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Research Article

Allelopathy effects of essential oils from Juniperus phoenicea L and Artemisia herba-alba on several weedy species

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Abstract

Utilizing allelopathy as a bio rational management tool for natural resources in agroecosytems is a promising approach.the aim of this study was to investigate natural alternatives to chemical pesticides for weed control in agriculture by exploring the allelopathic effects of volatile essential oils (EOs) extracted from selected plant species native to Algeria .
Specifically;we evaluated the allelopathic potential of EOs from Artemisia herba-alba and Juniperus phoenicea L;on the germination and seedling growth of five weed species, including Daucus carota, Ampelodesmos mauritanica, Cynodon dactylon, Poa annua, and Avena fatua. Essential oils were extracted from the aerial parts of the two plants using hydro distillation. The results showed that the essential oils from A.herba-alba were highly effective in inhibiting seed germination of D. carota,P. annua and A.fatua,while the J.phoenicea essential oils suppressed seedling growth in all of the targeted weeds.In particular,a higher concentration of 50 µL/l of the essential oils completely inhibited germination and seedling growth in C. dactylon and A. fatua, and in P. annua at a concentration of 50µL/l. Furthermore, the essential oils from J. phoenicea at a concentration of 500µL/l inhibited seed germination of A. mauritanica, while the essential oils from A. herba-alba at concentrations ranging from 50 to 250µL/l achieved the same effect.The finding suggest that a combination of the essential oils from the two plants species or using Nano emulsion technology ;could be a promising bio-herbicide.

Keywords: Weeds;Essential Oils; Allelopathic potential; Seed germination; *herbicides;*Artemisia herba-alba; Juniperus phoenica L.

Juniperus Phoenicea L ve Artemisia Herba-Alba'nın Esansiyel Yağlarının Bazı Yabani Türler Üzerindeki Alelopatik Etkileri

Öz

Agroekosistemlerde doğal kaynakların biyo-rasyonel yönetimi için alelopatiyi kullanmak umut verici bir yaklaşımdır. Bu çalışmanın amacı, Cezayir'e özgü seçilmiş bitki türlerinden elde edilen uçucu esansiyel yağların (EO'lar) alelopatik etkilerini araştırarak tarımda kimyasal ilaçların yerine doğal alternatifler bulmak için yabani otların kontrolü için doğal yöntemleri incelemektir.
Özellikle; Artemisia herba-alba ve Juniperus phoenicea L'den alınan EO'ların, Daucus carota, Ampelodesmos mauritanica, Cynodon dactylon, Poa annua ve Avena fatua gibi beş yabani türün çimlenme ve tohum çimlenmesi üzerindeki alelopatik potansiyelini değerlendirdik. İki bitkinin havadaki kısımlarından hidro distilasyon kullanarak esansiyel yağlar çıkarıldı. Sonuçlar, A.herba-alba'dan elde edilen esansiyel yağların D. carota, P. annua ve A.fatua'nın tohum çimlenmesini engellemede çok etkili olduğunu, J.phoenicea esansiyel yağlarının ise hedeflenen tüm yabani otların tohum çimlenmesini baskıladığını gösterdi. Özellikle, esansiyel yağların 50 µL / l'lik daha yüksek bir konsantrasyonu, C. dactylon ve A. fatua'nın tohum çimlenmesini ve tohum çimlenmesini tamamen inhibe etti ve P. annua'da 50µL / l'lik bir konsantrasyonda etkili oldu. Ayrıca, J. phoenicea esansiyel yağları, 500µL / l konsantrasyonda A. mauritanica'nın tohum çimlenmesini inhibe ederken, A. herba-alba esansiyel yağları, 50 ila 250µL / l arasındaki konsantrasyonlarda aynı etkiyi elde etti. Bulgular, iki bitki türünden elde edilen esansiyel yağların bir kombinasyonunun umut verici bir biyo-herbisit veya Nano emülsiyon teknolojisi kullanımı için olabileceğini düşündürmektedir.

Anahtar Kelimeler: Yabani otlar; Esansiyel Yağlar; Alelopatik Potansiyel; Tohum Çimlenmesi; Herbisitler; Artemisia herba-alba; Juniperus phoenica L..

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1. Introduction

Synthetic herbicides have been applied in weed management; however, their indiscriminate use has enhanced environmental pollution, human health hazards and weed .resistance [1];and minor weeds becoming dominant

In order to find manipulated and alternative strategies to manage weeds in ago-ecosystems, studies and subsequent test inbioassays ,reported allelochemicals isolate from plants has provided proof for their phytotoxic potential against weed species.use of allelopathy as novel weapons for natural weed suppression.

Plant essential oils (EOs) have been known for their phytotoxicity and for their allelopathic effects on seed germination.

