

Original Research Article

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Allelopathic Effect of *Moringa peregrina* Forssk. on Germination and Early Seedling Development of Two Common Food Intercrops

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ABSTRACT

Keywords

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The present study aims at evaluating the possible allelopathic potential of *Moringa peregrina* Forssk. on some growth attributes of two economically important food crops; *Hordeum vulgare* and *Trigonellafoenum-graecum*. The results indicate that *Hordeumvulgare* is more sensitive to *Moringa peregrina* leaves aqueous extract than *Trigonellafoenum-graecum*, and a concentration of 2.5% of that extract express the highest allelopathic effect on the degree of inhibition on seed germination of *Hordeum vulgare*. Radicle lengths of both recipient species were largely dependent on the concentration of the extracts of the donor species where it decreased with increasing the extract concentration. Highest reductions were achieved using 10% aqueous extracts. The effect was statistically significant at $p \leq 0.001$ for most treatments. In conclusion, the cultivation of *Moringa peregrina* accompanied with *Hordeum vulgare* and *Trigonellafoenum-graecum* as intercrops is not recommended for its dramatic effects on germination efficiency and growth.

Introduction

Genus *Moringa* is the only genus in family *Moringa ceae* and comprises 13 species from Africa, Madagascar, western Asia and the Indian subcontinent (Verdcourt, 1985). It is drought resistant, preferring regions with a wet/dry climate, but can grow in a wide range of habitats on a variety of soils. *Moringa* species are one of the most useful trees in the tropics and subtropics of Asia and Africa, with multiple uses. *Moringa peregrina* Forssk. is native to the region extending from the Dead Sea to Southern Arabia and northern Somalia (Dehshahri *et al.*, 2012). In the past, *Moringa peregrina* was both an indigenous and a cultivated tree in Sudan (Jahn *et al.*, 1986).

Moringa peregrina is widely grown in Saudi Arabia. It is a fast growing tree (Abd El-Wahab, 1995). It has a grayish green bark, long, alternate leaves, and yellowish white to pink, showy, fragrant flowers (Boulos *et al.*, 2000). The tree loses its leaves from December to January, though during droughts it may also lose its leaves at other times of the year (HDRA, 2002).

The *Moringa* tree is used for nutrition and medicine in many countries in MiddleEast. It is most praised for its nutritional abilities (Ghodsi *et al.*, 2014). Ecology and nature of growth of the *Moringa peregrina* were studied by Zaghloul *et al.*, (2010) and Gomaa

and Pico (2011). It is an economic threat to agriculture in cropping areas for its probable allelopathic potentiality of their falling leaves. Allelopathic potentiality under field conditions can be utilized in different ways. For example, incorporation into the soil (Sati *et al.*, 2004), aqueous extracts (Iqbal and Cheema, 2007a), or mix cropping /intercropping (Iqbal and Cheema, 2007b).

Intercropping; the agricultural practice of cultivating two or more crops in the same space at the same time is an old and commonly used cropping practice aimed to match efficiently crop demands to the available growth resources and labor.

The most common advantage of intercropping is the production of greater yield on a given piece of land by making more efficient use of the available growth resources using a mixture of crops of different rooting ability, canopy structure, height, and nutrient requirements based on the complementary utilization of growth resources by the component crops (Lithourgidis *et al.*, 2011). One should be aware by the chemical interfering between the mixed crops in order to avoid undesirable potential effects of some crop on the others. Consequently, the main objective of the present study was to assess the probable allelopathic effects of *Moringa peregrine* on some growth attributes of the two economically important food crops; *Hordeum vulgare* and *Trigonellafoenum-graecum* in mixed cropping system.

Materials and Methods

Preparation of donor species aqueous extracts

Leaves of *Moringa peregrine* (donor species) were collected from cultivated fields at Al-Madina governorate during the year 2016. Healthy leaves were selected carefully, washed in running tap water for removing the

surface contaminants and dust and dried at room temperature for three days in shade. After drying, leaves were powdered using electric blender. Stock aqueous extract was obtained by soaking 50 g leaf powder in 500 ml of cold and boiled distilled water (10 % w/v) at room temperature ($20 \pm 2^\circ\text{C}$) for 24 hours with occasional shaking. The mixtures were filtered through two layers of cheese cloth and centrifuged for 20 minutes at 5000 rpm to remove particulate materials. The purified extracts were kept in the refrigerator at 5°C . Series of subsequent dilutions (2.5%, 5.0%, 7.5% and 10%) were prepared in addition to the control (distilled water) and tested for their effects on germination and seedling growth of *Hordeum vulgare* and *Trigonellafoenum-graecum* (recipient species).

