ALLELOPATHIC EFFECTS OF MULTIPURPOSE TREE SPECIES *Melia azedarach* WITH EMPHASIS ON AGRICULTURAL CROPS

T. L. SHAPLA[1], R. PARVIN[2], M.H.A. AMIN[2] AND S.M. RAYHAN[3]

[1]Assistant Professor, Department of Agroforestry & Environmental Science, Sher-e-Bangla Agricultural University, Bangladesh; [2]Department of Agroforestry, Hajee Mohammad Danesh Science and Technology University, Bangladesh; [3]Department of Agronomy, Hajee Mohammad Danesh Science and Technology University, Bangladesh.

Corresponding author & address: M.H.A. Amin, E-mail: hafizallamin@yahoo.com
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ABSTRACT

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A pot experiment was conducted at the Agroforestry Farm, Hajee Mohammad Danesh Science and Technology University during May 2009 to July 2009 to observe the allelopathic effects of *Leucaena leucocephala,* two agricultural crops *viz*: mungbean and soybean. There were five treatments *viz*: T_1 (top soil); T_2 (root zone soil); T_3 (soil mulched with dry leaf); T_4 (soil watered with aqueous leaf extract); T_5 (control/fresh garden soil). The experiments were laid out in the Randomized Complete Block Design (RCBD) with four replications. The results of the present studies revealed that inhibition of germination and growth parameters of mungbean and soybean were varied according to different parts of plants and soil from different place. *Melia azedarach*: T_2 (root zone soil) >T_3 (soil mulched dry leaf) >T_4 (soil watered with aqueous leaf extract >T_1 (top soil > T_5 control / fresh garden soil.

Key words: multipurpose tree, allelopathic effects, agricultural crops

INTRODUCTION

In Bangladesh, under the traditional agroforestry system, several tree species are grown in or around the agricultural crop fields. Although, recent attempts have been made to use available lands more efficiently, agricultural losses are concentrated about the adverse effect of farm trees on cultivated land standing crops. Because of this, and with the need to grow food crops for subsistence, the planting of tree crops has not been practiced on a large scale, inspite of the fact that the country is also experiencing a shortage of fuel wood and fodder for domestic uses (Huq and Alim, 1995). Presently, over 100 Non government Organizations (NGOs) are engaged in rural development activities, which include nursery raising and tree planting programme all over the country. Participatory forestry initiatives by the forest Department and the NGOs include roadside tree plantations, homestead tree planting programme etc (Huq and Alim, 1995). Total plantation areas proposed in the current 20 years Forestry Master Plan are 164500 ha under participatory plantation programme and 398300 ha under industrial and environmental programme at a moderate level of development (Huq and Alim, 1995). It is expected that the future plantation will increase yield per unite land by replacing bare, low quality, sparse or degraded areas, on one hand, and increase yield of commercial products on the other. Under integrated land use system a tree crop and a food crop may be grown on the same piece of land with a proper combination of both the tree and agricultural crops (Bene *et al*. 1977). An increased productivity in the future plantations, both on forest lands and rural areas, can only be achieved by planting tree species and agri-crops in a combination which can imply a promtory rather than inhibitory tree crop interaction. Substantial information is available from developed countries on the basis aspects of allelopathy but very little information is available from the under-developed countries of the tropics and subtropics where biochemical interactions between the plants are intense owing to practice of multiple cropping agroforestry and different agro-ecosystem (Uddin *et al*. 2000). Agroforestry species remain a part of the agro-ecosystem for a longer period and often produce large amount of litter. The accumulation of such litter on the soil under agroforestry system of farming does not only mean a nutrient enrichment, but can also have negative effects on the agricultural crops due to the release of the toxic substances (Ahlgren and Ahlgren, 1981). These toxic substances may be released by rain action or through decomposition of litter. Consequently, the release of allelochemicals into the soil inhibits seed germination and establishment of certain crops (Rice 1979), slowing down of cell division, formation of tyloses (growth in the stem), block water movement from roots to leaves and increased membrane permeability (Jenson and Welbourne, 1962). After one or two years of tree removal, the toxicity gradually diminishes (Martin *et al*. 1956). Some scientists reported the inhibitory effect of *Eucalyptus*, *Babusa* spp*., Tectonia grandis, Acacia nilotica, Dalbergia sissoo, Morus alba, Bauhinia variegata, Ficus bengalensis, Poplus deltoides, Salix babylonica* and *Leucaena leucocephala* on germination and seedling growth of certain crops (Hossain *et al*. 2002). King (1979) pointed out the need for investigations of allelopathy in various tree species used in agroforestry where there is a good chance of alllelochemicals release by the intercrop trees affecting food and fodder crops. *Albizia lebbeck*, *Leucaena leucocephala*, *Melia azedarach*, and *Litchi chinensis* are the common tree species which are planted with agricultural crops e.g. Mungbean, soybean, wheat, maize, rice, vegetables etc. There must be significant interaction (positive or negative) between these components of Agroforestry i.e. woody perennials and agricultural crops. Therefore, it seems essential that the allelopathic compatibility of crops with trees should be checked before introducing in agroforestry system (Khan and Alam, 1996). Though many works are being done all over the world on allelopathy, it is still very new in our country (Uddin *et al*.