The hypothesis of this study was that some EOs might be suitable for controlling some Mediterranean weeds.

the objective of this study was to evaluate the allelopathic effects of selected volatile EOs from two different plant species on seed germination and seedling growth of fives invasive species.

2. Material and Method

The present experiment aimed at assessing the allelopathic actions of essential oils of Artimisia and Juniperus,on germination and seedling growth of monocotyledon of and dicot weed plants.

2.1. Bioassay

2.1.1. Sample Collection

Artemisia herba-alba,known also as «desert wormwood»or «shih»in Arabic ,is an aromatic and medicinal shub,20to 40cm high,growing wild in arid areas of the Mediterranean bassin.[14]

About,Juniperus species belong to coniferous plants,Juniperus phoenica is an evergreen tree indigenous to the North Africa and belongs to the family Cupressaceae.[13]

Artemisia herba alba and Juniperus phoenica plants were collected in Aurès region at the maturity stage (2022).

The plants left air -dried for 14 days ,then separated into two shoot and leaves parts.

Mature seeds of five weedspecies (Daucus carota, Ampelodesmos mauritanica,Cynodondactylon ,Poa annua,and Avena fatua.) were collected from crop fields;Palm Grove in Tolgua ,Biskra region.

2.1.2. Extraction of the Essential Oils (EOs)

The volatile essential oils (EOs) of Artemisia herba alba and Juniperus phoenica was extracted via steam distillation using a Clevenger-typeaparatus for 300 min using500g,700g of dried aerial part leaves , in 2-L distillation units .The oil were stored in hermetically sealed dark-glass containers and kept at 4°c for further use.

2.1.3. Assay

To prepare an essential oil solution, were formulated as active ingredients with different dose under current study,0.5µL,5µL,25 µL and

50 µL of : Artemisia herba alba ,Juniperus phoenica essential oil were mixed with 100ml of distilled water,the final solutions were shaken to get homogeneous.

Ten seeds of weedspecies and rapeseed were separately placed in 9 cm diameter petri dishes lined with filter paper.

25 ml of each solutions were applied to the petri dishes There were 5 replications of each seed species dishes were incubated in a growth chamber at 24±2°C in the dark for a week after that exposed to ambient temperature of the month Aout at (38 ±2)°C

Germination was determined by counting the number of germinated seeds at 48h intevals till 7days after 15 days,recorded seed germination percentage, shoot length, root length.[3]

3. Results and Discussion

3.1. Seed germination

The essential oil of Artemisia herba alba and of Juniperus phoenica significantly inhibited the seed

germination of 5 weed plants (Daucus carota, Ampelodesmos-mauritanica,Cynodon dactylon ,Poa annua,and Avena fatua.)

The essential oils of Juniperus phoenica have harmful effects on seed germination of weed species (fig1);

Juniperus phoenica's EOs shown to inhibit seeding emergence of weed species Avena fatua,Cynodon dactylon and the lowest values of pourcentage seed gemination was recorded in Daucus carota, Ampelodesmos-mauritanica under 20%.

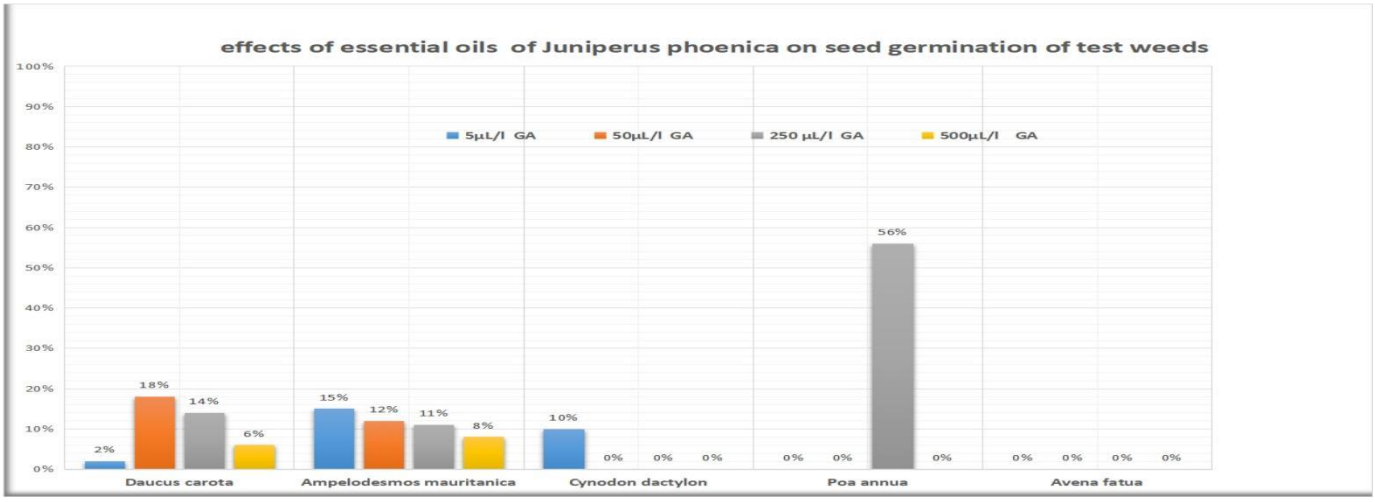


Fig. 1 Effects of essential oils of Juniperus phoenica (GA) on seed germination of test weeds

