



Evaluation of Herbicidal Potential of Eucalyptus spp for Biological Control of Dactyloctenium aegyptium L.

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Keywords:

Dactyloctenium aegyptium L.
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ABSTRACT

Pots culture experiment was conducted to evaluate the herbicidal potential of Eucalyptus spp. (aceae) on growth of Dactyloctenium aegyptium L. (Poaceae). Leaves extract with concentrations of 10, 20 and 40% of Eucalyptus plant were applied as soil and foliar application to seeds and seedlings of D. aegyptium species. The result indicated that the application of Eucalyptus leaves extracts caused significant reduction in germination traits, root and shoot length, seedling fresh and dry weights. Also, the result revealed that the Inhibitory effect of Eucalyptus extract on D. aegyptium L was more noticeable in plant growth traits than on germination traits. Results show that among the different concentration of Eucalyptus leave extracts used in this study, 40% was the most toxic and caused the significant effect on germination and growth traits of Dactyloctenium aegyptium. Application of 40% of Eucalyptus leave extract decreased germination percentage by 30%, mean daily germination by 45%, shoot length by 38%. root length by 54%, number of branches by 61%, number of leaves by 59%, seedling fresh weights by 23%, seedling dry weights by 62% and seedling vigor index by 60%. The results of this study concluded that the use of Eucalyptus plants have the potential to be developed further as a bio-herbicide system to control weed such as Dactyloctenium aegyptium L. However, more researches are needed to evaluate the negative impact of Eucalyptus on crop growth.

تقييم فعالية نبات الأوكالبتوس Eucalyptus spp كمبيد للمكافحة البيولوجية لاعشاب Dactyloctenium aegyptium L.

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الكلمات المفتاحية:

Dactyloctenium aegyptium
الأوكالبتوس
مبيدات الأعشاب
مبيد حيوي

الملخص

أجريت هذه الدراسة لتقييم قدرة نبات الكافور (Eucalyptus) كمبيد للأعشاب ودراسة تأثيره على إنبات ونمو نبات Dactyloctenium aegyptium L. حيث تم استخدام مستخلص لأوراق نبات الكافور بتركيز 10 و 20 و 40 وذلك بإضافة المستخلص للتربة ورش أوراق نبات D. aegyptium L في مراحل الإنبات. أشارت النتائج إلى أن استخدام مستخلص أوراق الكافور أدى إلى انخفاض معنوي في صفات الإنبات ونمو البادرات. وأوضحت النتائج أن التأثير التثبيطي لمستخلص أوراق نبات الكافور على إنبات Dactyloctenium aegyptium L كان أكثر وضوحاً في صفات نمو البادرات منه في صفات الإنبات. كما بينت النتائج أنه من بين التراكيز المختلفة لمستخلص أوراق الكافور المستخدمة في هذه الدراسة، كان التركيز 40% هو الأكثر سمية وتسبب في التأثير الأكبر على إنبات ونمو نبات Dactyloctenium aegyptium L. حيث أدى استخدام مستخلص الأوراق لنبات الكافور بتركيز 40% إلى انخفاض نسبة الإنبات بنسبة 30%، ومتوسط الإنبات اليومي بنسبة 45%، وانخفاض طول البادرات بنسبة 38%. وطول الجذر بنسبة 54%. وانخفاض عدد الأفرع للنبات بنسبة 61%، وعدد الأوراق بنسبة 59%، وكذلك انخفاض الوزن الطري للنبات بنسبة 62%، بينما كان انخفاض الوزن الجاف للنبات بنسبة 23%، ومؤشر قوة البادرات

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بنسبة 60%. وخلصت نتائج هذه الدراسة إلى أن استخدام مستخلص أوراق نبات الأوكالبتوس لديه القدرة على تثبيط النمو ويمكن ان يعمل كمبيد حيوي للأعشاب ومكافحة الحشائش مثل *Dactyloctenium aegyptium* L. ومع ذلك ، تري هذه الدراسة بان هناك حاجة إلى المزيد من البحوث لتقييم التأثير السلبي للأوكالبتوس على نمو المحاصيل الحقلية.

