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RESEARCH PAPER

Allelopathic potential of radish (*Raphanus sativus L.*) on germination and seedling growth of some plants species.

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A B S T R A C T:

The purpose of this study was to determine the allelopathic activity of shoot and root aqueous extracts of radish (*Raphanus sativus L.*) on germination and seedling growth of bread wheat (*Triticum aesitivum* L.), barley (*Hordeum vulgare*), wild barley (*Hordeum spontaneum* L.), and wild oat (*Avena fatua* L.). The concentration was used in this study were (0%, 15%, 30%, 45%, and 60%). The experiment was conducted in a sterilized Petri dish for 10 days at 22 °C, with the experimental units arranged in a randomized complete design. In general, the study's findings revealed the significant effects of concentration levels (15%, 30%, 45%, 60% compared to control treatments. The concentration 40% and 60% were completely inhibiting the seedling germination and growth while the lowest concentration 15% had the least negative effect on seedling growth and germination. Aqueous extract of shoot radish was more effective on seed germination than root of radish. So, all results recommended that the aqueous extract of shoot and root of radish may act as a bioherbicide to inhibit germination and seedling growth.

KEY WORDS: Allelopathy, Raphanus sativus L, Inhibition, Bioassay.
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1. INTRODUCTION:

The direct impact of an organic component emitted from one plant on the growth and development of other plants is known as allelopathy (Ranagalage and Wathugala, 2016). Allelopathy is any direct or indirect negative or positive impact of one plant or microbe on other plants as a result of the release of chemicals known as allelochemicals into the environment (Dayan and Duke, 2009, Rice, 1984).
Allelopathy is "any process involving secondary metabolites generated by plants, algae, bacteria and fungus that affects growth and development of agricultural and biological systems," according to the International Allelopathy Society (IAS, 1996). Allelopathic effects are associated with several secondary plant products. In natural plant processes like germination and early development, several secondary plant metabolites, such as phenolics and alkaloids, are crucial phytochemical component (Dayan and Duke, 2009, Bogatek et al., 2006, Inderjit, 1996).

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Allelopathic substances are second-generation plant products that are discharged into the environment by root exudation, volatilization, leaching, and soil-borne plant residue decomposition (Rice, 1984, Reigosa and Souto, 1999). These metabolites, including phenolics, flavonoids, alkaloids, terpenoids, and cyanogenic glycosides, have frequently drawn scientists' attention to shed light on their biological function and structure (Cutler and Cutler, 1999, Rice, 1995). There are up to 290 weed species which are resistance to chemical herbicides(Heap, 2005, Mennan et al., 2012).
Due to the presence of secondary metabolite chemicals like isothiocyanates and p-hydroxybenzoic acid, radish *(Raphanus sativus L.),* a member of the Brassicasea family, has a considerable impact on many plant species (Lawley et al., 2012, Petersen et al., 2001, Uremis et al., 2009). Different aspects of the allelopathic effect of Brassicaceae crops on weeds have been studied (Norsworthy, 2003) It was noted that some crops and weed plants were sensitive to

radish plant extracts, as some crops and weed plants showed germination sensitivity to wild radish (Raphanus raphanistrum L.) extract at varing egrees and some weeds' radicle development was hindered (Kadioglu and Yanar, 2004) The objective of this study was to assess the allelopathic capability of radish shoot and root aqueous extracts on germination and seedling growth of two crop and two weed species.

2: Materials and Methods:

This study was conducted in a laboratory to estimate the allelopathic potential of radish (Raphanus sativus L.). This bioassay aimed to distinguish the allelopathic potential of root and shoot of radish (Raphanus sativus L.) on germination and some growth parameters of bread wheat (Triticum aesitivum L.), barely (Hordeum vulgare), wild barley (Hordeum spontaneum L.), and oat (Avena fatua L.).

2.1 Seed source: the seed of four different plants such as bread wheat *(Triticum aesitivum* L.), barley *(Hordeum vulgare),* wild barley *(Hordeum spontaneum* L.*),* and oat *(Avena fatua* L.*)* were received from Erbil Agricultural Research Center.

2.2. Sample Collection and Preparation of Aqueous Extract:

Black radish was collected from Soran City and shoot separate from the root of radish then washing of root radish to a make aqueous solution of each them, cutting each part of radish to put in a blender without any adding amount of water made pure aqueous solution of shoot and root of radish then used Watman filter paper No.1. Finally, the extracts were put in the bottle and frizzed in 20^{o}C until required to bioassay and spray experiment in November of 2021 at the research laboratory of Soran University.

2.3.1 Bioassay:

Is the test that starts With prepare four different concentrations (0 %,15%, 30%, 45% and 60%) for shoot and root of radish that using aqueous extract and reaches distilled water to the desired concentration, also distilled water is considered as treatment control. In bioassay test thatis using four different plant seeds (wheat, barley, wild barley and oat) so before using, it must be sterilized with 10% commercial hypochlorite bleach solution (sodium hypochlorite) for 5 min followed by rinsing five times in distilled water to prevent contamination with the pathogen. After sterilizing twenty seeds putwere put in the 9 cm of petridish then added 10 ml of concentrations that were prepared and then sealed with para-film tape and placed in incubator at 22-25^{o}C. take the results after 3days, 6 days, 9 days, of germination and growth after ten days take germination percentage, root and shoot length of 5 seeds in each Petridishs. Finally, dry weight of seedling root and shoot were noted after drying sample in 70^{o}C in oven for 72 hours. Factorial (CRD) completely randomized design were used with three replications, The data were compared at the level $p<0.01$ by Duncan test using SPSS Program.

2.3.2. Recorded Data

1. Germination percentage (G %): it was measured based on the following equation as followed by (Oliveira et al., 2013).

Germination percentage = germinated seeds /total tested seeds×100 …………...3.1

2. Inhibition of germination percentage (I.O.G. %): these data were calculated by (Ali and Aziz, 2002) as follow.

I.O.G.% = (G.P.C.−G.P. T G.P.C.) ×100 ……………3.3

Where G.P.C. = germination percentage of control, G.P.T. = germination percentage of treatment.

