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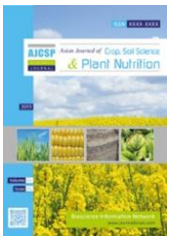

Allelopathic effects of *Eucalyptus camaldulensis* on growth, yield and yield contributing character of mungbean

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ABSTRACT

Selection of suitable cultivar under agroforestry systems is crucial to sustain the productivity of a crop. Therefore, an experiment was conducted at Agronomy Research field, HSTU, Dinajpur during March to May 2017 to determine the allelopathic effect of eucalyptus leaf extract (0, 5, 10, 15 and 20% eucalyptus leaf extract) on yield and yield attributes of Mungbean variety (BARI Mung-3, BARI Mung-4, BARI Mung-5 and BARI Mung-6). Most of the growth parameters viz., plant height, branches plant^{-1}, fresh and dry weight of leaf, stem, root performed better at control condition whereas decreased with increasing leaf extract concentration. Similar result found in yield and yield attributing characters (number of pods plant^{-1}, pod length, number of seeds pod^{-1}, 1000 seed weight, yield plant^{-1}). BARI Mung-5 performed better with eucalyptus leaf extract than the other variety.

Key Words: *Eucalyptus, Allelopathy, Mungbean and Yield traits.*

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I. Introduction

Mungbean (*Vigna radiata* L. Wilczek) is important pulse crop having high nutritional values and rich in protein content (Tahir et al., 2013). It also possess high nutritive value, digestibility and non-flatulent behavior. Mungbean is cultivated in the area of 0.108 million ha land with production of 0.03 million tons in our cuntry (BBS, 2014). It contains 26 % protein, 62.5 % carbohydrates, 1.4 % fat, 4.2 % fibers, minerals and vitamins (Ali and Gupta, 2012). Eucalyptus (*Eucalyptus camaldulensis*) is one of the most important plants used to prevent soil erosion. It is also planted as awindbreak and used as medicinal herb. *Eucalyptus* spp. belongs to Myrtaceae family and native to Australia (May and Ash, 1990). They have been introduced worldwide (Turnbull, 1999). Vast area of ground surface under *Eucalyptus spp.* remains totally bare and understory vegetation growth is limited in extent (El-Darier, 2002). It has been reported that at least for a number of years, crop will not grow well where eucalyptus stand is replaced by the agricultural crop (Fikreyesus et al., 2011). Del Moral and Muller (1970) concluded that annual vegetation near to *Eucalyptus camaldulensisis* often severely inhibited by allelochemicals

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released by this species. The allelopathic influence of eucalyptus is the production of many volatile terpenes and phenolic acids (Djanaguiraman et al., 2005; Sasikumar et al., 2002). Phytotoxic phenolic compounds in leaf litter and leaf aqueous extracts of *E. globulus* produce volatile terpenoids that have retarditory effects on germination and seedling growth of various crops (Sasikumar et al., 2002). Phytotoxic materials are mixed with soil ecosystem through root exudation, volatilization and leaching from the foliage (Djanaguiraman et al., 2005). These allelochemicals shows multiple mode of action. They have shown both inhibitory and stimulatory roles in growth substances synthesis, enzymatic activities, cell division and elongation, respiration, photosynthesis, biosynthesis of chlorophyll, stomata and membrane integrity, water relations and mineral uptake (El-khawas and Shehata, 2005; Mohamadi and Rajaie, 2009). The leaf extract of *E. globulus* inhibited seed germination and growth of rice, sorghum and blackgram (Djanaguiraman et al., 2005). Moreover, the extract of *E. globulus* inhibited seed 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 mungbean and *E. camaldulensis* 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 reduction of mungbean by allelopathic effect?

II. Materials and Methods

The experiment was conducted at Agronomy Research field, HSTU, Dinajpur during March to May 2017. The leaves of *E. camaldulensis* L. were collected from alongside the road in the Faculty of Agriculture, HSTU, Dinajpur. These leaves were washed thoroughly and sun-dried for two weeks 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 BARI, Gazipur. Twenty-five seeds of each variety were sown on plastic glasses. The experiment was laid out in CRD design with three replication. The leaves were ground/powdered and then soaked in distilled water in a ratio of 1:20 and kept for 24 hours. Then the extract was filtrated and designated as stock solution of 100% concentration. From this stock solution, required concentrations viz., 5, 10, 15 and 20% were prepared by diluting stock solution with distilled water and the control contained only distilled water. The data were recorded on plant height, branches plant^{-1}, fresh and dry weight (leaf, stem, root), number of pods plant^{-1}, pod length, number of seeds pod^{-1}, 1000 seed weight. The data recorded were statistically analyzed and significant means were separated by using Least Significant Difference Test.