Introduction

Weeds are one of the major causes of economic losses in crop production worldwide [1]. *Dactyloctenium aegyptium* L is a creeping C4 annual species with semi-prostrate about 30-70 cm high, rooting at the node and reproduces from seeds [2]. *D. aegyptium* is among the 20 most globally widespread weeds [3]. In a many regions worldwide, weeds inflict 20-30% losses in different crops on the average [4], [5]. *D. aegyptium* L is one of the serious weed in Libya as well as many regions around the globe. The grass usually controlled through a variety of management strategies, such as traditional tillage, hand weeding, mechanical cultivation, cultural practices or chemical herbicides [6], [7]. Worldwide, enormous quantities of chemicals herbicides are applied to manage these weeds. However; artificial chemical herbicides might be toxic and may harm the environment [8], [9]. Also chemical herbicides may cause human health problems, cause groundwater contamination, and may cause toxicity in foods [10]. In addition, over-applying of herbicides has led to development of weed biotypes with herbicide resistance [11], [12]. Therefore, to reduce dependence on synthetic chemicals herbicides, the use of plants that possess strong allelopathic properties has shown promising results for weed control [10]. Inhibitors substances released from allelopathic plants can control weeds in a sustainable manner and reduce labor costs.

Allelopathy as defined by the International Allelopathy Society “any procedure involving secondary metabolites produced by plants, algae, bacteria and fungi that influence the growth and development of agricultural and biological systems” [4]. The allelochemicals can be generally classified as plant phenolics and terpenoids, which show great chemical variety and are involved in a number of metabolic and ecological processes [13]. Allelochemicals are toxic phenols, terpenes and alkaloids and may inhibit or retard seed germination, inhibit shoot and root growth, reduce nutrient uptake, reduced dry weight accumulation and lowered reproductive capacity of different plants [14]. Many allelopathic and medicinal plants have been revealed and confirmed to regulate agricultural weeds and therefore might be used as an alternative for weed control [15]. All the plant parts could display allelopathic effects and may significantly affect nearby plants, however the allelopathic effects of various parts of the same plant vary for their effects on growth of plants [1], [16].

Plants of the genus *Eucalyptus spp* possess strong pesticide potential due to the presence of a wide array of biologically active compounds [17]. Eucalyptus plants are well known as a source of biologically active compounds accountable for its phytotoxic and allelopathic properties [18] and therefore Eucalyptus plants may be used as weed control. In literature, there were some researches and studies have been addressed the allelopathic properties of this plant. Recent study reported that Eucalyptus Labill leaf extracts was extremely effective in reduction of germination and seedling growth of *Physalis alkekengi* L. and could be considered in management program of *P. alkekengi* L control [19]. Another study investigated the negative allelopathic effect of *Eucalyptus citriodora* essential oil on some of weeds in Algeria and reported that seed germination and seedling's growth were severely inhibited in due to the application of *Eucalyptus citriodora* essential oil and the study concluded that *E. citriodora* essential oil might has the potential use as bioherbicide for weed control [20]. Also a study on the effect of Eucalyptus on *Cyperus rotundus* L. and *Cynodon dactylon* L weeds found that aqueous leachate of fresh leaves of eucalyptus significantly inhibited the establishment of vegetative propagules and early seedling growth of these weeds [21]. However, to our knowledge, few studies have been done to prove phytotoxic effect of any Eucalyptus plant against

Dactyloctenium aegyptium L weeds. Therefore, the aim of this research was to assesses the herbicidal potential of Eucalyptus on growth of *Dactyloctenium aegyptium*.

Materials and methods

This study was conducted in summer of 2020, in semi controlled environment facilities at Joddam farm. Both Eucalyptus leave and *D. aegyptium* L seeds were obtained from a farm in Zawia area. This study was conducted to evaluate the inhibitory potential of Eucalyptus leave extract on germination and seedling growth of *Dactyloctenium aegyptium* L weeds.

Experimental details

Eucalyptus leaves extracts was prepared following the methods of [22]. In brief leaves of Eucalyptus plants at vegetative stage were collected and washed gently with tap water to remove dust and any contaminants. Then green leaves were cut into smaller pieces, and soaked in alcohol and water at 1:1 proportion and kept in overnight. After that, soaked leaves were ground with the help of mixer grinder. Then, the leaves extract was prepared by filtrating the mixture, which represented 100 percent stock solution. From the stock solution, 10, 20 and 40% concentration were prepared and sprayed following the treatment schedule.

