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# Allelopathic effects of *Eucalyptus camaldulensis* on germination and seedling growth of mungbean

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### *ABSTRACT*

*The term of allelopathy, whereby one plant chemically interferes with seed germination, growth and development of others has been documented for over 2000 years. Allelochemicals are secondary metabolites of plants, released into the nearby environment through volatilization, leaching, root exudation and decomposition of residues. This experiment was aimed to examine the allelopathic effect of aqueous extracts of Eucalyptus leaves on seed germination and early growth of mungbean. Two pot experiments were carried out at Agronomy laboratory and research field, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur during February 2017 to March 2017 to find out the response of mungbean variety on Eucalyptus camaldulensis leaf extract. For screening four mungbean varieties (BARI Mung-3, BARI Mung-4, BARI Mung- 5 and BARI Mung-6) were tested with five levels of Eucalyptus camaldulensis leaf extract as allelopathic chemical (0, 5, 10, 15 and 20% concentration) for 8 DAS in small plastic pot. The germination rate of mungbean varieties was delayed and germination percentage was reduced with increasing leaf extract concentration compared to control. Fresh and dry weight of seedling was also lessened significantly compared to control. The inhibitory effects of Eucalyptus leaves were augmented as the extract concentration increased. These findings revealed that eucalyptus leaf extract adversely affect the germination and seedling growth of mungbean.*

***Key words**: Eucalyptus camaldulensis, Extract concentration, Allelopathic effects and Mungbean*

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## I. Introduction

Mungbean (*Vigna radiata* L. Wilczek) is widely grown in Bangladesh due to its speedy growth and prompt maturity. It is an environmental friendly food grain leguminous crop of dry land farming (Keatinge et al., 2011). Mungbean is cultivated in the area of 0.108 million hectare land with production of 0.03 million tons in Bangladesh (BBS, 2014). It contains 26 % protein, 62.5 %

carbohydrates, 1.4 % fat, 4.2 % fibers, vitamins and minerals (Ali and Gupta, 2012). The term allelopathy is derived from the Greek words *allelon* means "of each other" and *pathos* means "to suffer" (Rizvi et al., 1992). Allelopathy refers to the effects of one plant on another in crop and weed species, by the release of toxic chemicals from plant parts into the soil environment via root exudation, leaching, and volatilization or decaying plant tissue. Plants are known to synthesize chemical compounds that affect seed germination, seedling growth, metabolism, development, distribution, behavior, and reproduction of other organisms (Narwal et al., 1997). These allelochemicals can be toxic gases, organic acids, aromatic acids, unsaturated lactones, couramins, quinones, flavonoids, tannins, alkaloids, terpenoids and steroids, miscellaneous and unknown (Rice, 1984). Allelopathy may be one of several attributes which enable a plant to establish in a new ecosystem. *Eucalyptus* species has strong allelopathic activity among other plants (Gliessman, 2007). Generally leaves are the most potent source of allelochems; however, the toxic metabolites are also distributed in different plant parts in various concentrations. The presence of these allelochems often imparts plant defence against pathogens, insects, nematodes, and reduces infestation of weeds (Copping, 1996). Most of the agroforestry species provide a huge amount of leaf, litter and debris that are rich in allelochemical. Agroforestry scientists had little attention on allelopathic properties of agroforestry species. Melkania (1984) found inhibition of germination of seeds of barnyard grass (*Echinochloa crusgalli*), buckwheat (*Fagopyrum sagttatum*), soybean (*Glycine max*) and turnip (*Brassica napa*) by leachates of leaf, wood and leaf litter. Maize (*Zea mays*), mustard (*Brassica campestris*), pea (*Pisum sativum*), and wheat (*Triticum aestivum*) seed germination was also inhibited by litter extract (Joshi and Prakash, 1992).