III. Results and Discussion

Plant height

The interaction effect between eucalyptus leaf extract concentration and the variety on plant height was statistically significant (Table 01). The tendency of inhibition at 5, 10, 15 and 20% treatments was not similar for all the variety. At 5% concentration, the highest plant height (36.83 cm) was observed in BARI Mung-5 and the lowest Plant height (33.42 cm) was recorded from BARI Mung-3 which was statistically similar to that of BARI Mung-4 and BARI Mung-6. Again at 20% concentration the highest plant height (26.76 cm) was observed in BARI Mung-5 and the lowest plant height (24.90 cm) was recorded from BARI Mung-3 which was statistically similar to that of BARI Mung-4, BARI Mung-5 and BARI Mung-6. Reduction of plant height under allelopathic condition may be due to the decrease cell turgor pressure (El-Khawas and Shehala, 2005), transpiration rate, enzyme activity, metabolic energy for respiration and development activity, mitosis division, DNA replication, protein and hormone synthesis and finally decreasing cell growth.

Leaf fresh weight

Interaction between treatment and varieties were significant. All mungbean variety significantly had lower leaf fresh weight under eucalyptus leaf extract conditions than that of normal conditions (Table 01). At 5% level the highest leaf fresh weight (6.65g) was observed in BARI Mung-5 and the lowest leaf fresh weight (5.19g) was recorded from BARI Mung-3 which was statistically similar to that of BARI Mung-6. At 20% level the highest leaf fresh weight (3.30g) was observed in BARI Mung-5 and the

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lowest leaf fresh weight (2.21g) was recorded from BARI Mung-3 which was statistically similar to that of BARI Mung-6. Similar influencing in shoot fresh weight was reported by (Khan et al., 2009).

Shoot fresh weight

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 (4.23g) was observed in BARI Mung-4 which was statistically similar to that of BARI Mung-4 and BARI Mung-6 and the lowest shoot fresh weight (3.68g) was recorded from BARI Mung-3 which was statistically similar to that of BARI Mung-6. At 20% level the highest shoot fresh weight (2.01g) was observed in BARI Mung-5 and the lowest shoot fresh weight (1.36g) was recorded from BARI Mung-3 which was statistically similar to that of BARI Mung-6. Similar type of result was observed by (Khan et al., 2009).

Root fresh weight

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 (0.927g) was observed in BARI Mung-5 and the lowest root fresh weight (0.648g) was recorded from BARI Mung-3. At 20% level the highest root fresh weight (0.269g) was observed in BARI Mung-5 and the lowest root fresh weight (0.130g) was recorded from BARI Mung-3 which was statistically similar to that of BARI Mung-6. Similar result was observed by Fikreyesus et al. (2011).

Leaf dry weight

The results showed that there was a significant interaction effect between mungbean cultivars and eucalyptus leaf extract concentrations on root dry weight (Table 01). The highest root dry weight (1.071g) was observed in BARI Mung-4 at 5% concentration and the lowest root dry weight (0.873 g) was recorded from BARI Mung-3. At 20%, BARI Mung-5 had the highest root dry weight (0.397g) in composition to other variety studied which was statistically similar to that of BARI Mung-4 and the lowest root dry weight (0.180 g) was recorded from BARI Mung-3 which was statistically similar to that of BARI Mung-6. Similar type of result was observed by Hossain et al. (2012) in mungbean.

Shoot dry weight

Interaction between treatment and varieties were 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 (1.005g) was observed in BARI Mung-5 which was statistically significant with BARI Mung-4 and the lowest shoot dry weight (0.690 g) was recorded from BARI Mung-3 which was statistically significant with BARI Mung-6. At 20% level, the highest shoot dry weight (0.453g) was observed in BARI Mung-5 which was statistically significant with BARI Mung-3 BARI Mung-4and BARI Mung-6 and the lowest shoot dry weight (0.355g) was recorded from BARI Mung-3. These results are in agreement with the findings of Hossain et al. (2012) in mungbean.