The experiment was sown in pots in randomized complete design (RCD) with four replications. 2L Plastic pots (16 cm diameter *13 cm height) were filled with peat moss and loamy soils (1-1) and 10 of *Dactyloctenium aegyptium* seeds were planted in each pot. Pots were divided into four groups with four replications, each group represents one treatment which include no application of Eucalyptus leave extract (control) and 10, 20, 40 % of Eucalyptus leave extract. The freshly prepared extracts of 10, 20 and 40% were sprayed on the soil surface before the emergence of *Dactyloctenium aegyptium* seedlings and control pots were maintained by spraying with water. After 24h of planting the germinated seeds were recorded in a daily basis for 10 days and germination percentage and mean daily germination were calculated. After seedling establishment, seedlings were thinned to only 4 seedlings per pot and kept under monitoring and irrigated manually as needed by adding 250 ml of tap water for 30 days. During this period, 10, 20, and 40% of leaves extracts were applied weekly to compounding pots.

Data collection

1. Germination percentage (G %) was expressed according to the following formula [23].

$$G \% = (NSG \div TNSS) \times 100$$

Where NSG is the number of seeds germinated at the end of the experiment (8 days after sowing). TNSS is the total number of seeds sown.

2. Mean daily germination (MDG) was calculated using the following formula [24].

$$MDG = TNGS \div TNDG$$

Where TNGS is total number of germinated seeds and TNDG is total number of days taken for final germination.

Seedling growth

After 30 days of sowing, the experiment was terminated and one plant from each replicate was collected for data collection. Data on number of branches, number of leaves, shoot length (cm), root length (cm) and seedling fresh weight (g) were recorded. Dry weight (g) of seedling was recorded after drying in oven maintained at 60°C for 48 hours. Using the morphological traits and germination traits, seedling vigor index (SVI) were calculated using the following formula [25].

$$SVI = (SL \times G\%) \times 100$$

Where SL is seedling length and G% is germination percentage.

Weed control efficiency (WCE) was calculated based on the dry weight of weed seedling following the equation (22) $WCE(\%) = (WDC - WDT) / WDC \times 100$.

Where, WDC = Weed seedling dry weight in control pot, WDT = Weed seedling dry weight in treated pot.

Statistical analysis: The experimental design was a randomized complete design with four replications. Data were analyzed using GLM procedure in statistical software SAS 9.4 for mean and standard error estimation. Separation of means was carried out using the LSD test ($P < 0.05$).

Results

The Probability values for germination and plant growth traits are presented in Table 1. Eucalyptus leaves extract inhibited germination traits of *Dactyloctenium aegyptium* L (Table 1) showed a significant effect at $p < 0.05$ on germination traits include germination percentage, germination speed and mean daily germination.

Table:(1). Probability values of the effects of Eucalyptus spp leaves extract on germination and growth traits of Dactyloctenium aegyptium weeds.

Traits	Probability values
Germination percentage (%)	0.0415
Mean daily germination	0.0385
Shoot length (cm)	0.0477
Root length (cm)	0.0357
Number of branches	0.0458
Number of leaves	0.0469
Seedling fresh weight (g)	0.0484
Seedling dry weight (g)	0.0313
Vigour index	0.0336
Weed control efficiency (%)	0.0319

The result also indicated that there was significant differs between the extract concentration of Eucalyptus leaves extract used in this study (Table2)

Table:(2). The effects of Eucalyptus spp leave extract on germination and growth traits of Dactyloctenium aegyptium weeds.