3. Plumule length (cm) (P.L.): measured the lengthier and nearest plumule in a millimetre of the germinated seed for each petri-dish.

4. Radicle length (cm) (R.L.): was measured the lengthier and nearest radicle in a millimetre of the germinated seed for each petri-dish.

5. Plumule elongation velocity (cm/day) (P.E.V.): It was calculated by dividing plumule length by the duration of in days (Ali, 2016).

Plumule elongation vilocity (cm / day) = plumule length/ Total days ……...3.4

6. Radicle elongation velocity (cm/day) (R.E.V.): It was calculated by dividing radicle length by the duration of in days (Ali, 2016).

Radicle elongation velocity (cm / day) = radicle length / total days…….3.5

7. Plumule and radicle dry weight (mg) (P.D.W. and R.D.W.): were recorded by placing the samples in an electronic oven at 40°C for 72 hours or until weight consistency to get and record the plant part's dry weight, and then weighed by sensitive electronic balance (Denver Instrument) (Jiang and Lafitte, 2007).

2.4. Statistical analysis:

in advance of statistical analysis all data were examined for normality and homogeneity before statistical analysis of variance (ANOVA) using SPSS version 20 at the 1% significance level and the Duncan test for mean separation (Koley et al., 2016).

3. Results

3.1. The effects of shoot and root extracts of radish on germination and seedling growth of studied plant species

All studied parameters were affected by the shoot and root of radish aqueous extracts, (Figure 1) In wheat plants, shows the difference between shoot and root extract of radish through parameters. The highest data were recorded for germination percentage (49.06%) in root extract while the lowest in shoot extract (26.13%), inhibition of germination were the value of the height noted (68.91%) in shoot extract, while the lowest value noted (45.03%) in root extract. In plumule length the highest value was recorded (4.77cm) in shoot extract, while the lowest in root extract. In radical length the highest value was noted (4.32cm) in root extract, however the lowest value in shoot extract. The highest data were recorded for plumule elongation velocity (0.47cm/day) in shoot extract while the lowest in root extract. Radical elongation velocity was the highest value noted (0.43cm/day) in root extract while the lowest in shoot extract. The highest value for plumule dry weight recorded (0.16mg) in root extract, while the lowest in shoot extract. Radical dry weight the highest value recorded (0.08mg) in root extract while the lowest in shoot extract.

In wild barley, (figure.2.) root and shoot extract of radish, the highest values were recorded for root extract (7.59cm, 5.78cm, 70.12%) for plumule length, radical length, and inhibition of germination respectively, while the lowest value was recorded for shoot extract. In Germination percentage, the highest value was recorded (31.47%) for shoot extract, while the lowest was recorded for root extract. In radical dry weight, plumule dry weight, plumule elongation velocity and radical elongation velocity was recorded the highest values for root extract (0.33mg, 0.37mg, 0.76cm/day, 0.58cm/day) respectively. While the lowest was recorded for shoot extract.

In barely, (figure.3) in shoot and root extract of radish, the highest values were recorded in root extract (26.13%, 3.89cm) of germination percentage and radical length respectively. While, the lowest value was recorded in the shoot extract. Plumule length and inhibition of germination percentage were recorded as the highest values in shoot extract (74.07 cm, 6.24%) respectively although the lowest value was recorded in root extract. The highest values were recorded in root extract (0.08mg, 0.16mg and 0.43cm/day) of radical dry weight, plumule dry weight, and radical elongation velocity correspondingly, although the lowest value was recorded in shoot extract. Plumule elongation velocity the highest value was recorded in the shoot extract(0.47cm/day), however the lowest value was recorded in the root extract.

In oat, (figure.4) based on the results in root and shoot extract of radish, for the germination percentage the highest value was recorded (38.93%) in shoot extract while the lowest value was noted (31.20%) in root extract. Other parameters such as plumule length, radical length, and inhibition of germination the highest values were recorded (8.66cm, 5.26cm, and 67.93%) respectively in root extract, although the lowest value was noted in shoot extract. In plumule elongation velocity and radical elongation velocity, the highest values were recorded (0.87cm/day, 0.53cm/day) respectively for root extract, though the lowest value was noted in shoot extract. Radical dry weight was no difference between value (0.01mg) of shoot and root extract. Plumule dry weight was the highest value which was recorded (0.03mg) in shoot extract, although the lowest value was recorded (0.02mg) in root extract.