Root dry weight

The results showed that, there was a significant interaction effect between mungbean cultivars and eucalyptus leaf extract concentrations on root dry weight (Table 01). The highest root dry weight (0.116 g) was observed in BARI Mung-5 at 5% concentration and the lowest root dry weight (0.080g) was recorded from BARI Mung-3 which was statistically significant with BARI Mung-4 and BARI Mung-6. At 20%, BARI Mung-4, BARI Mung-5 and BARI Mung-6 had the highest root dry weight (0.033g) in composition to other variety studied and the lowest root dry weight (0.017g) was recorded from BARI Mung-3. Similar type of result was observed by Hossain et al. (2012) in mungbean.

Total dry weight

Interaction between treatment and varieties were also significant. All mungbean varieties significantly had lower total dry weight under eucalyptus leaf extract conditions than that of normal conditions (Table 01). The highest total dry weight (2.191g) was observed in BARI Mung-5 which was statistically significant with BARI Mung-4 and the lowest total dry weight (1.643 g) was recorded from BARI Mung-3 which was statistically significant with BARI Mung-6 at 5%. Under 20% concentration the highest total dry weight (0.883 g) was observed in BARI Mung-5 which was statistically significant

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with BARI Mung-4 and the lowest total dry weight (0.552g) was recorded from BARI Mung-3 which was statistically significant with BARI Mung-4 and BARI Mung-6.

Number of pods plants^{-1}

The interaction effect between eucalyptus leaf extract and the variety on number of pods was significant (Table 01). The highest number of pods (7.00) was observed in BARI Mung-5 with 5% treatment condition and the lowest number of pods (5.33) was recorded from BARI Mung3 and BARI Mung-6. On the other hand, at 20% treatment condition the highest number of pods (3.66) was observed in BARI Mung-5 and the lowest number of pods (2.67) was recorded from BARI Mung-3. Similar influencing in number of pods per plant of mungbean was reported by Hossain et al. (2012).

Pod length

The interaction effect between eucalyptus leaf extract and the variety on pod length was significant at different concentration (Table 01). BARI Mung-5 was the least affected than the other variety. The highest pod length (7.05 cm) was observed in BARI Mung-5 at 5% concentration and besides this the lowest pod length (6.12 cm) was recorded from BARI Mung-3 which was statistically significant with BARI Mung-6. At 20% concentration the highest pod length (4.41 cm) was observed in BARI Mung-5 which was statistically significant with BARI Mung-4 and the lowest pod length (3.5 cm) was recorded from BARI Mung-3 which was statistically significant with BARI Mung-6. Similar type of result was observed by Hossain et al. (2012) in mungbean.

Seed pod^{-1}

The interaction effect between eucalyptus leaf extract and the variety on seed pod^{-1} was significant at different concentration (Table 01). The seed pod^{-1} at 5% concentration was significantly lower than control and greater than the subsequent higher concentration (20%) for all the variety. The tallest seed pod^{-1} (8.65) was observed in BARI Mung-5 at 5% condition and the shortest seed pod^{-1} (6.69) was recorded from BARI Mung-3. At 20%, the tallest seed pod^{-1} (4.72) was observed in BARI Mung-5 which was statistically similar to that of BARI Mung-4 and BARI Mung-6 and the shortest seed pod^{-1} (3.27) was recorded from BARI Mung-3. Similar type of result was observed by Hossain et al. (2012) in mungbean.

1000-seed weight

The results showed that there was a significant interaction effect between mungbean cultivars and leaf extract concentrations on 1000-seed weight (Table 01). At 5% level the highest 1000-seed weight (38.29g) was observed in BARI Mung-5 and the lowest 1000-seed weight (34.45 g) was recorded from BARI Mung-3. At 20% level the highest 1000-seed weight (25.62 g) was observed in BARI Mung-5 and the lowest 1000-seed weight (21.73 g) was recorded from BARI Mung-3 which was statistically similar to that of BARI Mung-6. Similar type of result was observed by Hossain et al. (2012) in mungbean.

