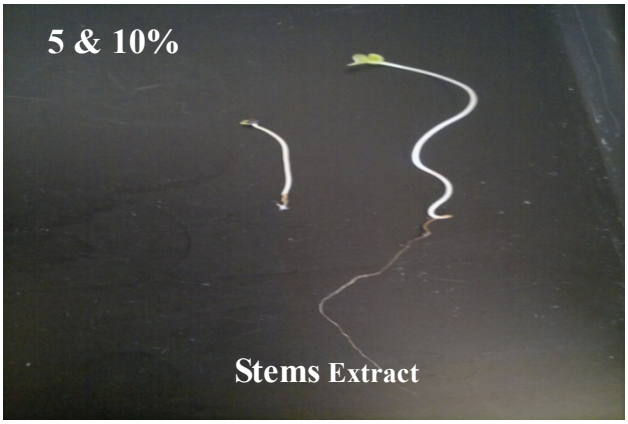
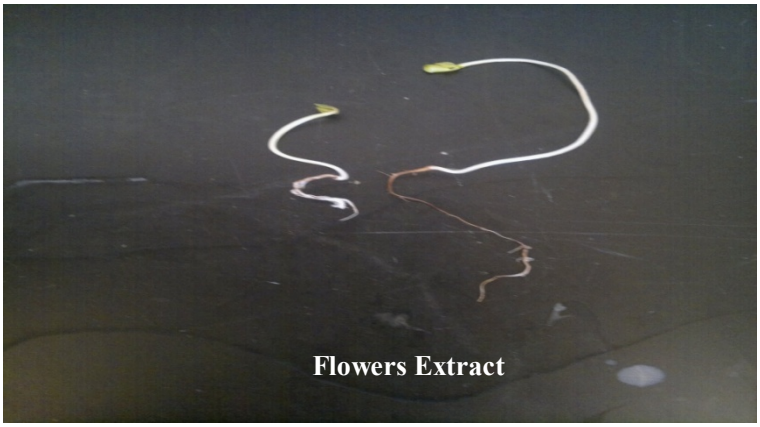


Fig (12)

Allelopathic effect of *Convolvuls arvensis* 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







C- Control F- Flower L- Leaves S- Stems R- Roots

Plate. Allelopathic effect of *Convolvuls arvensis* L. aqueous extracts at different concentrations of different plant parts on of Radish (*Raphanus sativus* L.) 5 days after planting

4. Discussion

Investigations were carried out with an aim to study allelopathic potential of some weed species growing in different crop field in Benghazi Libya on seed germination and seedling development of radish (*Raphanues sativus* L.) as test plant. Investigations were carried out under laboratory conditions. The results obtained were discussed here in this chapter. Allelopathic effects of aqueous extracts of different parts of bindweed (*Convolvuls arvensis* L.) on seed germination and seedling development of radish (*Raphanus sativus* L) has been observed in Petri-dish bioassays. According to 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. Evaluation of allelopathic effect of aqueous extracts of different parts of bindweed seed germination and seedling development of radish as analysis of variance results showed, there were significant effects of interaction of bindweed extracts at different concentrations and plant parts on all mentioned traits. These results similar to that obtained by Shahrokhi *et.al.* (2011) and Fateh *et.al*. (2012).They found that the inhibitory effects on the measured traits increased with the increase of concentration, which is consistence with our findings except at low concentrations of some extracts we found stimulatory effects to some traits. Similar effects observed by Fateh *et.al.* (2012). Ismail and Chong (2002) believe that allelopathic materials in low concentration may be have positive or negative effect on plant growth while; in higher concentrations have only inhibitory (negative) effects. This we observed for the effect of bindweed on seed germination and seedling development of radish.

Conclusions

The present study was conducted to investigate the allelopathic effects of bigweed (*Convolvulus arvnsis* L) growing in Benghazi agricultural fields on seed germination and seedling development of radish (*Raphanus sativus* L.). Flowers, Leaves, Stems and root aqueous extracts of bindweed 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), hypocotyel length (HL), seedlings fresh weight (FW) and seedlings dry weight (DW) of tested plant 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 of some weeds 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 pherolics, alkaloids, long-chain fatty acids, terpenoids, and flavanoids (Rice, 1984 and chou, 1995). The compounds exhibit a wide range of mechanisms of an action, effect. On DNA (alkaloids), phytosynthic and mitochondrial function (quinines), phytohormone activity ion uptake and water balance.