The data presented in (fig2) weeds germination percentage show the variations in the weeds control of five weeds species at four concentrations of Artemisia alba-herba essential oils

Inhibitory effects of two essentiel oils data presented in (fig3); complete inhibition of Avena fatua seed germination was observed at icreases conentrations essential oil of Juniperus phoenica (GA) and Artemisia herba alba(AM), 100%inhibition of seed germination was observed in Daucus carota,and Poa annua at (5µL/l to 500µL/l)Artemisia herba alba essential oil.

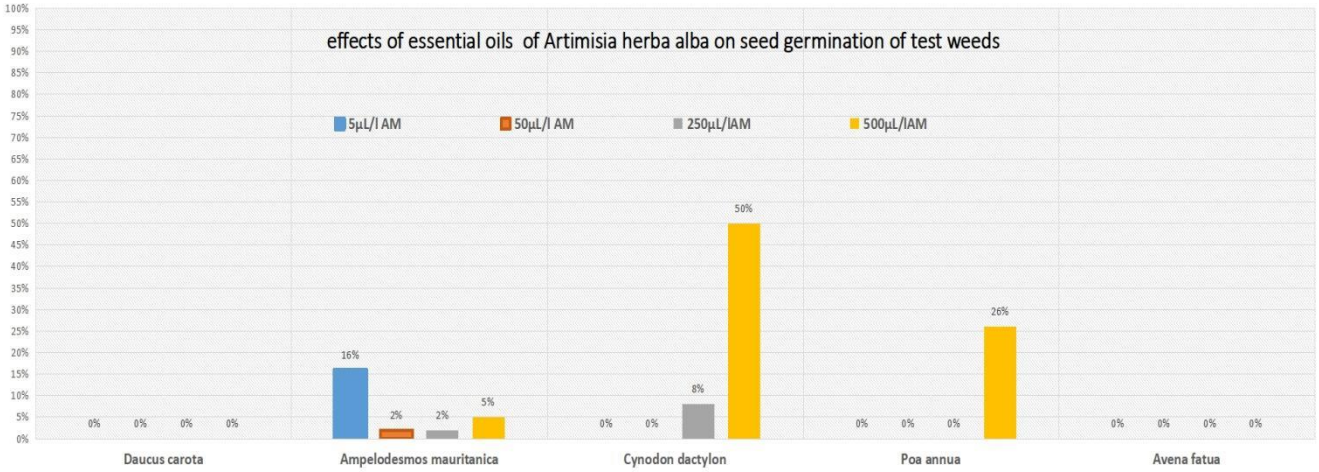


Fig. 2 Effects of essential oils of Artemisia herba alba (AM) on seed germination of test weeds.

As can be seen from the data ,the seed germination of frour targeted weeds was significantly,the complete inhibition of seed germination was observed of Daucus carota and Avena fatua,at higher dose of Artemisia herba alba essential oil more than (50µL/l) decreased the germination of Ampelodesmos mauritanica and for lower concentrations (50 µL/l) of oil ,no germination of treated seeds Cynodondactylon.

Poa annua but at higher concentration more than (50 µL/l) of oil we record increased germination :Poa annua (26%) at (500µL/l),Cynodon dactylon (50%)..

At lower doses of Juniperus phoenica (5µL/l),and at higher concentration (50µL/l) concentration of Juniperus phoenica essential oil treatment,92%,94%,100% inhibition in germination was observed in Daucus carota, Ampelodesmos mauritanica,Cynodon dactylon