Traits	Leaves extract concentrations (%)			
	control	10%	20%	40%
Germination percentage (%)	90 ^a	83 ^{ab}	70 ^{ab}	63 ^b
Mean daily germination	2.4 ^a	2 ^{ab}	1.6 ^b	1.3 ^b
Shoot length (cm)	11 ^a	10.5 ^a	8 ^{ab}	7 ^b
Root length (cm)	6 ^a	5 ^{ab}	4 ^{ab}	2.9 ^b
Number of branches	4.5 ^a	4 ^a	2.8 ^{ab}	1.8 ^b
Number of leaves	18 ^a	16 ^a	11 ^{ab}	7 ^b
Seedling fresh weight (g)	2.9 ^a	2.7 ^{ab}	2.5 ^{ab}	2.2 ^b
Seedling dry weight (g)	0.9 ^a	0.7 ^{ab}	0.5 ^{ab}	0.3 ^b
Vigour index	16 ^a	13 ^a	9 ^{ab}	6 ^b
Weed control efficiency (%)	-	23 ^b	43 ^{ab}	64 ^a

* Individual value is the mean of 4 plants under different leave extract concentrations. Values followed by different letters are significantly different according to LSD test ($P < 0.05$).

The results showed that 10%, 20% and 40% of *Eucalyptus* leaves extract decreased germination percentage by 8%, 22% and 30% respectively over control (Fig 1a). The same trend was found with mean daily germination. Fig1b showed that mean daily germination decreased by 20%, 40% and 45% due to the application of 10%, 20% and 40% of Eucalyptus leaves extract respectively.

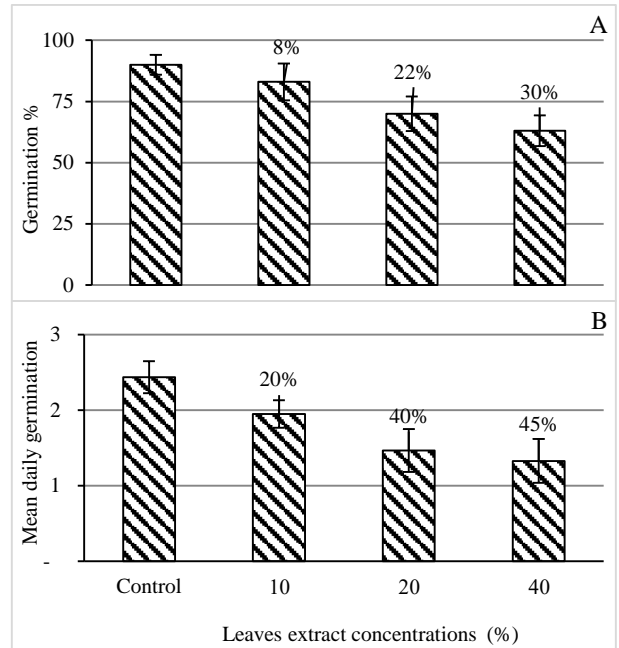


Figure: (1). The effects of *Eucalyptus spp* leave extract on (A) germination percentage and (B) mean daily germination of *Dactyloctenium aegyptium* weeds. Each datum indicates mean value and vertical lines on top of bars indicate standard error of means (n = 4). Values in parenthesis indicates the percent reduction from control.

In addition, the results illustrated that 10, 20 and 40% of *Eucalyptus* leaves extract significantly ($p < 0.05$) decreased the shoot and root length of *Dactyloctenium aegyptium* L (Table 1). The result also indicated that there was significant differs between different concentrations of *Eucalyptus* leaves extract used in this study (Table2).

