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Allelopathic influence of *Eupatorium odoratum* L. on germination and seedling growth of somepulses

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ABSTRACT

A case study on the allelopathic potential of *Eupatorium odoratum* on three common pulse seedsviz., *Pisum sativum*,*Phaseolus mungo* and *Lens esculenta* revealed significant inhibition of seed germination and seedling growth.The shade dried leaf powder (1, 2, 5 and 10 g) was soaked separately in 100 ml distilled water for 12 and 24 hours. The aqueous extracts showed inhibitory effects on seed germination, root and shoot length of 12 days old seedlings. The inhibitory effects were proportional to the concentrations of leaf extracts, and the two higher concentrations (5 and 10%) had more inhibitory effects. Among the test cropseeds, *Pisum sativum* showed least sensitive to the application of various concentrations of leaf extracts while *Phaseolus mungo* and *Lens esculenta* seeds were more susceptible to the allelopathic effects of *Eupatorium odoratum*. The results suggest that leaf extracts of *Eupatorium odoratum*had potent allelopathic activity although the magnitude of activity differed depending on concentration.The present study could be important in planning the field under different crops in view of the prevalent agro-ecosystem for higher yield. It is also suggested that these pulses should not be planted close to *Eupatorium odoratum*due to its adverse effects on their growth and development or the crop field should be kept free from this obnoxious weed.

Introduction

The inhibitory effect of one plant by another through releasing allelochemicals is commonly called “Allelopathy”. Itinfluences one plant upon another growing in its surrounding area by the release of certain metabolic toxic products. Allelopathy can be regarded as a component of biological control in which plants are used to decrease the vigour and development of other plants. Allelopathy is a natural occurrence whereas plant produces one or more biochemical substances that influenceseed germination, growth, survival and reproduction of other plants. Allelopathy involves the release of chemicals into the ecosystem. The biochemical substances are released by plant leaching, root exudation, volatilization, residue decomposition and other processes in both natural and agricultural systems (Kruse *et al*., 2000). These chemicals have harmful effects on the crop in the ecosystem resulting in the reduction and delaying in germination, mortality of seedlings and reduction in growth and yield.It has been shown that where *Eucalyptus* stand is replaced by the agricultural crop, that crop will not grow well, at least for a number of years (Fikreyesus *et al*., 2011). Several studies revealed that large areas of theground surface beneath the *Eucalyptus* remains completelybare and ground vegetation

is very limited in extent. The allelopathic effects of *Eucalyptus* species have greatly been investigated on different plant species (Willis, 2010; Yamagushi *et al.*, 2011).Different plant parts, including flowers, leaves, leaf litter and leaf mulch, stems, bark, roots, soil and soil leachates and their derived compounds, can have allelopathy activity that varies over a growing season (Madane and Bhimrao, 2015; Sikolia and Ayuma, 2018). Allelopathic chemicals can also persist in soil, affecting both neighbouring plants as well as those foliar and leaf litter leachates of *Eucalyptus* species, for example, are more toxic than bark leachates to some food crops (Sasikumar *et al.*, 2002). These parts possess allelochemicals like phenolic compounds, flavonoids, terpenoids, alkaloids, amino acids and have an inhibitory or stimulatory effect on the seed germination of crop plants (Mali and Kanade, 2004; Ghodake*et al.*, 2012). The leaf extract has much allelopathic property studied by Kumbhar and Patel (2012).*Eupatorium odoratum*leaf extracts caused inhibitory effect on seedling development of some legume crops (Rafiqul *et al.*, 2003).Hence, the present study is undertaken to assess allelopathic effects of *Eupatorium odoratum* which is a common bushy herb and to analyse how it exerts influence on common pulses.

Materials and Methods

Preparation of *Eupatorium* leaf extracts:

One hundred grams (100 g) of fresh mature leaf of *Eupatorium odoratum*, after shade duringfor 10 days, were powdered with the help of grinder and stored in polyethene bags.Theshade dried leaf powder (1, 2, 5 and 10 g) was soaked separately in 100 ml distilled water for 24 hours at room temperature.The collected extracts were filtered through fine cloth to remove debris and finally filtered using Whatman No. 1 filter paper. The filtrate was a stock solution and then prepared 1, 2, 5, and 10% concentration with distilled water. The four extract levels, besides the control (distilled water), were undertaken to perform the experiment under both laboratory and field conditions.The vigorousidentical seeds of *Pisum sativum,Phaseolus mungo* and *Lens esculenta*were surface sterilized with 1% sodium hypo-chloride for 10 minutes, then rinsed with distilled water for several times to eliminate excess adhering water on seeds. Then surface sterilized seeds were soaked for treatment with different concentrations of plant extracts along with distilled water (control) for 12 and 24 hours.All the treated seed samples were placed on 90 × 15 mm sterilized Petri dishes containing wet blotting paper and covered with a lid. The Petri dishes were then kept in a germinating Biochemical Oxygen Demand (B.O.D) type chamber, regulated at 25ÚC constant temperature with 12 hours photoperiod for five days. For each treatment, four replicates were used and each replicate containing 20 seeds.The percentage of seed germination was calculated after five days. The average growth of shoot and root was measured and compared with the corresponding controls and data were statistically analyzed. The data were recorded on percent seed germination and shoot and root length of 12 days old seedlings

during the course of experiment.