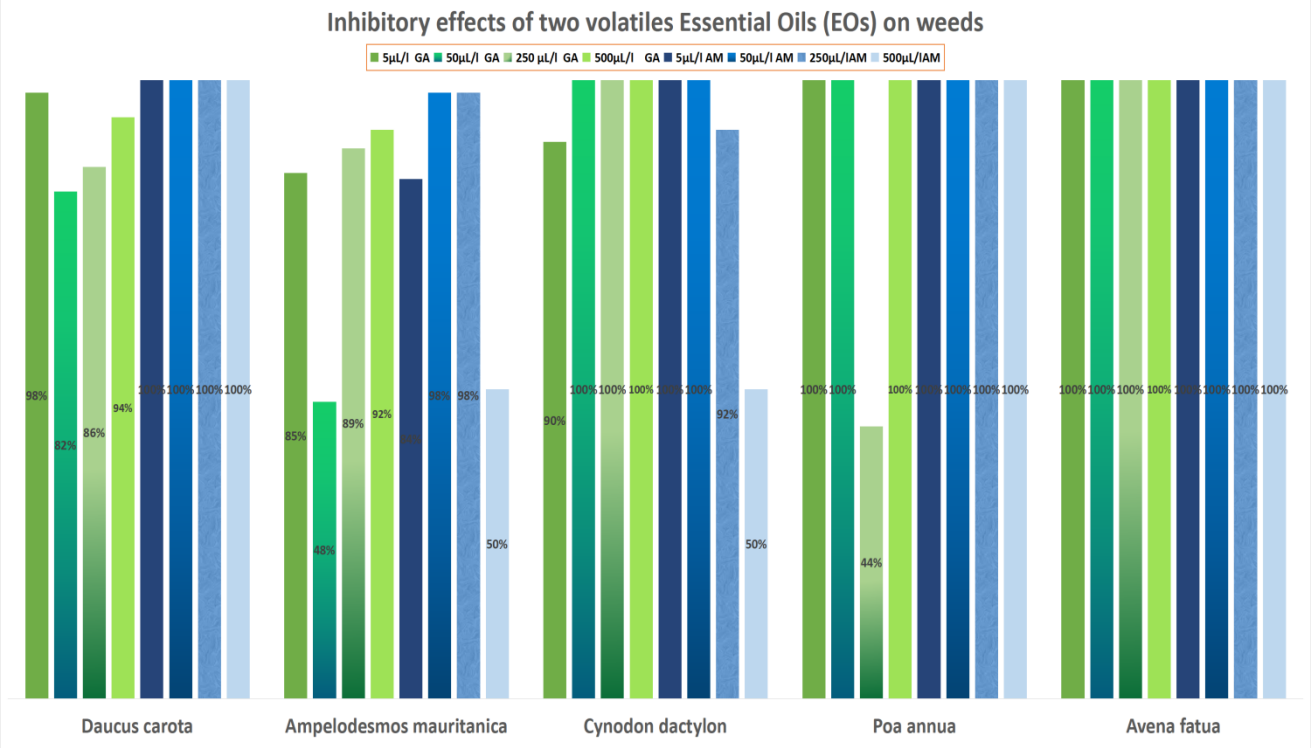


Fig.3 Inhibitory effects of essential oils of Juniperus phoenica (GA) and Artemisia herba alba (AM) on seed germination of test weeds.

3.2. Seedling development

The effects of Essential oils of Artemisia herba alba (AM) and Juniperus phoenica were tested on seedling development(Radicle and shoot length(mm)) of weed species.(fig.4) .

For instance;we found that low concentrations of Juniperus phoenica(5µL/l) had harmful effects on roots and shoot elongation,also increased concentrations of Artimisia herba-alba essential oils (250µL/l-500µL/l) showed suppressor of radicle and shoot growth of the Cynodon dactylon (fig.5) .