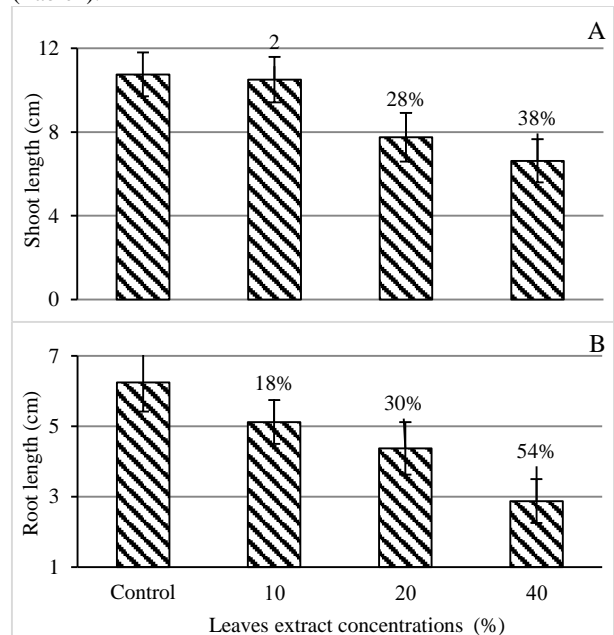


Figure: (2). The effects of *Eucalyptus spp* leave extract on (A) shoot length (cm) and (B) root length (cm) of *Dactyloctenium aegyptium* weeds. Each datum indicates mean value and vertical lines on top of bars indicate standard error of means (n = 4). Values in parenthesis indicates the percent reduction from control

The application of 10% of *Eucalyptus* leaves extract caused reduction in *D. aegyptium* shoot and root length by 2% and 18% respectively. At the same time the application of 20% of *Eucalyptus* leaves extract caused reduction in *D. aegyptium* shoot and root length by 28% and 30% respectively. Whereas; the application of 40% of *Eucalyptus* leaves extract caused reduction in *D. aegyptium* shoot and root length by 38% and 54% respectively (Fig2a & b).

Leaves extract of *Eucalyptus* affected the early development of the tested weed, and this effect was pronounced in number of leave and

number of branches per seedling. According to the result obtained herein leaves extract of *Eucalyptus* caused reduction in branches number which was reduced by 11% at 10% concentration, by 39% at 20% concentration and by 61% at 40% concentration of *Eucalyptus* leaves extract over the control (Fig. 3a). The same trend was seen with leaf number per seedling which reduced by 9% at 10% concentration, by 36% at 20% concentration and by 59% at 40% concentration of *Eucalyptus* leaves extract over the control (Fig. 3b).

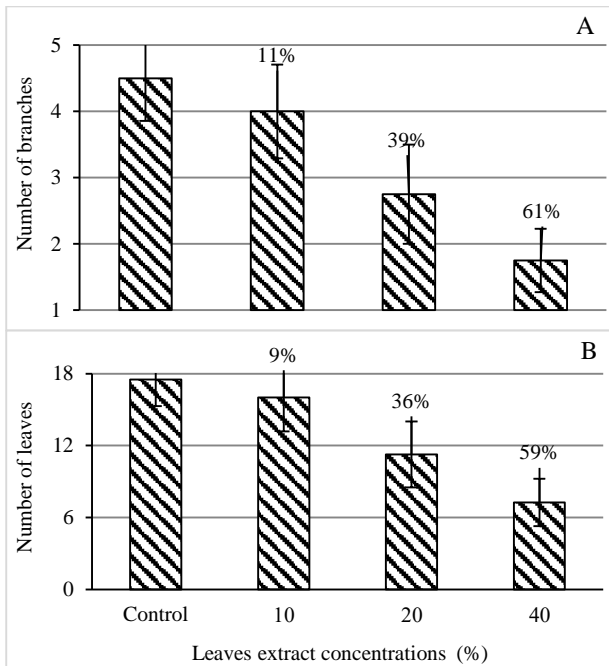


Figure (3). The effects of *Eucalyptus* spp leaf extract on (A) number of branches and (B) number of leaf of *Dactyloctenium aegyptium* weeds. Each datum indicates mean value and vertical lines on top of bars indicate standard error of means (n = 4). Values in parenthesis indicates the percent reduction from control.

Moreover, leaves extract of 10, 20 and 40% inhibited other plant growth traits of *Dactyloctenium aegyptium* L and there was a significant differs between different extract concentration used in this study. Table 1 showed that there were significant (p<0.05) decrease in both fresh and dry weight of *Dactyloctenium aegyptium* L seedlings due to the application of 10, 20 and 40% of *Eucalyptus* leaves extract. The result indicated that extract of 10% of *Eucalyptus* leaves extract decreased fresh and dry weight by 6% and 21% respectively. And 20% of *Eucalyptus* leaves extract decreased fresh and dry weight by 16% and 41% respectively. Whereas, 40% *Eucalyptus* leaves extract decreased fresh and dry weight by 23% and 62% respectively (Fig 4a & b).