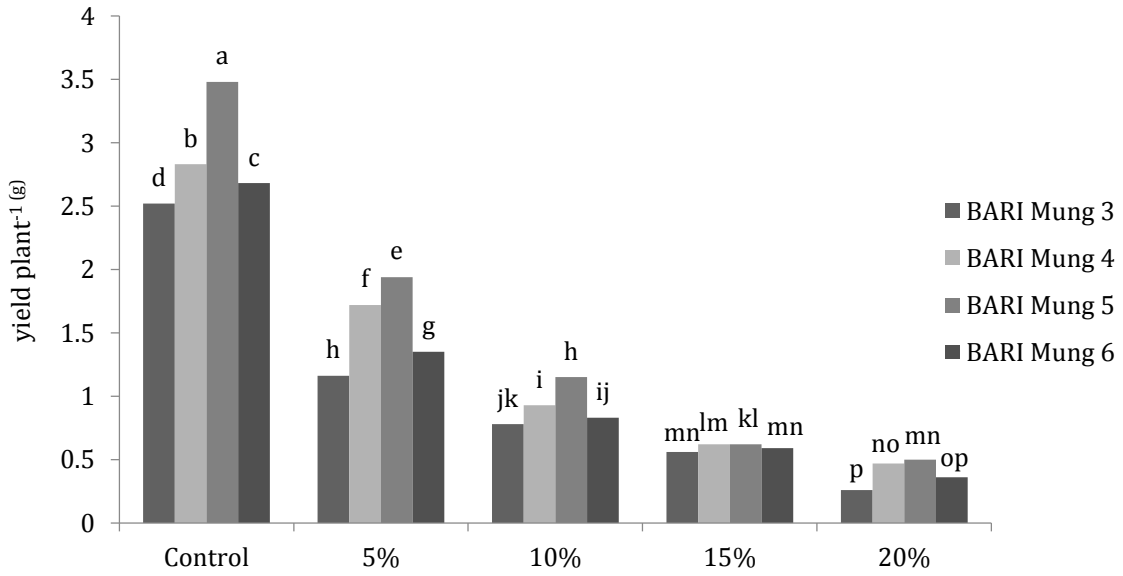

Figure 01. Interaction effect of different variety and various concentration of *E. camaldulensis* leaf extracts on yield plant^{-1} (g)

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Yield plant^{-1}

The study showed that there was a significant interaction between mungbean cultivars and eucalyptus leaf extract concentrations on yield plant^{-1} (Figure 01). The highest yield plant^{-1} (1.94 g) was observed in BARI Mung-5 at 5 % concentration and the lowest yield plant^{-1} (1.16 g) was recorded from BARI Mung-3. At 20 %, BARI Mung-5 had the highest yield plant^{-1}(0.50 g) in composition to other variety studied which was statistically similar to that of BARI Mung-4 and the lowest yield plant^{-1} (0.27 g) was recorded from BARI Mung-3 which was statistically similar to that of BARI Mung-6. Reduction of yield per plant under allelopathic condition may be due to the photosynthetic inhibitors may act as electron transport inhibition or uncouplers, energy-transfer inhibitors or a combination of the above (Batish et al., 2001; Hossain et al. (2012)).

IV. Conclusion

The present investigation revealed that aqueous extract of *Eucalyptus camaldulensis* at various concentration levels affects the yield and yield attributes of mungbean. The longest shoot length, root length and highest number of branch plant^{-1}, shoot fresh weight, shoot dry weight, root fresh weight, root dry weight, leaf fresh weight, leaf dry weight, number of pods plant^{-1}, seeds number plant^{-1}, seed weight plant^{-1} and 1000-seed weight were obtained from the control condition. On the other hand the shortest shoot length, root length and minimum number of branch plant^{-1}, shoot fresh weight, shoot dry weight; root fresh weight, root dry weight, leaf fresh weight, leaf dry weight and minimum yield contributing characters were obtained with 20 % solution treated plants. In case of yield of mungbean BARI Mung-5 showed the highest yield (3.48 g) plant^{-1} at control condition. At 20 % level BARI Mung-5 showed the highest yield (0.50 g) plant^{-1}, whereas the BARI Mung-3 provided the lowest yield (0.26 g) plant^{-1}. The results of this study revealed that eucalyptus leaf extract inhibited the mungbean germination, growth and development. It could be concluded that BARI Mung-5 was the best genotype in allelopathic condition than other genotype (i.e. BARI Mung-3 BARI Mung-4 and BARI Mung-6). The other conclusion is that, mungbean are incompatible with *Eucalypts* in agro-forestry systems.