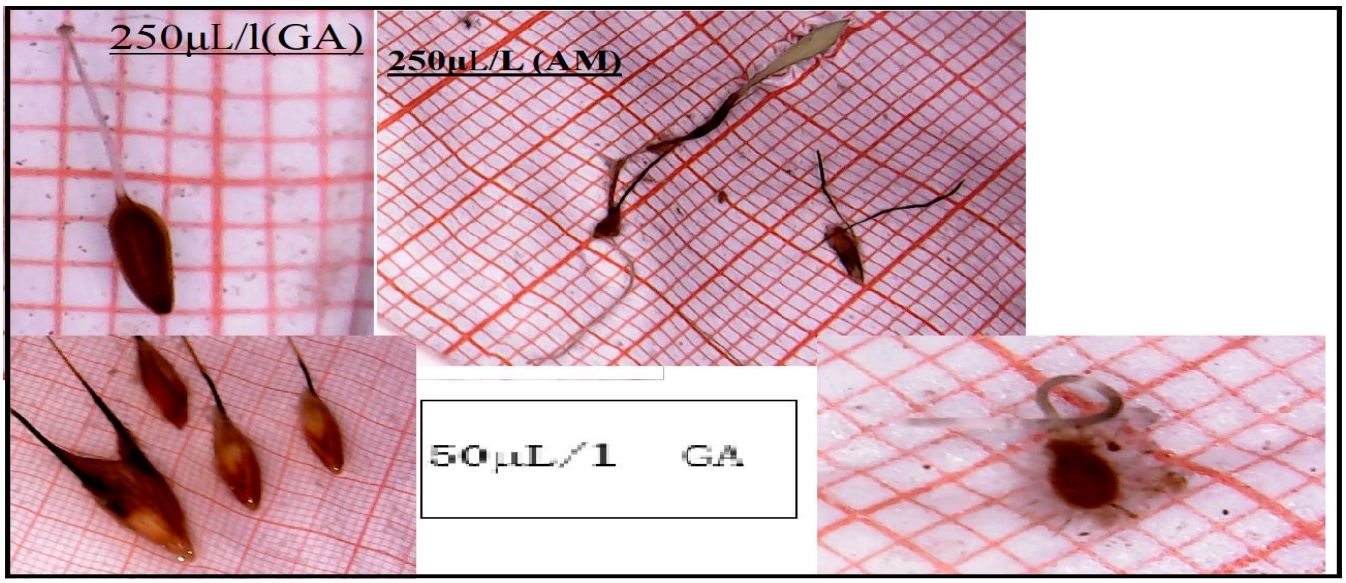


Fig.4 Effects of essential oils of Juniperus phoenica (GA) and Artemisia herba alba (AM) on weed seedling development.

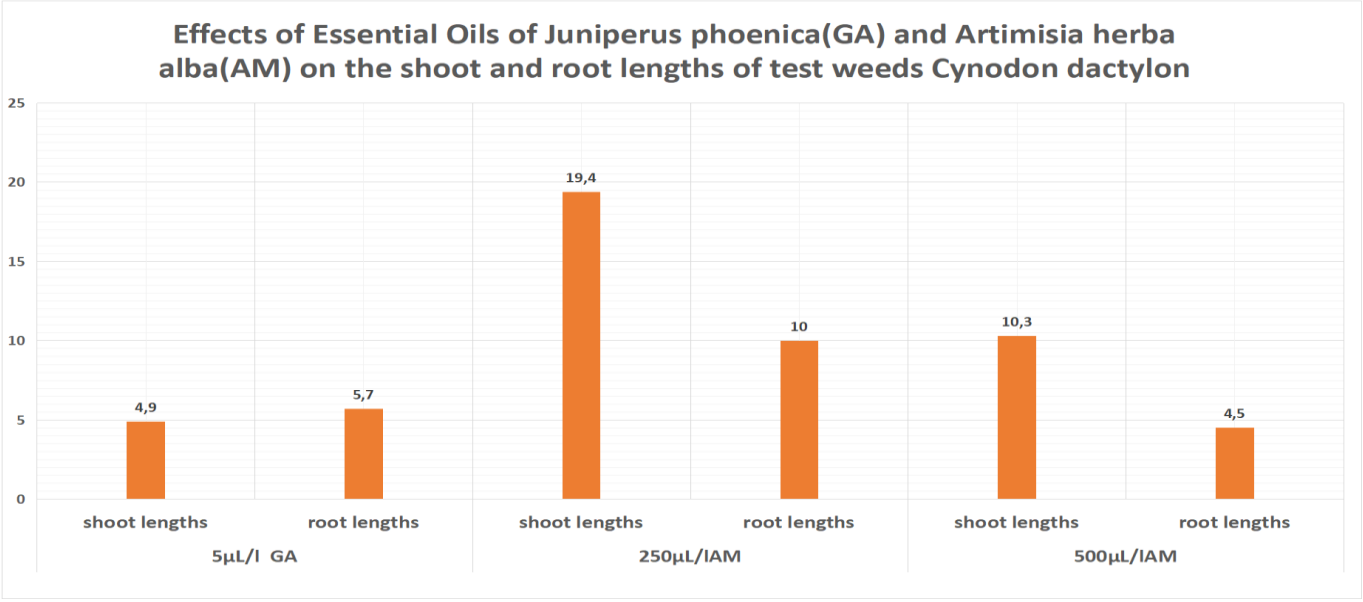


Fig. 5 Effects of essential oils of Juniperus phoenica (GA) and Artemisia herba alba (AM) on seeds development (mm) of test weeds Cynodon dactylon.

We have noticed that seedling grouth of Daucus carota were effected at increases concentrations essential oils of juniperus phoenica, at elongation root lengths stimulated the shoot lenghts showed supressor,vice versa.(fig.6)

Effects of increases concentrations of essentiel oils of Juniperus phoenica(GA) at elongation shoot lengths had decreased for stimulate elongation root of Ampelodesmos mauritanica.but the increases concentrations of essential oils of Artemisia herba-alba effects elongation root and shoot lenghts harmfully.(fig.7)