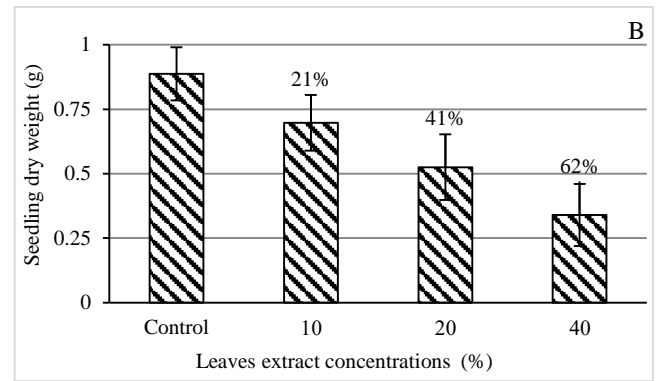
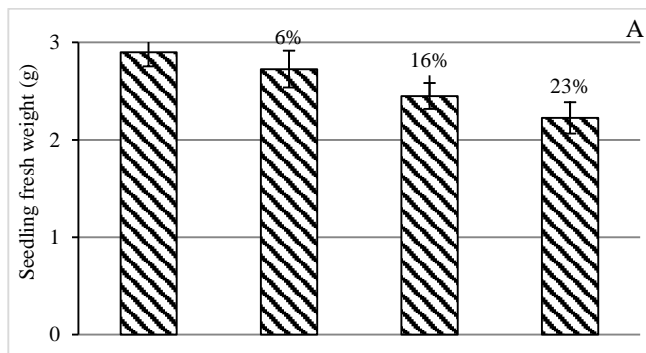


Figure (4). The effects of *Eucalyptus* spp leaf extract on (A) seedling fresh weight (g) and (B) seedling dry weight (g) of *Dactyloctenium aegyptium* weeds. Each datum indicates mean value and vertical lines on top of bars indicate standard error of means (n = 4). Values in parenthesis indicates the percent reduction from control.

Also, the results showed that 10%, 20% and 40% of *Eucalyptus* leaves extract decreased seedling vigor index of *Dactyloctenium aegyptium* L. seedlings by 15%, 43% and 60% respectively over control (Fig 5a).

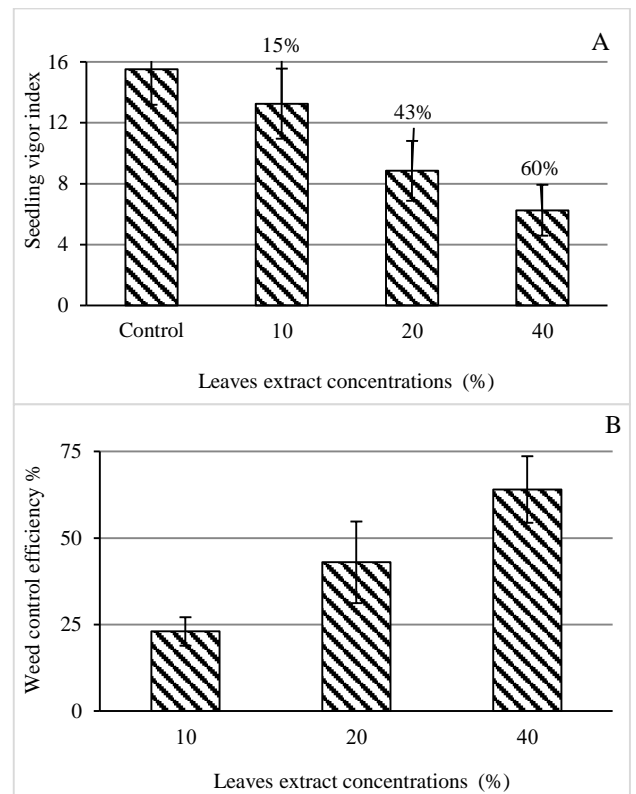


Figure (5). The effects of *Eucalyptus* spp leaf extract on (A) seedling vigor index and (B) weed control efficiency of *Dactyloctenium aegyptium* weeds. Each datum indicates mean value and vertical lines on top of bars indicate standard error of means (n = 4). Values in parenthesis indicates the percent reduction from control.