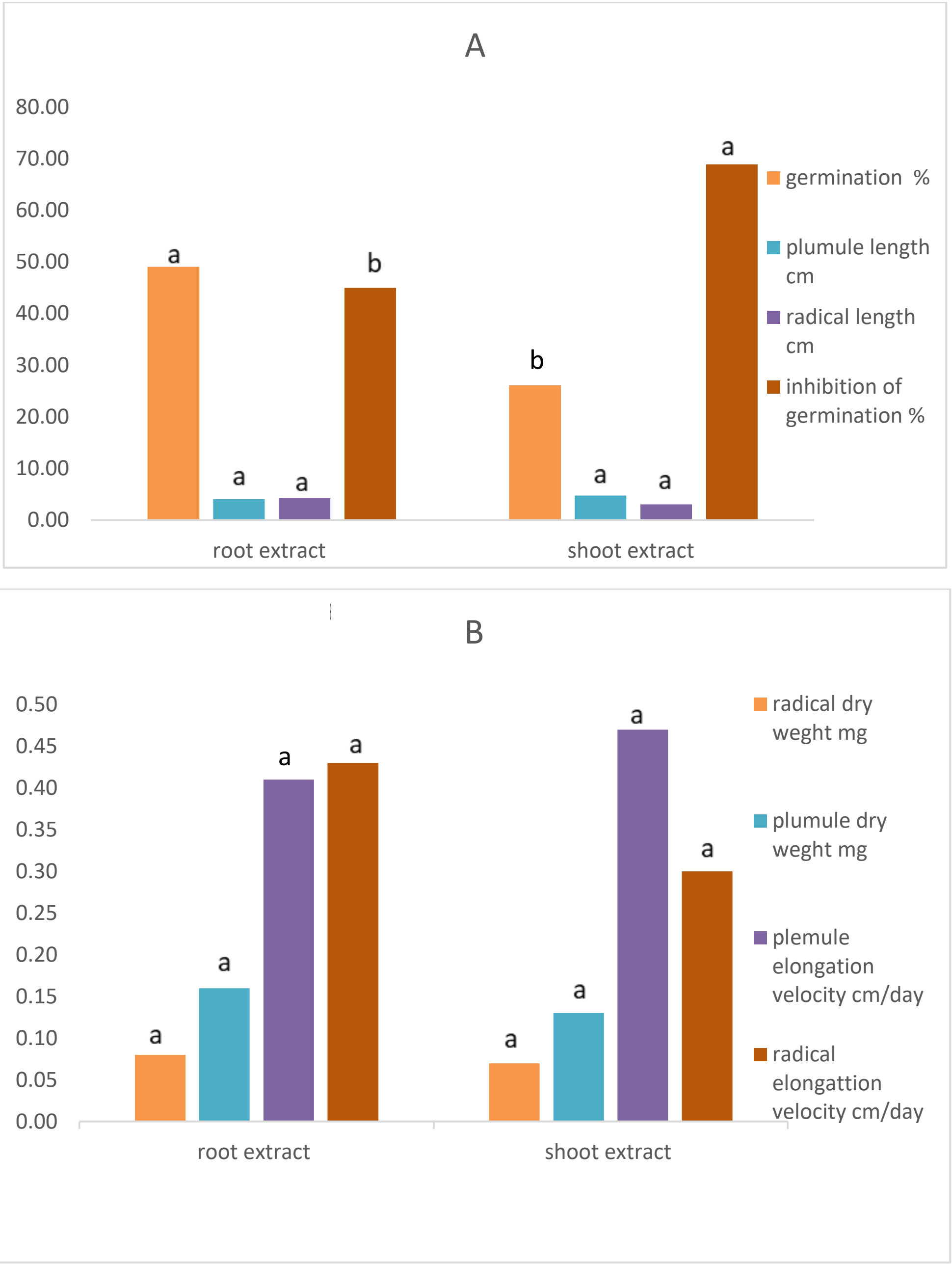


Figure.1(A, B). The effects of shoot and root extracts of radish on germination and seedling growth of studied plant species. Common letter means there are no significant different at probability level (1%) by Dunkan test.

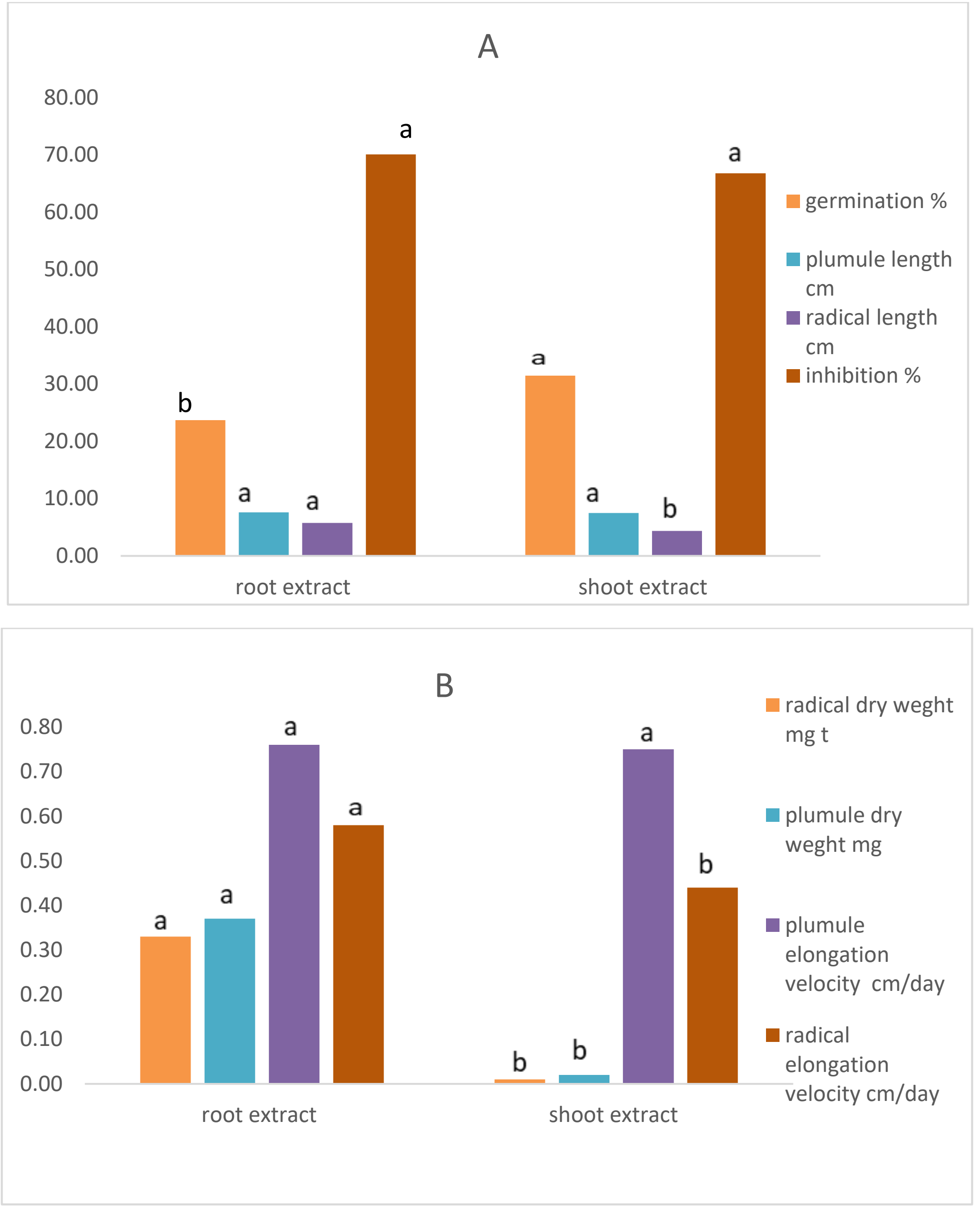
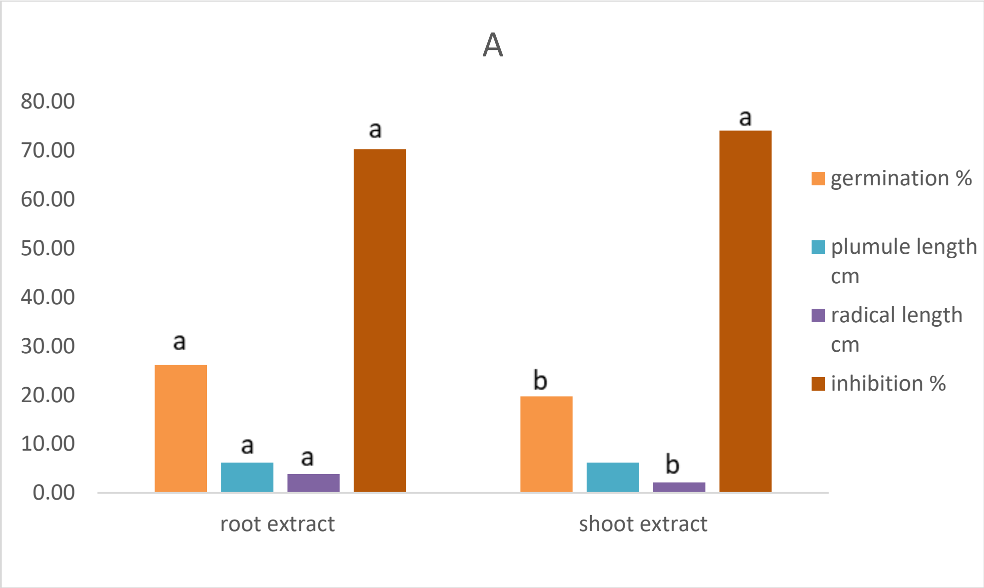