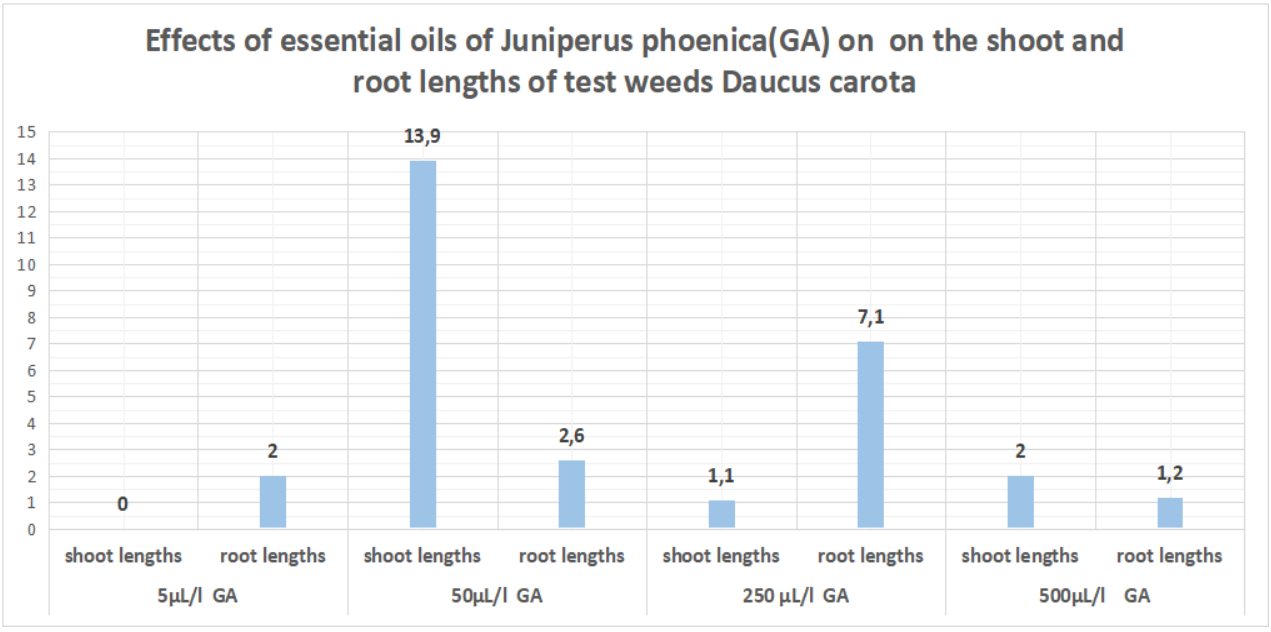
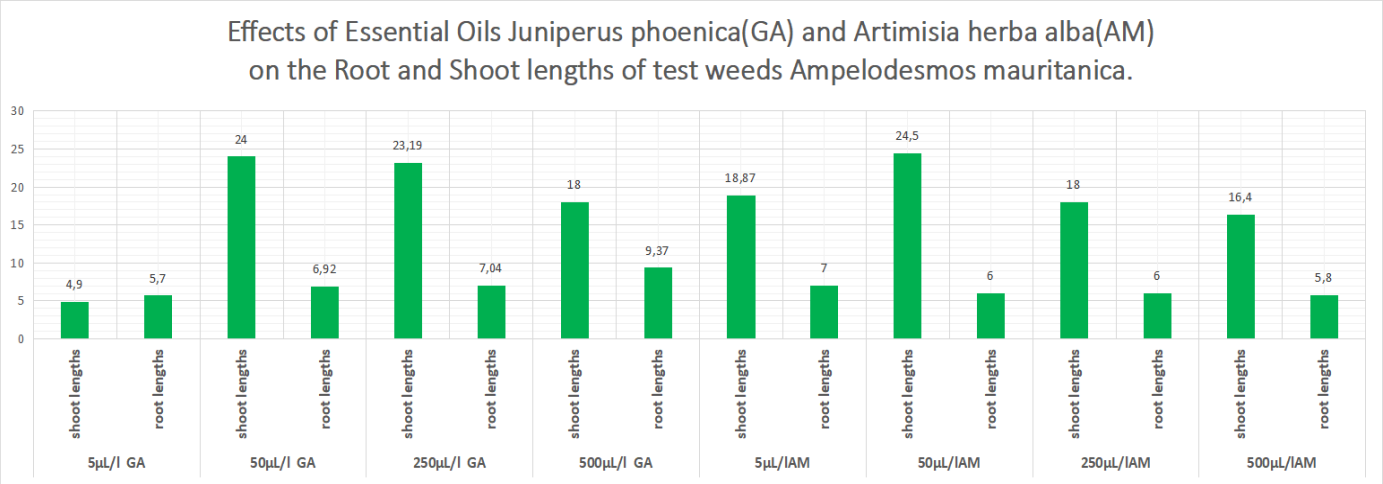


Fig. 6 Effects of essential oils of Juniperus phoenica (GA) on seeds development (mm)of test weeds Caucus carota.

Fig. 7 Effects of essential oils of Juniperus phoenica (GA) and Artemisia herba alba (AM) on seeds development (mm) of test weeds Ampelodesmos mauritanica.