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Table 01. Interaction effect of variety and concentration of Eucalyptus leaf extracts on growth and yield components of mungbean

Interaction	Plant height (cm)	Leaf fresh weight (g)	Shoot fresh weight (g)	Root fresh weight (g)	Leaf dry weight (g)	Shoot dry weight (g)	Root dry weight (g)	Total dry weight (g)	No. of pods	Pod length (cm)	Seed pod^{-1}	1000 seed weight (g)
$V_1 \times T_0$	45.47b	7.26c	4.57cd	1.02d	1.45d	1.02b-d	0.15d	2.62d	8.00 c	7.35c	9.19cd	39.33d
$V_1 \times T_1$	33.42d-f	5.19fg	3.68fg	0.65g	0.87gh	0.69ef	0.08fg	1.64fg	5.33 fg	6.12ef	6.69g	34.45h
$V_1 \times T_2$	29.92gh	4.44hi	2.98i-k	0.37j	0.63 j-l	0.58f-h	0.05h-j	1.26i-k	4.00 i	5.33hi	6.02hi	30.68j
$V_1 \times T_3$	27.23i-k	3.53kl	2.98 mn	0.27l	0.46m-o	0.48h-j	0.04kl	0.98lm	3.66 ij	4.62kl	4.89kl	26.82m
$V_1 \times T_4$	24.90l	2.21m	1.36 p	0.13n	0.18q	0.36k	0.02m	0.55o	2.67 k	3.54m	3.27n	21.73p
$V_2 \times T_0$	47.94a	8.44b	5.33 b	1.45b	1.97b	1.13b	0.19b	3.28b	9.00 b	7.94b	10.70b	44.56b
$V_2 \times T_1$	35.14cd	5.97de	4.12 e	0.77f	1.06ef	0.91d	0.10f	2.06e	5.67 ef	6.62d	8.22e	37.06f
$V_2 \times T_2$	31.49fg	4.68g-i	3.27 hi	0.46i	0.75h-j	0.61fg	0.07gh	1.40hi	5.00gh	5.68gh	6.18g-i	32.45i
$V_2 \times T_3$	29.14hi	4.01i-k	2.74 kl	0.33jk	0.58k-m	0.53g-i	0.05jk	1.15j-l	3.66 ij	5.13ij	5.40jk	28.55l
$V_2 \times T_4$	26.18kl	3.16l	1.71 op	0.21m	0.33op	0.41jk	0.02lm	0.76no	3.33 j	4.33l	4.33lm	24.06o
$V_3 \times T_0$	48.43a	9.79a	5.78 a	1.65a	2.11a	1.42a	0.23a	3.75a	10.33 a	8.36a	11.76a	47.32a
$V_3 \times T_1$	36.83c	6.65cd	4.23 de	0.93e	1.07e	1.01cd	0.12e	2.19e	7.00 d	7.06c	8.66de	38.28e
$V_3 \times T_2$	32.94ef	4.79gh	3.45 gh	0.56h	0.78hi	0.66ef	0.07gh	1.51gh	6.00 e	5.94fg	6.49gh	33.98h
$V_3 \times T_3$	29.53gh	4.26h-j	2.83 j-l	0.35jk	0.59k-m	0.53g-i	0.05i-k	1.17j-l	4.00 i	5.24i	5.80ij	29.52k
$V_3 \times T_4$	26.76j-l	3.31l	2.01 no	0.27l	0.40no	0.45ik	0.03k-m	0.88mn	3.66 ij	4.41l	4.72lm	25.62n
$V_4 \times T_0$	46.92ab	8.01b	4.97 bc	1.25c	1.74c	1.075bc	0.16c	2.98c	8.00 c	7.76b	9.58c	41.5 c
$V_4 \times T_1$	34.29de	5.56ef	4.05 ef	0.73f	0.93fg	0.760e	0.08fg	1.77f	5.33 fg	6.38de	7.40f	36.04g
$V_4 \times T_2$	30.37gh	4.54g-i	3.23 h-j	0.42i	0.70i-k	0.58f-h	0.06hi	1.37h-j	4.66 h	5.63gh	6.12g-i	31.78i
$V_4 \times T_3$	28.74h-j	3.73j-l	2.51 lm	0.31kl	0.51l-n	0.50g-j	0.04jk	1.05k-m	4.00 i	4.84jk	5.37jk	27.69lm
$V_4 \times T_4$	25.37kl	2.37m	1.61 op	0.15n	0.24pq	0.38 jk	0.02lm	0.65o	3.33 j	3.82m	4.14m	22.48 p
LSD	2.001	0.689	0.414	0.0526	0.139	0.117	0.016	0.217	0.627	0.372	0.597	0.929
CV (%)	3.59	8.14	7.46	5.20	9.49	9.76	9.76	7.83	7.06	3.85	5.33	1.71

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

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