Figure.2(A, B). The effects of shoot and root extracts of radish on germination and seedling growth of studied plant species. Common letter means there are no significant different at probability level (1%) by Dunkan test.



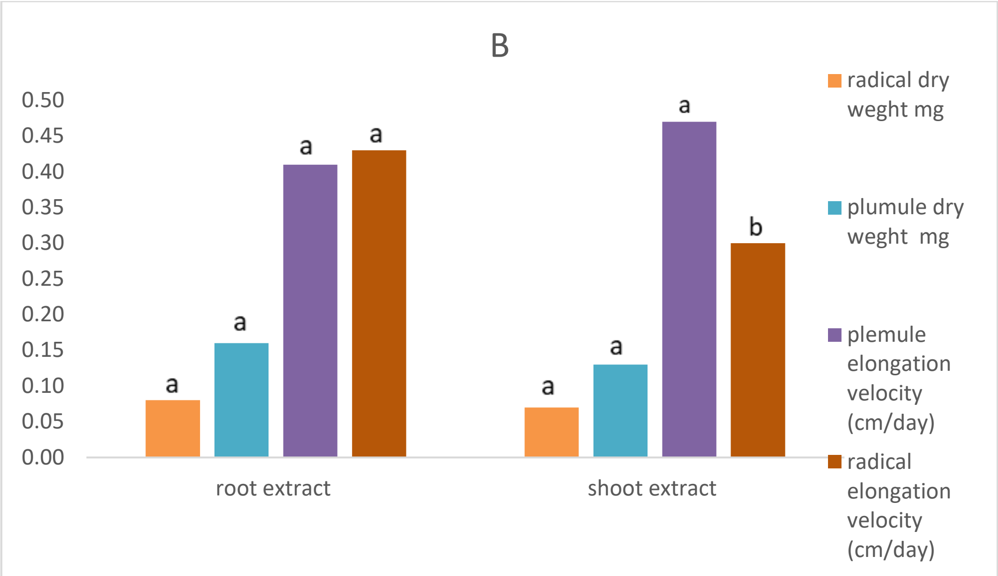
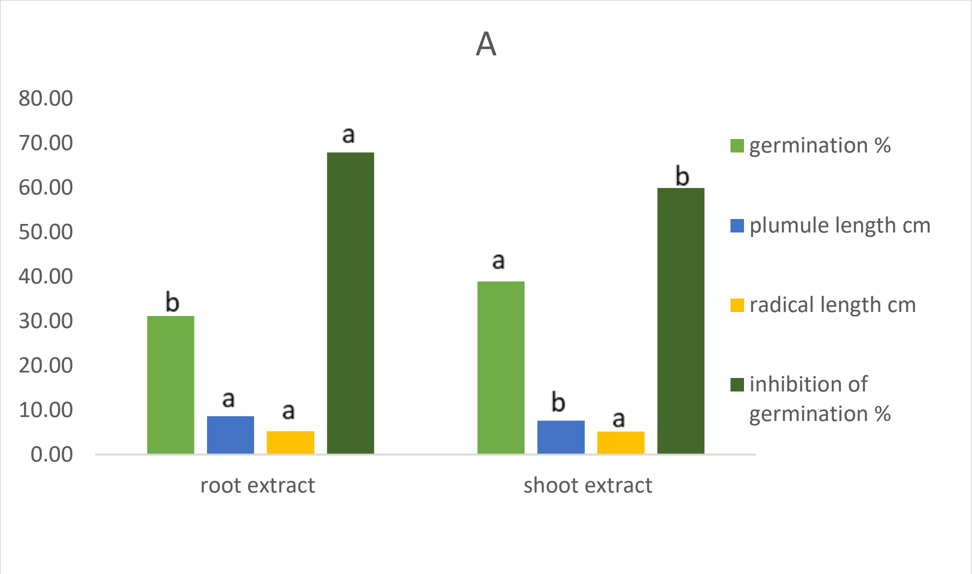


Figure.3(A, B). The effects of shoot and root extracts of radish on germination and seedling growth of studied plant species. Common letter means there are no significant different at probability level (1%) by Dunkan test.