Results

Effects on seed germination:

As shown in Table-1, among various leaf extract concentrations, maximum germination percentwas observed in 1% aqueous extract while the minimum was found in 10% extract in all tested seeds. In *P. sativum* 98%, 88%, 76%, 70% and 60% of seed germination takes place in control, 1%, 2%, 5%, and 10% extract solution respectively when the seeds were soaked for 12 hours. On the other hand, about 98%, 71%, 57%, 55% and 39% of seed germination takes place in control, 1%, 2%, 5%, and 10% extract solution respectively when the seeds were soaked for 24 hours in the same species. Different concentrations of leaf extract of *E.odoratum*significantly inhibited the germination and seedling growth of *Pisum sativum,Phaseolus mungo* and *Lens esculenta*as compared to the control. It is clear from the results that application of aqueous extracts reduced germinationpercent of all the experimentalpulses. Seed germinabilityas shown in Table-1, among various concentrations of leaf extracts and time period on seed treatment, maximum germination percent was observed in control while the minimum was found in 10% leaf extract on both 12 and 24 hours duration of treatment. The study revealed that the inhibitory effect of leaf extracts increased with increasing extract concentration and time (Table-1). Seed germination of *P. sativum* wasstrictly inhibited and only 60 and 39 percent seed germinationwas observed in 10% extract when the seeds soaked for 12 and 24 hours respectively. On the other hand, only 40 percent and 38 percent seed germination was observed on *P. mungo* and *L. esculenta* when soaked in 10%extractfor 12 hours treatment respectively (Table-1).

Shoot Length:

Comparison of treatments revealed that shoot length of *Pisum sativum, Phaseolus mungo* and *Lens esculenta* was reduced with the application of leaf extracts. Shoot length decreased significantly with increasing concentrations of leaf extract of *E. odoratum* in all the treatments (Table-2). The highest inhibitory effects on shoot length were found in 10% concentration of leaf extract while the lowest was found in 1%. Shoot length of *P. sativum*was inhibited and only **2.9±0.2 cm** and **2.2±0.4**cm lengthwas observed in 10% extract when the seeds were soaked for 12 and 24 hours treatment respectively. On the other hand, only **3.0±0.1 cm** and **2.2±0.5 cm shoot length** was observed on *P. mungo* and *L. esculenta* when soaked in 10% extract for 12 and 24 hours treatment respectively (Table-2).

Root length:

Root length was found to decrease significantly with increasing concentration of leaf extract of *E. odoratum* in all the treatments (Table-3). The highest inhibitory effects on root length were found in 10% concentration of the leaf extract. The highest root length wasobserved in control where the length of roots was recorded **3.2±0.3**

cm, 3.2±0.4 cm and 3.0±0.1 cm in *P. sativum*, *P. mungo* and *L. esculenta* respectively. Root length of *P. sativum* was drastically inhibited and only **2.2±0.5 cm** and **2.1±0.2** cm length was observed in 10% extract when the seeds experienced soaking for 12 and 24 hours treatment respectively. On the other hand, only **2.0±0.4 cm** and **1.7±0.1 cm root length** was observed on *P. mungo* and *L. esculenta* when seeds underwent soaking in 10% extract for 12 hours treatment respectively (Table-3).

Discussion

The allelopathic effect of leaf extract iscaused due to the various phytotoxic compounds present in the extracts which may independently or conjointly impair to plant growth and inhibit seed germination. The results of this study showed that all the leaf extracts had allelopathic effects on germination and seedling growth, and inhibition was amplified with increasing concentrations used. These results were correlated with the findings of Kil and Lovett (1999),who reported inhibition of seed germination and seedling growth of some herbaceous plants such as chick pea, maizeand pea by aqueous leaf extracts of *Eucalyptus camandulensis* Dehnh. Plants may favourably or adversely affect other plants through allelochemicals, which may be released directly or indirectly from leaf, produced by dead plants or organic residues. This study examined the inhibitory nature of interference of aqueous leaf extract of *E. odoratum* on *Pisum sativum*, *Phaseolus mungo* and *Lens esculenta*. Some workers have reported on the allelopathic potential of common weeds on seed germination, seedling growth and yield of several crop species (Kong *et al*., 2007; Ilory *et al*., 2011). The results of present study were found similar to those of Malik (2004)and Yamagushi *et al*.,(2011)who studied allelopathic effects of *E. globulus* leaf extract on seed germination and seedling growth of some crop plants.