At concentration of essential oil of Juniperus phoenica (250µL/l)and at concentration essential oil of Artemisia herba-alba (500µL/l) stimulated the root elongation without shoot elongation (0mm).(fig.8) .

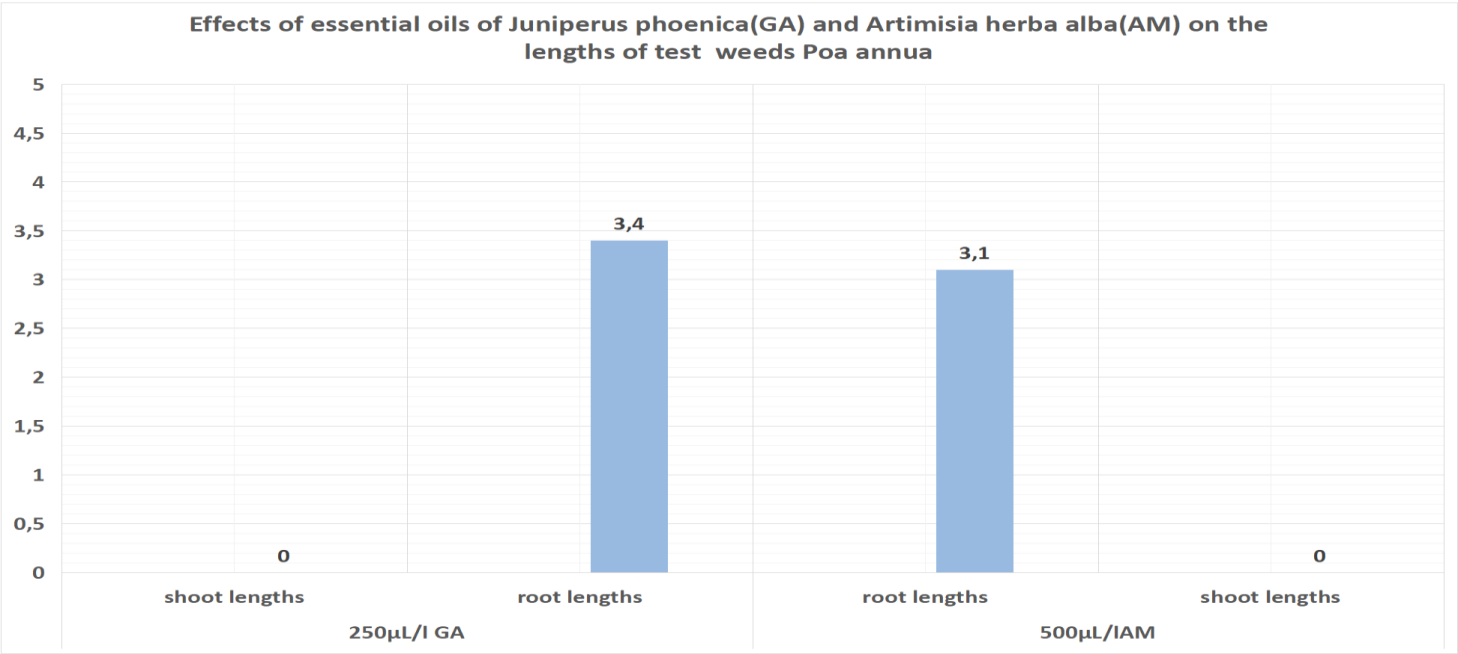


Fig. 8 Effects of essential oils of Juniperus phoenica (GA) and Artemisia herba alba (AM) on seeds development (mm) of test weeds Poa annua.

3.3. Discussion

The literature reports numerous papers on the composition of essential oil from Artemisia herba-alba, originating from different parts of the world [3,1,4]. The analysis of the oils revealed a high degree of polymorphism, leading to the identification of multiple chemotypes [2]. Essential oils from A. herba-alba collected from Morocco, Algeria, and southern Spain showed different compositions [7,2]. In Tunisia, where the climate is semi-arid and arid, the essential oils exhibited varying compositions, with some dominated by a single component such as α-thujone, β-thujone, 1,8-cineole, camphor, chrysanthenone, or trans-sabinyl acetate, while others were characterized by the presence of two or more of these compounds [7,2,4].

Many studies around the world have been performed on the chemical composition of the EOs and extracts of Juniperus species.

Juniperus Oils and extracts contain various chemotypical compounds: from 2,6-dimethyloctane to sesquiterpene skeletons, and flavonoids and biflavonoids, but the main classes identified in almost all Juniperus are mono and sesquiterpenoids and their derivatives .[13,21]

Bouguerra and coworkers found ,The major volatile compounds of Juniperus phoenica.L.,found that pinene, - myrcene and caryophyllene, -cadienene,farnesol and -humulene[16]

There are not many reports on the use of Juniperus phoenica L.essential oils allelopathic effect on seed germination and seedling development. to discuss the resultats,Biotic and abiotic factors must be taken into consideration, exemple The temperature was higher by comparison to other studies because our objectif is study allelopathy potentiel of essential oils in arid areas at weeds species.