Additionally, the results revealed that 40% of *Eucalyptus* leaves extract resulted in higher weed control efficiency for *D. aegyptium* with control efficiency of 64%, which maybe as a result of active inhibition of germination and decrease in seedling growth (Fig 5b).

Discussion

In this study the evaluation of herbicidal potential of *Eucalyptus* spp plants. For biological control of *Dactyloctenium aegyptium* weeds was investigated. This investigation revealed that extract of leave of *Eucalyptus* plants inhibited germination and seedling growth of *D. aegyptium* species (Table 2). 20 and 40% concentration of plant leaves extract included in this study showed inhibitory effects on germination and growth traits. These results were confirmed by previous studies that addressed the inhibitory effect of different plant

species on neighbouring plants such as the inhibitory effect of black mustard on germination and growth of wild oat [26], the phytotoxic action of *Ageratum conyzoides* L. on weeds [27], the Allelopathic activity of *Peganum harmala* L on germination and growth of *Avena fatua* L. and *Convolvulus arvensis* L [28]. and the phytotoxic effect of *Ageratum conyzoides* on Wheat [29]. This inhibitory effects may be caused by the phytotoxic potential of Eucalyptus plants. Even though, both concentrations 20 and 40% of *Eucalyptus* leaves extracts used in this study displayed inhibitory effects on germination and plant growth traits, however, the study found that 40% of *Eucalyptus* leaves extract exhibited the strongest inhibitory activities as compared with 20%, this finding was corroborated with the findings of [30]. Many researches have been done on some plants species and came out with a number of plants that have chemicals suitable for promoting or suppressing the growth and yield of surrounding plants. The result revealed that leaves extracts of *Eucalyptus* plant inhibited germination traits of *D. aegyptium* weeds. This outcome is supported by other study which indicated that aqueous extract of *A. conyzoides* inhibited radish germination [27]. Also the analysis of variance revealed significant differences among the extract of different concentrations of Eucalyptus plant on shoot and root length (cm) of *D. aegyptium*. This result is in agreement with other study which indicated that *P. harmala* reduced plant growth of wheat and barley plants [31]. Another study found that the lengths of the radicle and coleoptile and the seedling dry weight of wheat were significantly decreased due to releasing of phytotoxins when wheat was grown in field soil previously infested with *A. conyzoides* [29]. Also our result indicated that both fresh and dry weight of *D. aegyptium* was effected by the application of Eucalyptus leaves extract Fig3. Other earlier studies investigated the effect of aqueous extract of different plants on growth and biomass accumulation of other plants found the same results for diverse crops such as Allelopathic effect of black mustard on wild Oat (26), aqueous extract of *A. conyzoides* reduced radish dry weight [27] and *Eucalyptus citriodora* leaf extract for weed control in pea fields [32]. Also data herein support those reported in early study which indicated that shoot dry weight of *D. aegyptium* was significantly affected under aqueous extract application of *Senna angustifolia* plants [4]. The present study concluded that Eucalyptus has phytotoxic effect and inhibited seed germination and seedling length of *D. aegyptium*. Similar results were observed on shoots and roots length of wheat and mustard treated with different concentration of aqueous plant extracts of *P. harmala* [33]. Also these results agree with a recent study which conclude that Eucalyptus globulus essential oil could be used to manage some weeds such as *Echinochloa crus-galli* L. due to its post-emergent herbicidal activity [34]. By these findings it is evident that Eucalyptus plants can produce phytochemical compounds with plant growth inhibitory activities. It appears that the allelopathic activity which usually cause delaying or maybe preventing germination and reduce plant growth traits is resulted from original effects of these materials on metabolic process of nearby plants.

Conclusion

Generally, the results suggest that *Eucalyptus spp* could be developed and used as a natural herbicide for controlling *Dactyloctenium aegyptium* plants and as a result reduce the dependence on chemical herbicides. Also according to the results, the phytotoxic potential of Eucalyptus plants varied with different concentrations of Eucalyptus leaves extract. Among concentrations used, 40% activated a greater growth inhibitor for *Dactyloctenium aegyptium* plants. However, more researches are needed to evaluate the negative impact of Eucalyptus on crop growth.

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