In our study, comparison of treatments revealed that shoot length of *Pisum sativum*, *Phaseolus mungo* and *Lens esculenta* was reduced with the application of *Eupatorium* leafextract irrespective of concentration. The lengths of shoot and root were highly reduced in all leaf extracts of *E. odoratum* and the magnitude of inhibition increased with increasing concentrations. Zhang and Shenglei (2010) reported that the length of radicles and plumules of radish, cucumber and chinese cabbage treated with leaf litter, root exudates of three *Eucalyptus* species were shorter than control and higher concentration induced greater phytotoxicity. In addition, leaf extracts of *E. camaldulensis* decreased root and shoot lengths of tomato (Fikreyesus *et al*., 2011).

From the present study, it can be concluded that aqueous extracts of leaves of *E. odoratum*renderedallelopathic effects on seed germination and seedling growth of *Pisum sativum*, *Phaseolus mungo* and *Lens esculenta*. The extracts reduced germination and growth of seedlings and this inhibitory effect increased with increasing extract concentrations.

Conclusion

The present study thus concludes that *Eupatorium odoratum* has strong allelopathic property as its leaf extracts succeeded in suppressing seed germinability and seedling growth of three pulses, namely *Pisum sativum*, *Phaseolus mungo* and *Lens esculenta*. Moreover, allelopathy is a concentration dependent phenomenon as its effect increases as the concentration of the extracts increases. Compared with the control (0%), higher concentrations remarkably reduced the seed germination percentage, shoot and root length. Therefore, it is suggested that the weed *Eupatorium odoratum* should be removed from pulse crop fields before the allelochemicals wash down in soil with rain water.

Table-1: Allelopathic effects of *Eupatorium odoratum* on seed germination (%)of different pulses. Results are the mean of 6 replicates.

	Seed germination (%) on 12 hrs of treatment					**Seed germination (%) on 24 hrs of treatment**				
Crops	**Control**	**1%**	**2%**	**5%**	**10%**	**Control**	**1%**	**2%**	**5%**	**10%**
Pisum sativum	98	88	76	70	60	98	71	57	55	39
Phaseolus mungo	98	77	60	58	40	98	70	54	50	29
Lens esculenta	96	61	55	51	38	96	55	49	44	30

Table-2: Allelopathic effects of *Eupatorium odoratum* on shoot length (cm) of different pulses. Results are the mean of 6 replicates (±SE).

	Shoot length(cm) after 12 hrs of leaf extract treatment on seeds					**Shoot length(cm) after 24 hrs of leaf extract treatment on seeds**				
Crops	**Control**	**1%**	**2%**	**5%**	**10%**	**Control**	**1%**	**2%**	**5%**	**10%**
Pisum sativum	**4.8±0.6**	**4.4±0.2**	**4.0±0.2**	**3.2±0.3**	**2.9±0.2**	**4.5±0.3**	**3.5±0.4**	**3.0±0.2**	**3.0±0.1**	**2.2±0.4**
Phaseolus mungo	**4.8±0.5**	**4.2±0.1**	**3.9±0.4**	**3.3±0.2**	**3.0±0.1**	**4.6±0.3**	**3.5±0.1**	**3.1±0.2**	**3.0±0.1**	**2.2±0.5**
Lens esculenta	**4.1±0.5**	**4.0±0.3**	**3.2±0.2**	**3.0±0.4**	**2.2±0.5**	**4.0±0.2**	**3.2±0.4**	**3.2±0.2**	**3.0±0.3**	**2.2±0.2**

Table-3: Allelopathic effects of *Eupatorium odoratum* on root length (cm) of different pulses. Results are the mean of 6 replicates (±SE).

	Root length(cm) after 12 hrs of leaf extract treatment on seeds					Root length(cm) for 24 hrs of leaf extract treatment on seeds				
Crops	**Control**	**1%**	**2%**	**5%**	**10%**	**Control**	**1%**	**2%**	**5%**	**10%**
Pisum sativum	**3.2±0.3**	**3.0±0.4**	**2.6±0.3**	**2.2±0.5**	**2.2±0.5**	**3.0±0.3**	**3.0±0.1**	**2.2±0.8**	**2.2±0.2**	**2.1±0.2**
Phaseolus mungo	**3.2±0.4**	**3.1±0.4**	**2.8±0.1**	**2.5±0.4**	**2.0±0.4**	**2.8±0.4**	**2.8±0.4**	**2.2±0.6**	**2.1±0.2**	**2.0±0.3**
Lens esculenta	**3.0±0.1**	**2.6±0.2**	**2.1±0.5**	**2.1±0.1**	**1.7±0.1**	**2.8±0.1**	**2.5±0.6**	**2.1±0.1**	**1.9±0.5**	**1.5±0.1**

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