Eucalyptus (*Eucalyptus camaldulensis*) is one of the most important plants used to prevent soil erosion. *Eucalyptus* spp. belongs to Myrtaceae family and are indigenous to Australia (May and Ash, 1990). It has been reported that agricultural crops do not grow well where eucalyptus stand is replaced by the crop (Fikreyesus et al., 2011). Del Moral and Muller (1970) reported that annual vegetation adjacent to *Eucalyptus camaldulensisis* often severely inhibited by allelochemicals released by this species. The allelopathic effect of eucalyptus has been attributed by producing many volatile terpenes and phenolic acids (Djanaguiraman et al., 2005; Sasikumar et al., 2002). Phytotoxic phenolic compounds in leaf extracts of *E. globulus* released volatile terpenoids that have inhibitory effects on seed germination and seedling growth of various crops (Sasikumar et al., 2002; Florentine and Fox, 2003). Phytotoxic chemicals are released into nearby ecosystem through volatilization, root exudation and leaching from the foliage (Djanaguiraman et al., 2005). These allelochemicals show a wide range of mode of action. They have shown both inhibitory and stimulatory roles in growth substances synthesis, enzymatic activities, respiration rate, photosynthesis or chlorophyll content, stomata and membrane integrity, water relations and mineral uptake (El-khawas and Shehata, 2005; Mohamadi and Rajaie, 2009). The leaf leachate of *E. globulus* inhibited germination and growth of rice, sorghum and blackgram (Djanaguiraman et al., 2005). Moreover, the extract of *E. globulus* inhibited germination and seedling growth of greengram and cowpea (Djanaguiraman et al., 2002) and blackgram (Sasikumar et al., 2002; Djanaguiraman et al., 2002). The allelopathic effect of leaf extract from *E. camaldulensis* was tested on tomato; the extract significantly inhibited germination and growth of this plant (Fikreyesus et al., 2011).

Due to the higher nutritive and economic value both the *E. camaldulensis* and mungbean in Bangladesh perspective may be grown in the same field in agroforestry system but there might have some questions whether *E. camaldulensis* may cause the yield deduction of mungbean as a result its allelopathic effects? The present study was carried out to know the effect of different concentrations of *E. camaldulensis* leaf extracts on the mungbean seed germination and seedling growth.

## II. Materials and Methods

The experiment was conducted at Agronomy Laboratory, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur during the period of February to March 2017. The leaves of *E. camaldulensis* L. were collected from alongside the road in the Faculty of Agriculture, HSTU, Dinajpur. These leaves were washed and then sun-dried for two weeks, ground and stored at room temperature. Good quality seeds of 4 mungbean varieties (BARI Mung-3, BARI Mung-4, BARI Mung-5 and BARI Mung-6) were collected from Bangladesh Agricultural Research Institute (BARI). The experiment was carried out in CRD design and replicated three times. The ground/powdered leaves material was



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soaked in distilled water in the ratio of 1:20 and kept for 24 hours. The filtrate was designated as stock solution of 100% concentration. From this stock solution, other concentrations viz., 5, 10, 15 and 20% were prepared by diluting it with distilled water and the control contained only distilled water. The data were recorded on germination, fresh and dry weight of stem and root. The data recorded were statistically analyzed and significant means were separated by using Least Significant Difference Test.

## III. Results and Discussion

### Germination percentage

The interaction effect between eucalyptus leaf extract and mungbean variety on germination percentage was statistically significant at different concentration of eucalyptus leaf extract. The result showed that germination percentage decreased markedly with increasing the concentration (Figure 01). The tendency of inhibition at 5, 10, 15 and 20% treatments was not similar for all the variety. At 5% concentration the highest germination percentage (85.33%) was observed in BARI Mung-5 and the lowest germination percentage (70.67%) was recorded from BARI Mung-3. Again at 20% concentration the highest germination percentage (34.67%) was observed in BARI Mung-5 and the lowest germination percentage (24.00%) was recorded from BARI Mung-3 which was statistically similar to that of BARI Mung-6.

