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Allelopathic Effect of *Euphorbia guyoniana* Aqueous Extract and Their Potential Uses as Natural Herbicides

(Kesan Alelopati Ekstrak Akuos *Euphorbia guyoniana* dan Potensi Penggunaannya Sebagai Herbisid Asli)

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ABSTRACT

The aim of the present study was to investigate the potential allelopathic effects of Euphorbia guyoniana *(donor species) aqueous extract on germination efficiency of two weeds (*Bromus tectorum *and* Melilotus indica*) and one crop species (*Triticum aestivum*) under laboratory conditions. The germination efficiency, plumule and radicle length of* Bromus *was completely inhibited at the highest concentration of aqueous extracts of the donor species level (10%). The two recipient species exerted weak measures as affected by the highest concentration level of the donor. This inhibition was markedly obvious in* B. tectorum *than in* M. indica *indicating that* B. tectorum *is more sensitive to the tested donor, while the* M. indica *is more adapted to the aqueous extract than the* B. tectorum.

Keywords: Allelopathy; aqueous extract; Euphorbia guyoniana*; germination; weeds*

ABSTRAK

Tujuan penyelidikan ini ialah untuk mengkaji potensi kesan alelopati ekstrak akuos Euphorbia guyoniana *(spesies penderma) ke atas kecekapan percambahan dua rumpai (*Bromus tectorum *dan* Melilotus indica*) dan satu spesies tanaman (*Triticum aestivum*) dalam keadaan makmal. Kecekapan percambahan, plumul dan panjang radikel* Bromus *telah terencat sepenuhnya pada kepekatan tertinggi ekstrak akuos bagi tahap spesies penderma (10%). Dua spesies penerima telah memberi kesan lemah seperti yang dikesan oleh tahap kepekatan tertinggi bagi semua penderma. Perencatan ini adalah sangat jelas dalam* B. tectorum *berbanding dalam* M. indica *menunjukkan bahawa* B. tectorum *adalah lebih sensitif kepada semua penderma yang diuji, sementara* M. indica *adalah lebih teradaptasi kepada ekstrak akuos dibandingkan* dengan B. tectorum.

Kata kunci: Alelopati; ekstrak akuos; Euphorbia guyoniana*; percambahan; rumpai*

INTRODUCTION

The term allelopathy refers to any process involving secondary metabolites (allelochemicals) produced by plants, microorganisms, viruses and fungi that influence the growth and development of agricultural and biological systems including positive and negative effects. Allelochemicals from plants are released into the environment by exudation from roots, leaching from stems and leaves or decomposition of plant material (Lovett & Ryuntyu 1992; Rice 1984; Rizvi & Rizvi 1992). Plants or organisms that release these compounds are called 'donor species', while those that are influenced in their growth and development are called 'target or recipient species'. Allelopathy includes plant-plant, plant-microorganisms, plant-virus, plant-insects and plant-soil-plant chemical interactions. Allelopathic effects can be stimulatory or inhibitory, depending on the identity of the active compound on the static and dynamic availability, persistence and fate of organics in the environment and on the particular target species (Inderjit & Keating 1999). Allelopathy offers the potential for weed control through the production and release of allelochemicals from leaves, flowers, seeds, stems and roots of living or decomposing plant materials (Weston 1996). Also, allelopathy is generally accepted as a significant ecological factor in determining the structure and composition of plant communities (Scrivanti et al. 2003). The weeds have allelopathic superiority over crops besides their competition superiority (Zzet & Yusuf 2003). In allelopathy, relations exist between weeds and crops, weeds and weeds and crops and crops (Narwal 1994; Rice 1984), because modern agriculture relies on synthetic chemicals to get rid of these unwanted plants.

Contemporary research in allelopathy focuses on isolating, identifying and quantifying specific active allelochemicals. Once these substances are identified and characterized they can be used as natural herbicides (Tehmina et al. 2005). Some medicinal plants have inhibitory effects (Lin et al. 2003, 2004) on selected weeds and their allelochemicals inhibit weed growth (Lin et al. 2004). In addition, many results (Fujii et al. 1991, 2003) published confirm that it is easier to screen allelopathic plants from medicinal plants than other plants, possibly because there exist certain metabolic compounds for curing of diseases of mankind.

Present research is a part of a specific study being carried out in Algeria to explore the allelopathic effects of *Euphorbia guyoniana* (donor species) aqueous extract on germination efficiency of two weeds and one crop species under laboratory conditions.