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تقيم النشاطات الكيمائية المثبطة لنبات العليق (*Convolvuls arvensis*)

الخلاصة

في الفترة من 2012-2013 تم إجراء عملية مسح لنبات العليق (*Convolvuls arvensis* L.) النامي في الحقول الزراعية بمدينة بنغازي وذلك بهدف معرفة النشاط المثبط لها. تم إجراء التجارب معملياً لدراسة تأثير المستخلصات المائية لأجزاء هذا النبات على أنبات بذور وتطور بادرات نبات الفجل (*Raphanus sativus* L) بقسم النبات- كلية العلوم- جامعة بنغازي. حيث تم قياس نسبة أنبات البذور، دليل الإنبات، معدل وسرعة الإنبات، دليل قوة البادرة، طول الجذر، طول السويقه، الوزن الرطب والجاف للبادرات ونسبة التثبيط للنمو. حيث أظهرت النتائج أن جميع المستخلصات المتحصل عليها من الكتلة الحية الجافة للأزهار، الأوراق، السيقان و الجذور عند التراكيز (1، 5، 10%) تحتوي على مواد مثبطة أو محفزة للنمو. هذه المواد موجودة في كل أجزاء النبات (الأزهار، الأوراق، السيقان والجذور). تباينت تأثيرات المستخلصات المتحصل عليها من أجزاء النبات المختلفة طبقاً للتركيز المستخدم حيث كانت لها تأثيرات مثبطة في التركيزات المرتفعة وتأثيرات محفزة أو ليس لها تأثير عند التركيزات المنخفضة. كما بينت النتائج أيضاً أن جميع المستخلصات لأجزاء النبات المختلفة والمختبرة عند تركيز 1% ليس لها تأثيرات معنوية على نسبة الإنبات (G%)، دليل الإنبات (GI)، طول السويقة (HL) والوزن الرطب (FW). في حين أن سرعة ومعدل الإنبات (SG/RG) دليل قوة البادرة (SVI)، طول الجذر (RL) والوزن الجاف (DW) في معظم المستخلصات سجلت تأثيرات محفزة مقارنة بالشاهد. من ناحية أخرى عند تركيز 5% فأن كل الأجزاء المختبرة لنبات العليق لم يكن لها تأثيرات معنوية على نسبة الإنبات و دليل الإنبات. في حين أن سرعة ومعدل الإنبات، دليل قوة البادرة، طول الجذر، طول السويقة والوزن الطري قد انخفضت معنوياً بواسطة معظم المستخلصات. وفي كل الأحوال فإن أعلى تأثيرات سجلت لجميع المستخلصات المتحصل عليها من مختلف أجزاء النبات التي تم اختبارها عند 10%، حيث أن معظم الصفات عند هذا التركيز انخفضت معنوياً لجميع أجزاء النبات. فكانت نسبة إنبات البذور (12%) لمستخلص الأوراق مقارنة بالشاهد (100%) فيما يخص دليل الإنبات فإن أعلى تأثير تم تسجيله لمستخلص الأوراق (0.48) مقارنة بالشاهد (2.92). كذلك مستخلص الأوراق لنبات العليق فقد خفض معنوياً معدل وسرعة الإنبات إلى أعلى مستوى (3.8) مقارنة بالشاهد (41.9) وأعلى تثبيط لدليل قوة البادرة، طول الجذر، طول الساق والوزن الرطب كان لمستخلص الأوراق (100%) حيث لم يسجل أي نمو لبادرات نبات الفجل. أخيراً فأن النتائج المتحصل عليها والمسجلة في هذا البحث تبين أن نبات العليق الذي تم اختباره يمكن أن يسبب في خسائر كبيرة في أنتاج المحاصيل من خلال إفرازه لمركبات كيميائية مثبطة للنمو والتي يمكن أن تثبط إنبات البذور وتطور البادرات.