Dias et al. (2020), the authors investigate the allelopathic potential of four different monoterpenes on the germination and early growth of maize. The monoterpenes tested were limonene, alpha-pinene, beta-pinene, and 1,8-cineole. The study found that all four monoterpenes had inhibitory effects on the germination and primary root growth of maize, with beta-pinene and 1,8-cineole showing the strongest inhibitory effects. The study also found that the monoterpenes had negative effects on mitochondrial respiration, indicating that they may affect the energy metabolism of the plant.

the study by Taheri et al. (2019) found that essential oils from Juniperus phoenicea L had a significant inhibitory effect on the seed germination and early growth of three weed species, suggesting that they could potentially be used as a natural herbicide for weed control in agricultural fields.

In our study,these results confirmed several studies have reported the volatile essential oil was active against radical elongation;Ilias and coworkers[7]have reported at doses 2.5 µg/mLand 0.25 µg/mLthe essential oil of A.herba alba inhibited the radicle elongation and at high doses of oils tested,the results show stimulatry activity of radicle elongation of radish.Escudero and cowerkers [9]noticed the inhibitory effects of aqueous extract of fresh A.herba-alba shoot and roots of Helianthemum squamatum(L)Dun Cours.

Li with coworkers [11]confirmed that the allelochemicals volatile released from leaves of Artemisia frigida willd and aqueous extracts of leaves and roots,inhibited seed germination and seedling grouwth of 3 dominants species inMongola steppe.

Also Jassbi and coworkers [12]demonstrated that the allelopathy potentiel of Artemisia tridentata at seed germination and seedling growth of the co-existant plant.

According to Dhifi and coworkers, The essentiel oil of Artemisia campestris affected the seed germination at the concentration 100 ppm resulted in an increase of the rate of seed germination of the weed D. carota undergoes a decrease with 1000 ppm and 2000 ppm whereas we noticed an increased germination rate (11.65%) compared to the control (10%) at the 100 ppm concentration.[30]

Abdel-Fattah and coworkers,founded that allelopathic effects can cause both stimulatory and suppressive effects at lower and higher concentrations respectively.[31]

From 4 to 7 days,no seed germination after week we start recording;Our findings were in agreement with those of Dhifi and coworkers;the speed of germination or the time required by D. carota seeds to germinate was also affected. Compared to the control, it increased from 6 to 8 days and from 6 to 11 respectively for the concentrations 1000 ppm and 2000.Daily monitoring of germination is necessary to assess the allelopathic effect, which may not affect the germination itself but rather the germination rate or other process parameters, as stated by Ferreira and Áquila (2000). These changes in germination patterns may impact various factors, such as membrane permeability, DNA transcription, RNA translation, secondary messenger operation, oxygen uptake (phenol), enzyme and receptor conformation, or a combination of these factors. Recent studies have shown that EOs and their constituents can significantly impact root growth and development by inhibiting cell division in growing root tips, interfering with DNA synthesis in growing meristems, inducing oxidative stress, enhancing lipid peroxidation and hydrogen peroxide accumulation, and increasing electrolyte leakage in root tissue. For example, Nishida et al. (2005) reported such effects in their research, while Scrivanti et al. (2003) and Singh et al. (2006) found similar outcomes. These findings suggest that EOs could potentially interfere with several essential cellular processes, leading to various physiological and biochemical alterations.

Therefore, to develop effective and sustainable bio-herbicides based on EOs, it is essential to understand their allelopathic effects thoroughly. This knowledge can help identify the most effective EO chemotypes, optimize their extraction processes, and develop efficient and safe application methods for agricultural and natural ecosystems.

4. Conclusions and Recommendations

The current research findings suggest that essential oil volatiles can impede the germination and initial growth of several weed species, including Daucus carota, Ampelodesmos mauritanica, Cynodon dactylon, Poa annua, and Avena fatua. To enhance our understanding and control of this process, it is imperative to determine the chemical composition of the two essential oils.

The results of current study suggest that alelochemicals in the essential oils of Juniperus phoenica and Aretemisia herba alba as altenative for sustainable weed management.

It is widely accepted that allelopathy can both inhibit and stimulate plant growth. To further explore this phenomenon, we need to investigate the potential bioherbicidal properties of a combination of Juniperus phoenica and Artemisia herba alba oils. This includes evaluating their allelopathic potential as post-emergence bioherbicides under field conditions and determining their effects on non-target weed species and crop agriculture.

More research is needed to fully understand their mechanisms of action and optimize their use in weed management.

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