Germination Bioassay

Petri-dish experiment was applied to investigate the potential allelopathic effects of aqueous extract of the donor species on germination percentage (GP), and radicle (RL) length of the recipient species. To accomplish this experiment, 10 seeds of the recipient species were arranged in 9 cm diameter Petri-dishes on 2 discs of Whatman No.1 filter paper under normal laboratory conditions with day temperature range of $25\text{-}30^\circ\text{C}$ and night temperature range $20\text{-}25^\circ\text{C}$. Five ml of aqueous extracts of the donor species were added daily to three replicates. GP, and RL were recorded daily for successive eight days.

Calculations

Germination percentage (GP)

$$\text{GP} = (\text{number of germinated seeds} / \text{total number of seeds}) \times 100$$

Statistical Analysis

Data were analyzed by standard analysis of variance (ANOVA) and student's t-test with

COSTAT 2.00 statistical analysis software (Zar, 1988). Differences were considered to be significant at $p \leq 0.05$.

Results and Discussion

Multiple cropping has been experienced in many parts of the world as a technique to maximize land productivity in a specific area in a growing season. However, plant litter or fallen leaves upon rainfall or irrigation water leaches out several allelochemicals which influence the growth of the same or other intercrops. The present study was conducted to investigate the biological interactions between *Moringa peregrine* leaves aqueous extract on the two recipient intercrops; *Hordeum vulgare* and *Trigonellafoenum-graecum*.

The allelopathic effects of *Moringa peregrine* leaves aqueous extract on germination percentage of *Hordeum vulgare* and *Trigonellafoenum-graecum* are presented in Table 1. Germination percentages of *Hordeum vulgare* was significantly affected by applying the different concentrations of *Moringa peregrine* leaves aqueous extract. The F values resulting from the application of analysis of variance (ANOVA), were high and the P values ranges from 0.012 to 0.001 (Table 1). Phiri and Mbewe (2010) reported that addition of *Moringa oleifera* leaves extracts reduced germination percentage of groundnut seed and caused lower seedling survival.

Oluwafemi (2014) also found that the higher concentrations of *Moringa oleifera* fresh leaves extract suppress the seed germination and some growth parameters of *Euphorbia heterophylla*. Seedling survival got reduced as the concentration of extract increased

which may suggest that *Moringa oleifera* possesses some bio-herbicidal properties.

The results of repeated t-test (Table 2) showed that *Hordeum vulgare* is more sensitive to *Moringa peregrine* leaves aqueous extract than *Trigonellafoenum-graecum*, and a concentration of 2.5% of that extract express the highest allelopathic effect on *Hordeum vulgare*.

Compared to the control, a gradual decrease in radicle lengths of the two recipient species was noticed along the gradual *Moringa peregrine* leaves aqueous extract concentration (Table 3). Obviously, all concentration levels had significantly reduced radicle length of the two recipient species. The application of ANOVA test resulting in high F values for both tested species, and probability p were almost less than 0.001.

Repeated t-test (Table 4) showed highly significant effect of all tested concentration levels of *Moringa peregrine* used in the experiment of the present study.

Reduction in radicle lengths of *Trigonellafoenum-graecum* and *Hordeum vulgare* is directly proportional to the increase in concentration of donor aqueous extracts (Fig. 1 and 2). Highest reductions were achieved using 10% aqueous extracts. The results of the present study indicate that the degree of radicle reduction of the recipient species is largely dependent on the concentration of the extracts of the donor species. These results are in agreement with Phiri and Mbewe (2010) who reported that addition of *Moringa oleifera* leaves extracts reduced hypocotyl formation and length resulting in delayed crop emergence and low field establishment of some legume crops.

Table.1 Comparison between the studied treatments according to germination %

Treatment (%)	Germination %							
	<i>Trigonellafoenum-graecum</i>				<i>Hordeum vulgare</i>			
	1	2	3	4	1	2	3	4
0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	76.7±15.3	100.0±0.0	100.0±0.0	100.0±0.0
2.5	96.7±5.8	100.0±0.0	100.0±0.0	100.0±0.0	53.3±15.3	70.0±10.0	70.0±10.0	73.3±15.3
5.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	66.7±5.8	80.0±10.0	80.0±10.0	80.0±10.0
7.5	96.7±5.8	96.7±5.8	96.7±5.8	96.7±5.8	93.3±11.5	100.0±0.0	100.0±0.0	100.0±0.0
10.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	90.0±10.0	95.0±5.0	90.0±0.0	90.0±0.0
F	0.750	1.000	1.000	1.000	5.614*	12.0*	12.750*	6.400*
P	0.580	0.452	0.452	0.452	0.012*	0.001*	0.001*	0.008*
LSD at 0.05	6.649	4.701	4.701	4.701	22.051	12.214	11.516	14.867