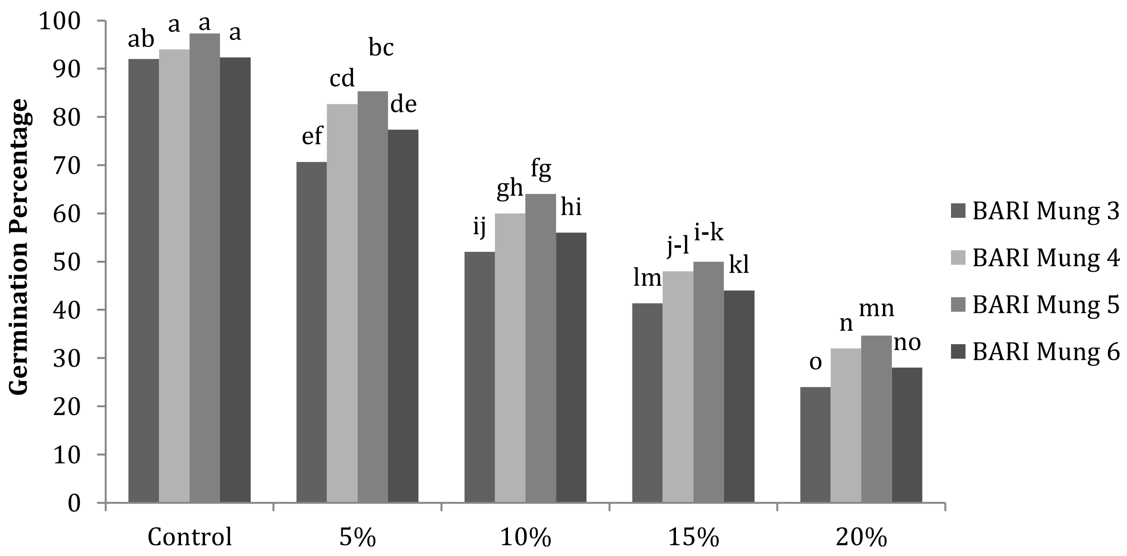


**Figure 01. Interaction effect of different variety and various concentration of *E. camaldulensis* leaf extracts on the germination percentage**

Germination reduction under allelopathic condition may be due to the hindrance of hilar opening in seeds treated with leaf extracts and these might have been adversely affected the normal opening of testa thereby reducing the uptake of water during germination which completely inhibition the germination of seeds. Plants having allelopathic potential can reduce seed germination ability, speed of germination and TTC (2,3,5 - Triphenyl tetrazolium chloride) stainability along with deranging of seed membranes causing leaky membrane structure (Nayek, 2002; Maiti, 2008).

### Germination index (%)

The interaction effect between eucalyptus leaf extract and the variety on germination index was significant (Table 01). The highest germination index (89.90 %) was observed in BARI Mung-5 with 5 % treatment condition which was statistically similar with BARI Mung-4 and the lowest germination index (71.10 %) was recorded from BARI Mung-3. On the other hand, at 20 % treatment condition the highest germination index (38.27 %) was observed in BARI Mung-5 which was statistically similar with BARI Mung-4 and the lowest germination index (25.15 %) was recorded from BARI Mung-3 which was statistically similar with BARI Mung-6. Similar type of result was observed by Sasikumar et al. (2006).

### Vigor index (%)



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The interaction effect between eucalyptus leaf extract and the variety on vigor index was significant at different concentration (Table 01). BARI Mung-5 was the least affected than the other variety. The highest vigor index (1498.92) was observed in BARI Mung-5 at 5% concentration and besides this the lowest vigor index (942.40) was recorded from BARI-3. At 20% concentration the highest vigor index (135.77) was observed in BARI Mung-5 which was statistically significant with BARI Mung-4 and the lowest vigor index (54.85) was recorded from BARI Mung-3 which was statistically significant with BARI Mung-6. Similar influencing in vigor index was reported by Sasikumar et al. (2006).

**Shoot length (cm)**

The interaction effect between eucalyptus leaf extract and the variety on shoot length was significant at different concentration (Table 01). The shoot length at 5% concentration was significantly lower than control and greater than the subsequent higher concentration (20%) for all the variety. The tallest shoot length (14.50 cm) was observed in BARI Mung-5 at 5% condition and the shortest shoot length (11.72 cm) was recorded from BARI Mung-3 which was statistically similar to that of BARI Mung-4 and BARI Mung-6. At 20%, the tallest shoot length (2.517 cm) was observed in BARI Mung-5 and the shortest shoot length (1.550 cm) was recorded from BARI Mung-3 which was statistically similar to that of BARI Mung-4 and BARI Mung-6. Length of shoot grown in control $T_0$ was better than any other treatments due to subdued levels of protein, insoluble carbohydrate, nucleic acids (DNA and RNA), chlorophyll as well as activity of catalase enzyme and other growth resources. Similar type of result was observed by Saberi et al. (2013).