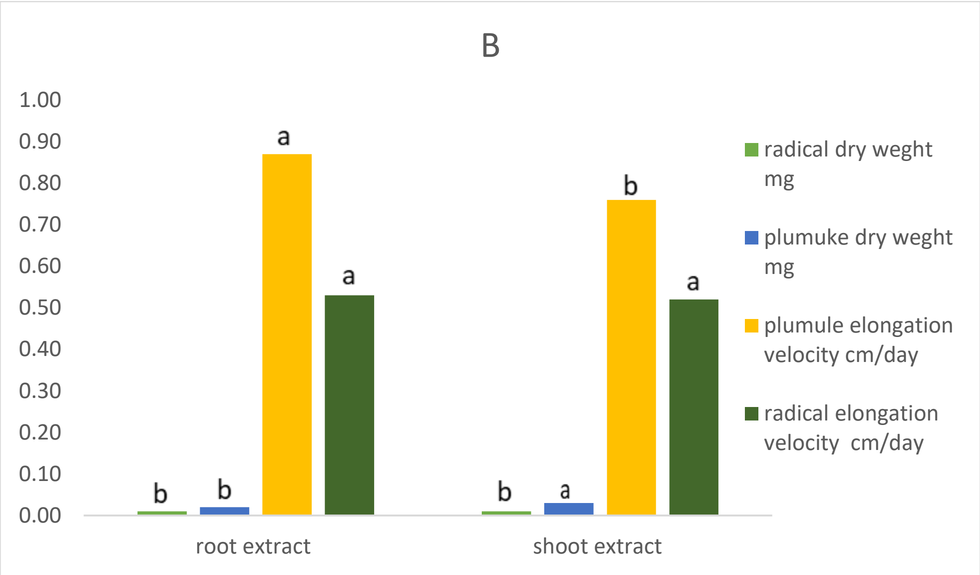


Figure.4 (A, B). The effects of shoot and root extracts of radish on germination and seedling growth of studied plant species. Common letter means there are no significant different at probability level (1%) by Dunkan test.

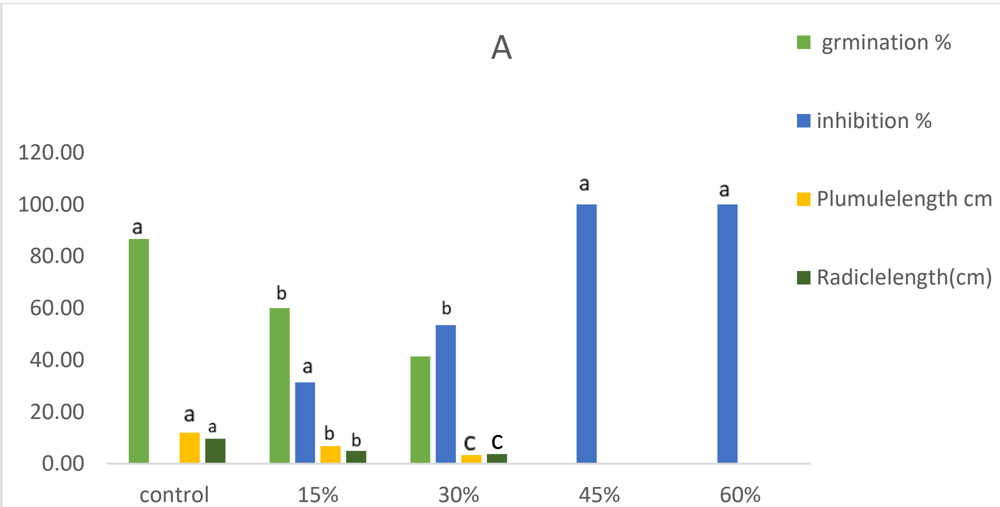
3.2. The effects of different concentrations of radish shoot and root aqueous extract on germination and growth of some studied plant species.

(Figure.5) shows that all plant species are significantly affected by different concentrations of radish extracts. Wheat species indicated the highest germination percentage (86.66%) in wheat species at control treatment while the lowest was noted (0.00%) for 45% and 60% concentrations. The inhibition percentage was noted (100%) highest value for 40 and 60% concentration, while the lowest values were noted (0.00%) for control. Plumule length and radical length had the highest value noted (12.06cm, 9.70cm) for control respectively. while the lowest values noted (3.32%,3.79%) respectively for 30% concentration. The highest value was recorded for plumule dry weight (0.37mg), radical dry weight (0.17mg), plumule elongation velocity (1.21cm/day) and radical elongation velocity (0.97cm/day) for control, while the lowest value recorded (0.00mg) (0.00mg/day) respectively for (45%, 60%) concentration.

In wild barely (Figure.6) the highest value of germination percentage noted (87.33%) for control, while the lowest value noted (0.00%) for (45% and 60%) concentrations. The highest value of inhibition percentage was recorded (100.00%) for (60%) concentration, while the lowest values were recorded (0.00%, 0.00cm,0.00cm) for germination percentage, plumule length, radical length respectively. Plumule length recorded (16.15cm) the highest value for (15%) concentration, while the lowest value recorded (0.00cm) for (45%, 60%) concentration. the highest value of radical length weres noted (12.36cm) for control, while the lowest value recorded (0.00cm) for (45%, 60%) concentration. Radical dry weight, plumule dry weight, radical elongation velocity was the highest value recorded (0.39cm, 0.42cm, 1.24cm/day) respectively for control, while the lowest value was noted (0.00cm, 0.00cm, 0.00cm/day) for (45%,60%) concentration. The highest value for plumule elongation velocity was recorded (1.62cm/day) for (15%) concentration, also the lowest value noted (0.00cm/day) for (45%, 60%) concentration

In barely (Figure 7) the highest value for germination percentage was recorded (82.00%) for control, while the lowest value was recorded (0.00%) for 45% and 60% concentration. Moreover the findings of germination percentage indicated the highest inhibition value was recorded (100.00%) for 45%, and 60% concentrations, however, the lowest value was recorded (0.00%) for control. The highest values of plumule length and radical length were recorded (13.42cm, 9.94cm) for control, while the lowest value noted (0.00cm) for 45%, 60% concentration. Radical dry weight, plumule dry weight, plumule elongation velocity and radical elongation velocity the highest values was recorded (0.11mg, 0.22mg, 1.34cm/day and 0.99 cm/day) respectively for control, although the lowest value was recorded (0.00mg, 0.00cm/day) for 45% and 60% concentration.