MATERIAL AND METHODS

A number of fresh samples from the aerial shots of *Euphorbia guanina* were collected from the natural habitats during the vegetative stage. The samples were air-dried then ground in a Wiley Mill to fine uniform texture and stored in glass jars until use. Stock aqueous extract was obtained by soaking 50 g air-dried plant material in 500 mL of cold distilled water (10% w/v) at room temperature (20±2°C) for 24 h with occasional shaking. The mixture was filtered through two layers of cheesecloth and centrifuged for 20 min at 10.00 rpm to remove particulate material and the purified extract was adjusted to pH6.8 with 1M HCl. Different concentrations (2.5, 5, 7.5 and 10%) were prepared from the stock solution in addition to the control (distilled water). For experimental purpose, ten seeds of each of the weed *(Bromus tectorum* and *Melilotus indica)* and crop species *(Triticum aestivum*) were arranged in 9 cm diameter Petri-dishes lined with two discs of Whatman No.1 filter paper under normal laboratory conditions with day temperature ranging from 19-22°C and night temperature from 12-14°C. Two mL of each level of the donor species extract (2.5, 5, 7.5 and 10%) were added to three replicates. The seeds were surface sterilized with 2% sodium hypochlorite for 2 min before sowing, then rinsed four times with distilled water. The sterilized seeds were soaked in aerated distilled water for 24 h. The germination percentage (GP), plumule (PL) and radicle length (RL) were recorded after one weak at the end of the experiment. Relative reduction or stimulation of seed germination and radicle length as affected by the allelopathic substance were calculated.

STATISTICAL ANALYSIS

A standard one-way analysis of variance (ANOVA) was applied for evaluation, using the COSTAT 2.00 statistical analysis software manufactured by CoHort Software Company (1986).

RESULTS

The GP of *B. tectorum* was significantly ($p \leq 0.01$) affected by the increase in concentration of *E. guyoniana* aqueous extract (EGAE) (Table 1). In control and 2.5% EGAE, GP values were nearly 100%. The percentage was reduced to 36.6% at 5 and 7.5% EGAE concentration levels and to 10% at 10% EGAE concentration. Generally, GP of *M. indica* seeds varied with of EGAE concentrations (Table 1) and it is supported statistically ($p \leq 0.01$). In the control series GP values were 60% but decreased upon applying 2.5 and 5% EGAE concentrations (55 and 50%, respectively). However, the reduction goes to a markedly lower level at 7.5 and 10% concentrations (40 and 35%, respectively). Table 1 shows a great variation in the calculated values of GP of wheat seeds. The GP was significantly ($p \leq 0.01$) affected by the increase in EGAE concentrations. In control, 2.5 and 5% EGAE, GP values were about 100%. The percentage was reduced at 7.5 and 10% EGAE concentration levels.

PL results of *B. tectorum* imply that allelopathic substances affect negatively the seedling stage (Table 2). PL was significantly reduced ($p \leq 0.01$) at different concentrations of treatments given. The value of PL was 19.66 mm at control level, but reduced to 10.66 mm at 2.5% EGAE concentration. The maximum allelopathic action was recorded in 5, 7.5 and 10% EGAE concentrations, which completely inhibited PL. Allelopathic effect of EGAE concentration on PL of *M. indica* is given in Table 2. The plumule elongation was not completely inhibited by the extract, but the length was reduced at higher concentration levels. Obviously, all allelopathic concentrations have reduced PL. Statistically; interactions of the applied concentrations of EGAE were highly significant ($p \leq 0.01$). In control series PL of *M. indica* was 20 mm. In 2.5, 5, 7.5 and 10% concentrations inhibition was observed and the values were 18, 11.5, 8.5 and 2.5 mm, respectively. PL of wheat was significantly ($p \leq 0.01$) inhibited in each treatment (Table 2). PL was 42 mm in control series but was reduced to 37.3 mm at 2.5% EGAE concentration. The maximum allelopathic action of 5, 7.5 and 10% EGAE concentrations was observed in the form of inhibition as 26.5, 19 and 18 mm, respectively.

A slight difference was observed among *B. tectorum* RL (Table 3). The control value was 34 mm. Elevated EGAE concentrations had significant inhibitory effect on radical growth ($p \leq 0.01$). At 2.5% EGAE concentration, it was 5.66 mm. Upon applying highest EGAE concentration

TABLE 1. Effect of *Euphorbia guyoniana* aqueous extract on germination percentage of *Bromus tectorum*, *Melilotus indica* and *Triticum aestivum*

Aqueous extract	Germination percentage (%)					
	0%	2.5%	5%	7.5%	10%	Statistical analysis
Bromus tectorum	100.0[a]	100.0[a]	36.6[b]	36.6[b]	10.0[c]	**
Melilotus indica	60[a]	55[ab]	50[b]	40[c]	35[d]	**
Triticum aestivum	100.0[a]	100.0[a]	100.0[a]	95.0[b]	95.0[b]	**