F: F test (ANOVA)

*: Statistically significant at $p \leq 0.05$

Table.2 Repeated t-test before and after treatments according to germination %

Treatment (%)	P values							
	<i>Trigonellafoenum-graecum</i>				<i>Hordeum vulgare</i>			
	1	2	3	4	1	2	3	4
2.5% vs Control	0.290	1.000	1.000	1.000	0.040	<0.001*	<0.001*	0.003*
5% vs Control	1.000	1.000	1.000	1.000	0.336	0.004*	0.003*	0.013*
7.5% vs Control	0.290	0.145	0.145	0.145	0.123	1.000	1.000	1.000
10% vs Control	1.000	1.000	1.000	1.000	0.207	0.383	0.082	0.165

*: Statistically significant at $p \leq 0.05$

Table.3 Comparison between the studied treatments according to radicle length

Treatment (%)	Radicle length (cm)							
	<i>Trigonellafoenum-graecum</i>				<i>Hordeum vulgare</i>			
	1	2	3	4	1	2	3	4
0	8.7±1.5	27.3±2.5	32.7±2.5	44.0±1.7	22.7±2.5	54.0±3.6	70.0±1.0	81.7±1.5
2.5	7.7±1.2	22.7±3.8	27.3±3.8	38.3±2.1	18.0±1.0	50.7±2.1	68.0±2.0	76.0±1.0
5.0	6.0±1.0	15.0±1.0	20.3±1.5	31.3±1.5	14.3±0.6	33.0±2.6	52.3±2.5	62.0±1.0
7.5	5.7±0.6	12.3±1.5	17.3±1.5	22.3±2.1	13.7±2.3	28.3±2.1	38.3±2.1	48.7±2.1
10.0	5.3±1.5	11.7±1.2	15.7±1.2	20.0±1.0	10.3±1.5	21.0±1.7	31.7±1.5	36.7±2.1
F	4.205*	28.112*	28.781*	104.70*	21.663*	97.353*	245.898*	403.077*
P	0.030*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*
LSD 5%	2.205	4.098	4.205	3.154	3.189	4.582	3.455	2.936

F: F test (ANOVA)

*: Statistically significant at $p \leq 0.05$

Table.4 Repeated t-test before and after treatments according to radicle length

Treatment (%)	P values							
	<i>Trigonella foenum-graecum</i>				<i>Hordeum vulgare</i>			
	1	2	3	4	1	2	3	4
2.5% vs Control	0.336	0.029*	0.018*	0.002*	0.009*	0.136	0.226	0.002*
5% vs Control	0.022*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*
7.5% vs Control	0.013*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*
10% vs Control	0.007*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*

*: Statistically significant at $p \leq 0.05$

Fig 1 Radicle length of *Trigonella foenum-graecum* under treatment with different concentrations of *Moringa peregrine* aqueous extract