In oat species (Figure8) the highest value for germination percentage, was noted (97.33%) for control, through the lowest value (0.00%) for 45% and 60% concentrations. In inhibition of germination percentage showed the highest value was noted (100.00%) for 45%, and 60% concentrations, although the lowest value was noted (0.00%) for control. Plumule length indicates highest value which was recorded (14.31cm) for 15% the lowest value (0.00 cm) for 45% and 60% concentrations. The biggest value for radical length the highest value was recorded (10.55cm) for control, while the lowest value were noted (0.00cm) for 45% and60% concentrations. The highest values were noted (0.02mg, 0.04mg, 1.43cm/day and 1.06cm/day for control of radical dry weight, plumule dry weight, plumule elongation velocity and radical elongation velocity correspondingly, through the lowest values was noted (0.00cm, 0.00cm/day) for 45%, 60% concentration.



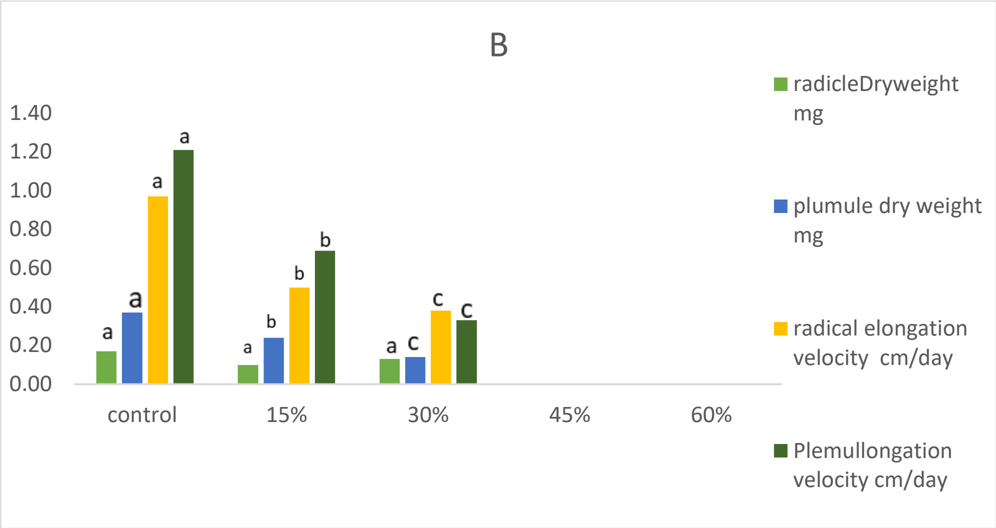
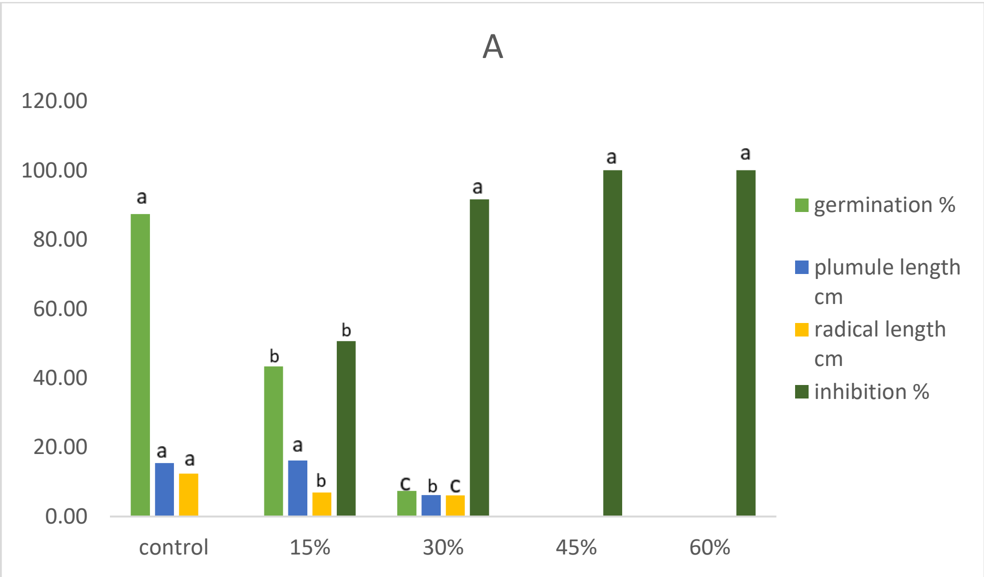


Figure.5. (A.B) The effects of concentrations on germination and growth of studied plant species Common letter means there are no significant different at probability level (1%) by Dunkan test**.**