TABLE 2. Effect of *Euphorbia guyoniana* aqueous extracts plumule length of *Bromus tectorum*, *Melilotus indica* and *Triticum aestivum*

Aqueous extract	plumule length (mm)					
	0%	2.5%	5%	7.5%	10%	Statistical analysis
Bromus tectorum	19.66[a]	10.66[b]	0.00[c]	0.00[c]	0.00[c]	**
Melilotus indica	20.00[a]	18.00[b]	11.50[b]	8.50[c]	2.50[d]	**
Triticum aestivum	42.00[a]	37.50[b]	26.50[c]	19.00[d]	18.00[d]	**

TABLE 3. Effect of *Euphorbia guyoniana* aqueous extract on radicle length of *Bromus tectorum*, *Melilotus indica* and *Triticum aestivum*

Aqueous extract	radicle length (mm)					
	0%	2.5%	5%	7.5%	10%	Statistical analysis
Bromus tectorum	34[a]	5.66[b]	2.66[c]	1.83[c]	1.33[c]	**
Melilotus indica	28.00[a]	14.50[b]	13.50[b]	11.00[c]	5.00[d]	**
Triticum aestivum	56.66[a]	22.50[b]	19.00[c]	17.50[d]	17.00[d]	**

(10%), it was reduced to 1.33 mm. A gradual decrease in RL of *M. indica* was observed with gradual increase in EGAE concentrations. RL was significantly affected by the treatment at $p\leq 0.01$. In the control, values of RL were 28 mm, but at higher concentrations of EGAE radicle emergence were clearly affected. At 2.5 and 5% concentrations, RL decreased to 14.5 and 13.5 mm; till it attained a value of about 11 and 5 mm at 7.5 and 10% concentrations. In the control series RL of wheat was 56.66 mm. High EGAE concentrations had significant inhibitory effect on radical growth ($p\leq 0.01$) (Table 3). At 2.5% EGAE concentration it was 22.5 mm. Upon applying the highest EGAE concentration (10%), it was reduced to 17 mm and at 5 and 7.5% EGAE, the values were 19 and 17.5 mm.

Discussion

Allelopathic effect of 2.5, 5, 7.5 and 10% aqueous extract besides the control from aerial shoots of *E. guyoniana* (donor species) was clearly demonstrated on germination percentage, plumule and radicle length of two weeds (*B. tectorum* and *M. indica*) and one crop species (*T. aestivum*). There are significant phytotoxic effects of *E. guyoniana* on germination and plumule and radicle length; which are in conformity with the findings that allelochemicals present in the aqueous extracts of plant species affect different physiological processes through their effects on enzymes responsible for phytohormone synthesis and they cause inhibition of nutrients and ion absorption by affecting plasma membrane permeability (Daizy 2007). This inhibition was more marked in *B. tectorum* than *M. indica* indicating that *B. tectorum* is more sensitive to the tested donors, while the *M. indica* is more adapted.

The aqueous extract of the donor plant showed wide range of activities as partial and complete inhibition, which may indicate the presence of certain allelochemicals causing inhibition (Qasem 2002; Rice 1974). Zzet and Yusuf (2004) stated that, plants directly affect another plant either positively or negatively through exuding chemical substances. Germination percentage (GP) of the two investigated recipient species demonstrated a gradual decrease related to the application of higher concentrations of the donor species as follows: *B. tectorum* >*M. indica*. Some species exhibited a stimulatory effect upon the recipient species which may be through hormonal activities or promotion of growth through adequate mineral supply. Other workers have indicated that effect of a given compound or plant metabolite may be inhibitory or stimulatory depending on their concentration in the surrounding medium (Chun-Mei et al. 2008; El-Darier 2002; Salhi et al. 2011).

Chemically, *E. guyoniana* has received little attention apart from the work done recently on the aerial parts from which two new diterpene polyesters with jatrophane skeleton have been isolated (Ahmed et al. 2006). These results are in agreement with those obtained by Fiorentino et al. (2009). The allelopathic effects of diterpenes, have been evaluated on the seed germination and seedling growth Mediterranean species and weeds (*Amaranthus retroflexus* and *Avena fatua*). The bioassay data, analyzed by principal component analysis, has shown more negative effects on weeds as compared with the coexisting species.

We can conclude that the species with strongest allelopathic potential like *E. guyoniana,* must be examined for their selective action on other specific plants including weeds and crops under field conditions. Analysis of possible allelochemicals in these plants is also required. The isolation and characterization of growth inhibitors, which might be responsible for the strong allelopathic potential of these species is needed. There is possibility of using these allelochemicals directly or as structural leads for the discovery and development of environment friendly herbicides to control weeds.

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