**Table 01. Interaction effect of variety and concentration of Eucalyptus leaf extracts on germination and seedling growth properties of mungbean**

| Interaction | Germination index | Vigour index | Shoot length (cm) | Root length (cm) | Shoot fresh weight (g) | Root fresh weight (g) | Shoot dry weight (g) | Root dry weight (g) |
|---|---|---|---|---|---|---|---|---|
| $V_1 \times T_0$ | 100.0 a | 2073.3 d | 16.45 c | 6.15 d | 1.553 c | 1.057 d | 1.507 d | 0.503 d |
| $V_1 \times T_1$ | 71.09 d | 942.4 h | 11.72 e | 4.31 g | 0.157 e-g | 0.032 f-h | 0.029 ef | 0.004 e |
| $V_1 \times T_2$ | 56.23 ef | 309.2 l | 4.18 gh | 1.72 i-k | 0.131 e-g | 0.016 g-i | 0.025 e-g | 0.003 e |
| $V_1 \times T_3$ | 44.31 gh | 172.3 no | 2.82 i-k | 1.27k-m | 0.110 gh | 0.010 i | 0.020 e-g | 0.002 e |
| $V_1 \times T_4$ | 25.15 k | 54.85 r | 1.55 m | 0.502 n | 0.053 h | 0.004 i | 0.009 g | 0.001 e |
| $V_2 \times T_0$ | 100.0 a | 2467.1 b | 19.11 b | 8.27 b | 1.753 b | 1.709 b | 1.745 b | 0.804 b |
| $V_2 \times T_1$ | 84.63 bc | 1325.1 f | 12.40 e | 4.94 ef | 0.258 d | 0.048 ef | 0.030 e | 0.004 e |
| $V_2 \times T_2$ | 66.14 d | 473.40 j | 5.56 f | 2.30 i | 0.141 e-g | 0.018 g-i | 0.028 ef | 0.003 e |
| $V_2 \times T_3$ | 50.72 fg | 226.3 m | 3.16 ij | 1.47 j-m | 0.118 f-h | 0.015 hi | 0.024 e-g | 0.003 e |
| $V_2 \times T_4$ | 34.29 ij | 116.3 pq | 2.25k-m | 1.03 l-n | 0.100 gh | 0.008 i | 0.017 e-g | 0.002 e |
| $V_3 \times T_0$ | 100.0 a | 2733.3 a | 21.15 a | 9.28 a | 2.230 a | 2.045 a | 2.025 a | 1.005 a |
| $V_3 \times T_1$ | 89.90 b | 1498.9 e | 14.49 d | 5.26 e | 0.204 de | 0.056 e | 0.033 e | 0.004 e |
| $V_3 \times T_2$ | 68.07 d | 642.5 i | 5.94 f | 3.08 h | 0.157 e-g | 0.020 g-i | 0.028 ef | 0.003 e |
| $V_3 \times T_3$ | 55.20 ef | 270.5 l | 3.48 hi | 1.55 j-l | 0.128 f-h | 0.016 g-i | 0.025 e-g | 0.003 e |
| $V_3 \times T_4$ | 38.26 hi | 135.7 op | 2.51 j-l | 1.17k-m | 0.110 gh | 0.009 i | 0.019 e-g | 0.002 e |
| $V_4 \times T_0$ | 100.0 a | 2279.8 c | 18.71 b | 7.15 c | 1.682 b | 1.386 c | 1.614 c | 0.604 c |
| $V_4 \times T_1$ | 79.44 c | 1136.1 g | 12.26 e | 4.59 fg | 0.187 d-f | 0.032 fg | 0.029 ef | 0.004 e |
| $V_4 \times T_2$ | 59.41 e | 364.2 k | 4.48 g | 1.99 ij | 0.135 efg | 0.016 g-i | 0.026 ef | 0.003 e |
| $V_4 \times T_3$ | 47.16 g | 193.8 mn | 2.99 i-k | 1.28k-m | 0.114 f-h | 0.012 i | 0.023 e-g | 0.002 e |
| $V_4 \times T_4$ | 30.53 jk | 84.46 qr | 1.95 lm | 0.85 mn | 0.088 gh | 0.006 i | 0.013 fg | 0.002 e |
| LSD | 6.550 | 43.20 | 0.7512 | 0.6355 | 0.07438 | 0.01663 | 0.01663 | 0.01663 |
| CV (%) | 5.66 | 12.41 | 5.40 | 11.19 | 8.90 | 0.31 | 5.72 | 0.92 |

The figures in a column having common letter(s) do not differ significantly at 5% level of significance as per DMRT. $V_1$-BARI Mung-3,$V_2$-BARI Mung-4, $V_3$-BARI Mung-5, $V_4$-BARI Mung-6 and $T_0$= Control, $T_1$= 5.0%, $T_2$= 10.0%, $T_3$= 15.0%, $T_4$= 20.0% leaf extract.