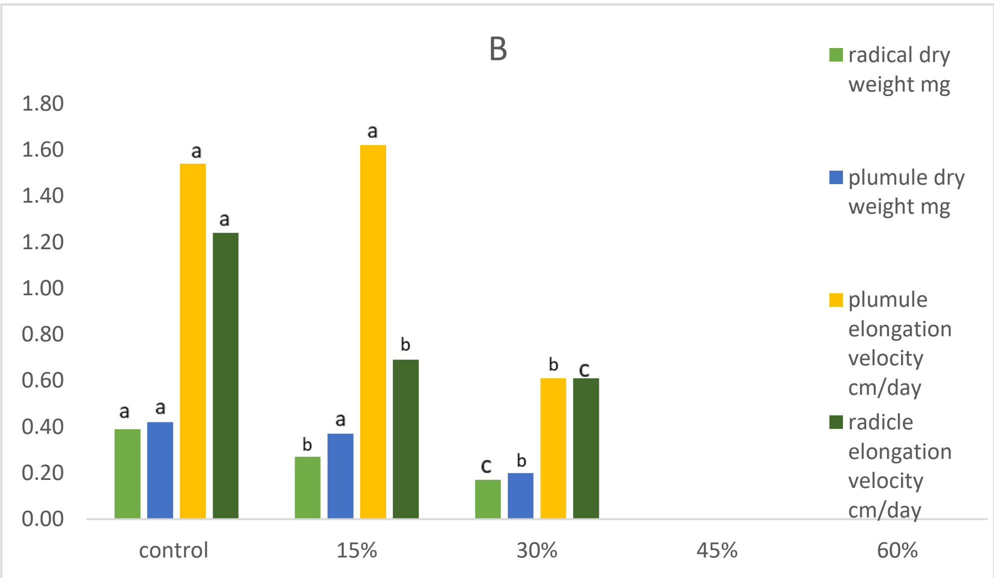
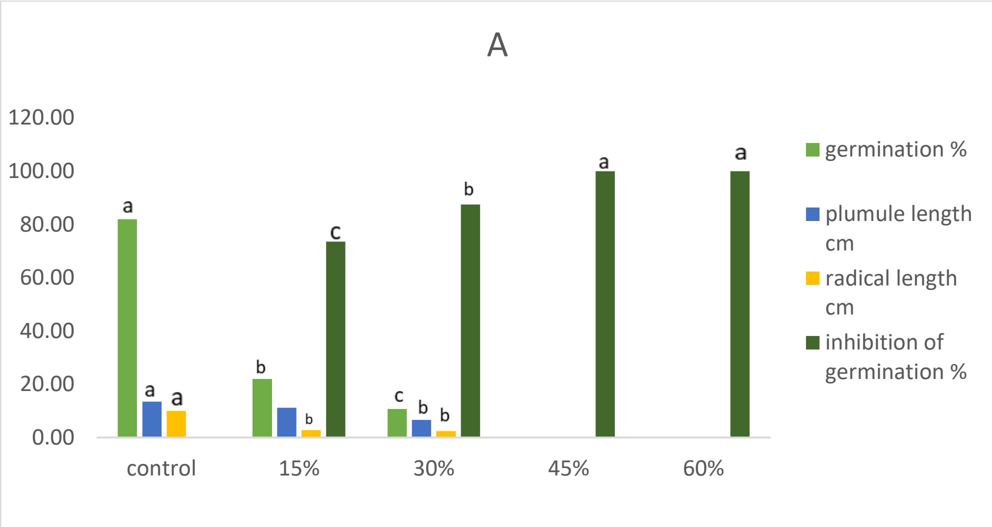


Figure.6. (A.B) The effects of concentrations on germination and growth of studied plant species Common letter means there are no significant different at probability level (1%) by Dunkan test



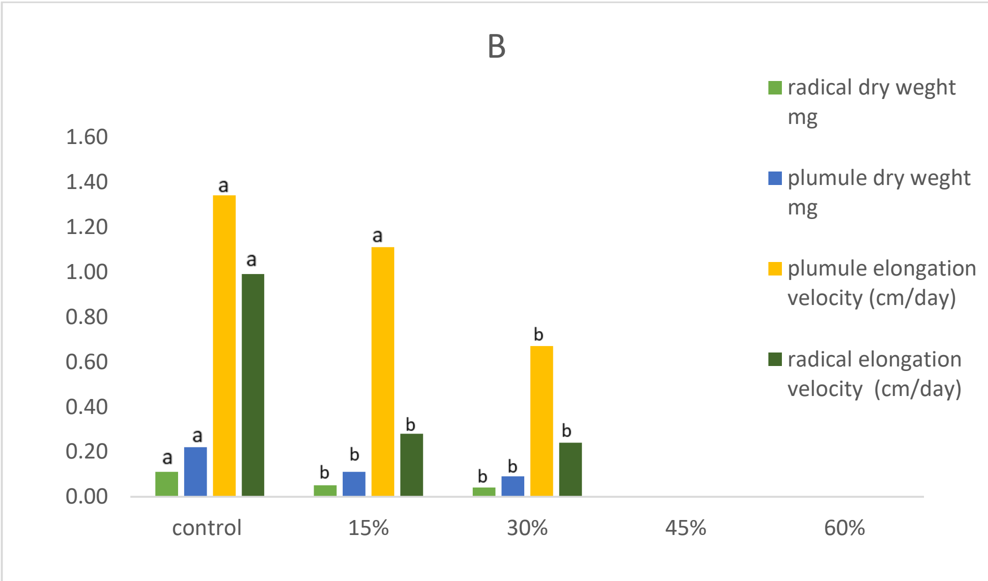
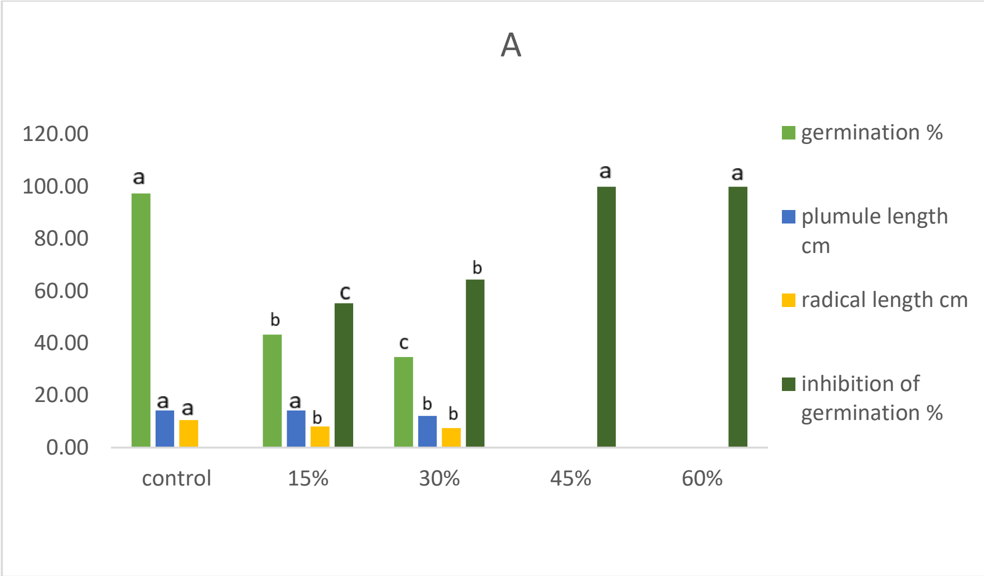