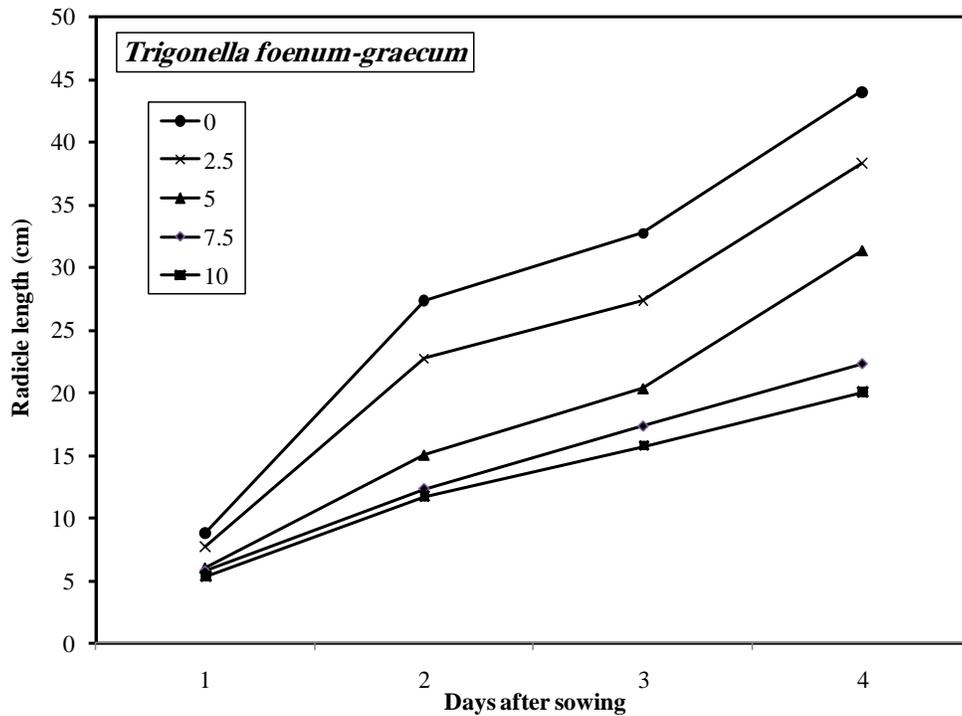
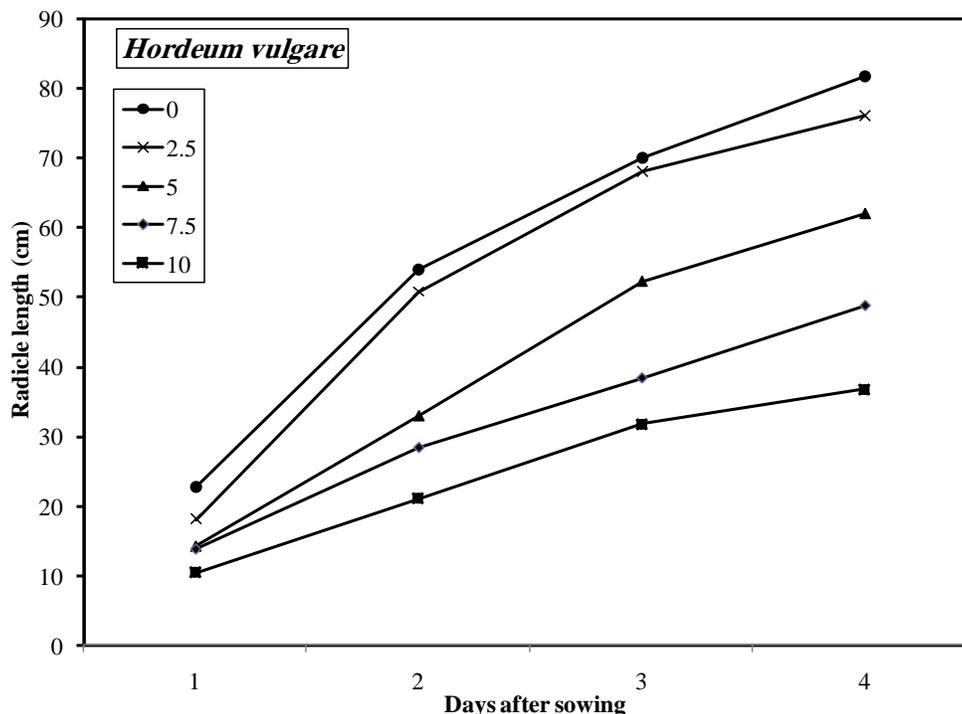


Fig 2 Radicle length of *Hordeum vulgare* seedlings under treatment with different concentrations of *Moringa peregrina* aqueous extract



Abou-Zeid and El-Darier (2014) suggested that the reduction in radicle lengths of *Chenopodium album* and *Portulaca oleracea* upon applying of *Eucalyptus rostrata* aqueous extract may be attributed to the presence of a diversity of allelochemicals in the extracts. Various studies have shown that, allelochemicals released by allelopathic plants do have negative effects on a large number of biochemical reactions on neighboring plant species (Oyerinde *et al.*, 2009). The allelochemicals released to the environment by plant species, have significant effects on neighboring plants by reducing the rate of photosynthesis and respiration processes and finally reduce yield (Bogatek and Gniazdowska, 2007).

In conclusion, the cultivation of *Moringa peregrina* accompanied with *Hordeum vulgare* and *Trigonella foenum-graecum* intercrops is not recommended for its dramatic effects on germination efficiency

and growth of the two species. Therefore, *Moringa peregrina* has to be considered as an allelopathic species posing risk in a rotation or an intercropping or mixed cropping system. With a view to alleviate its adverse effects on intercropping or subsequent crops, farmers should be conscious of leaves fallen from the mature trees and mixed with soil. The research needs further investigation to determine the nature of the chemical components of *Moringa peregrina* leaves aqueous extract then test their activities against the behavior of the intercrops.

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