**Root length (cm)**

The interaction effect between eucalyptus leaf extract and the variety on root length was significant at different concentration (Table 01). The largest root (5.26 cm and 1.174 cm) was observed in BARI Mung-5 both at 5 and 20% concentration, respectively. The shortest root (4.307 cm and 0.502 cm) was recorded from BARI Mung-3 at 5 and 20% concentration, respectively which was statistically identical



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with BARI Mung-4 and BARI Mung-6. Reduction of root length under allelopathic condition may be due to the significant decline in the mitotic index of the treated root tip cells of *Vigna radiata* undoubtedly pinpointed that the inhibitory effect of leaf extracts of *Eucalyptus* on cell division of root tips. The inhibitory effects on mitotic cell division behavior indicate the action of leaf extracts on possible alteration of the metabolism of interphase nucleus. Decrease in the mitotic index of this study clearly indicates the cytotoxic effect. Similar type of result was observed by Saberi et al. (2013).

**Shoot fresh weight (g)**
The results showed that there was a significant interaction effect between mungbean cultivars and leaf extract concentrations on shoot fresh weight (Table 01). At 5% level the highest shoot fresh weight (0.258 g) was observed in BARI Mung-4 and the lowest shoot fresh weight (0.157 g) was recorded from BARI Mung-3 which was statistically similar to that of BARI Mung-4 and BARI Mung-6. At 20% level the highest shoot fresh weight (0.110 g) was observed in BARI Mung-5 which was statistically identical with BARI Mung-4, BARI Mung-6 and the lowest shoot fresh weight (0.053 g) was recorded from BARI Mung-3 which was statistically similar to that of BARI Mung-4 and BARI Mung-6. Similar influencing in shoot fresh weight was reported by (Khan et al., 2009).

**Root fresh weight (g)**
Interaction between treatment and varieties were also significant. All mungbean variety significantly had lower root fresh weight under eucalyptus leaf extract conditions than that of normal conditions (Table 01). At 5% level the highest root fresh weight (0.056 g) was observed in BARI Mung-5 and the lowest root fresh weight (0.032 g) was recorded from BARI Mung-3 and BARI Mung-6. At 20% level, the highest root fresh weight (0.009 g) was observed in BARI Mung-5 and the lowest root fresh weight (0.004 g) was recorded from BARI Mung-3 which was statistically similar to that of BARI Mung-4, BARI Mung-5 and BARI Mung-6. Similar type of result was observed by (Khan et al., 2009).

**Shoot dry weight (g)**
Interaction between treatment and varieties were also significant. All mungbean varieties significantly had lower shoot dry weight under eucalyptus leaf extract conditions than that of normal conditions (Table 01). At 5% level, the highest shoot dry weight (0.033 g) was observed in BARI Mung-5 and the lowest shoot dry weight (0.029 g) was recorded from BARI Mung-3 and BARI Mung-6. At 20% level, the highest shoot dry weight (0.019 g) was observed in BARI Mung-5 and the lowest shoot dry weight (0.009 g) was recorded from BARI Mung-3 which was statistically significant with BARI Mung-4, BARI Mung-5 and BARI Mung-6. Similar influencing in Shoot dry weight was reported by (Khan et al., 2009).

**Root dry weight (g)**
The results showed that there was a significant interaction effect between mungbean cultivars and eucalyptus leaf extract concentrations on root dry weight (Table 01). At 5% concentration the highest root dry weight (0.004 g) was observed in BARI Mung-3 BARI Mung-4 BARI Mung-5 and BARI Mung-6. At 20%, the highest root dry weight (0.002 g) was observed in BARI Mung-4 BARI Mung-5 and BARI Mung-6 and the lowest root dry weight (0.001g) was recorded from BARI Mung-3 which was statistically similar to that of, BARI Mung-4, BARI Mung-5 and BARI Mung-6. Similar type of result was observed by (Khan et al., 2009).

## IV. Conclusion

The present study revealed that extract of *Eucalyptus camaldulensis* at various concentration levels inhibited the germination, reduced fresh and dry weights of mungbean seedlings. BARI Mung-5 showed better performance in terms of shoot and root growth (fresh and dry weights), lower reduction of germination percentage (GP), germination index (GI) and vigor index (VI). On the other hand BARI Mung-3 suppressed greatly in terms of fresh and dry weight, higher reduction of shoot and root lengths by the eucalyptus leaf extract. Shoot growth was more affected than root. Results on germination and seedling growth indicate that BARI Mung-5 was more tolerant and BARI Mung-3 was more sensitive variety.

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**APA**

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