Figure.7. (A.B) The effects of concentrations on germination and growth of studied plant species Common letter means there are no significant different at probability level (1%) by Dunkan test



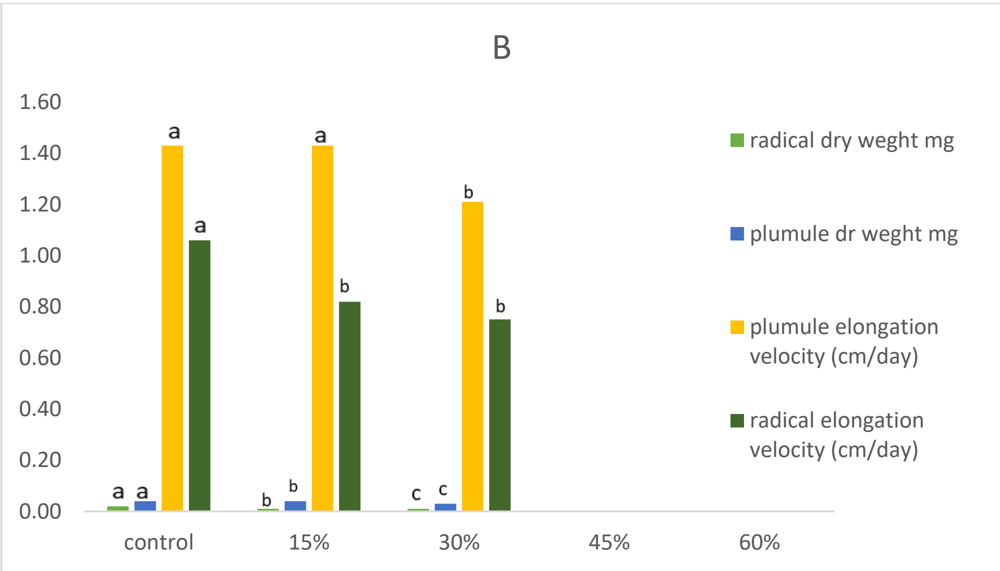


Figure.8. (A.B) The effects of concentrations on germination and growth of studied plant species Common letter means there are no significant different at probability level (1%) by Dunkan test.

4. Discussions:

The outcomes of this study's examination of how the radish root and shoot's allelopathic potential influenced various plant parts similar to those (Ali, 2016) noted that due to differences in genetic features, various plant species have varying degrees of susceptibility to allelopathic potential. Although crop and weed plants included in this study showed varying degrees of sensitivity toward allelochemicals of radish plants, it is well known that plant species vary in reacting to allelochemicals owing to genetic diversity(Wu et al., 2002, Uremis et al., 2009). All plant species at a concentration of 45% were completely inhibited from germination as a result of the presence of allelochemicals in the root and shoot of radish, and these results are consistent with those (de Moraes Gomes et al., 2017) who discovered the radish *Raphanus sativus L.* These allelochemical substances may be incharge of the observed effects. This study clearly shows that radish aqueous extracts at high concentrations completely inhibited seedling germination and development, which is findings are in (Rasul and Ali, 2020) showed radish root aqueous extraction adversely influenced the germination of bean and maize seeds; as concentrations increased, the germination rate rapidly decreased. Root radish aqueous extracts had an adverse effect on all plant species, however bread wheat was more resistant its accordance to (Tawaha and Turk, 2003), who discovered that the allelopathic potential of black mustard damaged wild barley seed germination and seedling growth, although is as according to the results, increasing quantities of aqueous extracts, particularly those from black radish, dramatically reduced seed germination and growth indices. These observations are in agreement with what have been reported by (Norsworthy, 2003) Radish extracts decreased the germination and shoot fresh weight of the bioassay plants sicklepod and prickly sida, with the degree of suppression depending on the concentration levels. In this work, aqueous extract of radish root adversely influenced germination and other seedling development parameters. in accordance to the results of (Kiemnec and McInnis, 2002) which have been mentioned that tawny cress when compared to distillated water, Cardaria draba water extract lowered the germination of wheat, alfalfa, blue bunch wheatgrass, crested wheatgrass, and hoary cress. The presence of phytotoxic chemicals may also limit other seedling growth and germination percentage. The majority of plants that are susceptible to allelochemicals included in the Brassica family cause germination inhibition at high concentrations The outcomes are entirely consistent to (Biswas et al., 2014) showed Brassica biomass was shown to have an allelopathic impact to reduce some plant species in wheat fields. Rapeseed's ability to limit weed growth in sweet potatoes was also documented.

5. Conclusion:

The findings of this study confirm that, in comparison to synthetic chemicals that are harmful to the environment, the root and shoot of radish plant contain effective chemical compounds that can be extracted, purified, and used to control harmful weeds and crops as well as reduce environmental pollution. Due to its eco-friendly bio herbicidal phenomenon, aqueous extract of radish root and shoot at a concentration of 45% can act as herbicidal phenomenon that made inhibition of germination of 100% of the studied plant species. This is a new method for controlling weeds compared to synthetic chemical herbicides.

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