2000; Hossain *et al*. 2002). So, the study was performed to fulfill the following objectives: to assess about the allelopathic effects of *Melia azedarach* commonly used tree species on agricultural crops.

MATERIALS AND METHODS

The experiment was conducted in the Agroforestry research field, Department of Agroforestry, Hajee Mohmmad Danesh Science and Technology University, Dinajpur, located between 25°13' latitude and 88°23' longitude and about 37.5m above sea level. The climate of the study area is characterized by scanty rainfall during Rabi season (November to February) and minimum rainfall during this period of the year. The mean of maximum temperature in winter (November to February) was 27.69^0C and the mean of minimum temperature 17.06^0C. The mean humidity during this period was 86.69. The mean rainfall was found 8.8 mm during this period from November to February. Duration of the experimental period was from May to July. The experiment was conducted with single factor. RCBD (Randomized Complete Block Design) were applied with four replications. These are: 5 (Five) treatments i) T_1=Top soil (depth of top soil is 15 cm.), ii) T_2=Root zone soil (depth of root zone soil is 2 feet), iii) T_3=Soil mulched with dry leaves (sun dry), iv) T_4=Soil watered with aqueous Leaf extract (5% fresh aqueous leaf extract) and v) T_5=Ordinary/Fresh garden soil. The selected test crops were Mungbean (*Vigna radiata*) and Soybean (*Glycine max*). The experimental pot size was 28.5 cm. × 22.5 cm and each pot containing 5 kg of soil as germination media. The treatment T_1- Top soil was collected from the native woodlots of the tree crops (depth of top soil is15cm), T_2- root zone soil collected from the root systems of tree crops from native woodlots (depth of root zone soil is 2 feet), T_3- Garden soil collected from experimental garden and oven dried crushed leaves (20 gms) mulched in the upper layers of each pot, T_4- Garden soil watered with aqueous extract of fresh leaves of tree crops, and T_5- Garden soil watered with ordinary water served as control. The pots were carried in the experimental field in 20th April. After cleaning the weeds in the experimental field by spade, the pots were placed. 32 pots were filled with top soil and 20 pots were filled with root zone soil in 7th May. 20 pots were filled with garden soil in 8th May.5% aqueous wash of the fresh leaves of tree was made in 21th May and 100ml of this extract was added to each of 20 pots which containing garden soil. Leaves of the trees were sun dried for 5 days. 20 g crushed leaves were added in each 20 pots as mulched in 20th May. Other 4 pots were used as control and the pots were filled with ordinary garden soil. Source of the crops seed were BADC, Dinajpur and varieties were BINA Mung 5 and BARI Soybean 5. 20 Seeds of crops were sown in each pot in 22th May. The pots were watered regularly. Weeding was done periodically whenever necessary. Seed germination (%) was recorded after 14 days of sowing. Then all plants were uprooted except 5 plants in each pot. seedling attributes, such as length of shoot(cm), no. of leaves, leaf length(cm), leaflet breath(cm), shoot diameter(cm) were recorded at 26,36,46 and 56 days after sowing and root length(cm), root fresh weight(gm), shoot fresh weight(gm) were recorded at 62 days after sowing. Fresh roots and shoots were oven dried for three days and dry weights were recorded at 65 days after sowing. By using the sum of root dry weight and shoot dry weight, total biomass of the plants were found. The collected data on various parameters under different experiments were statistically analyzed using statistical program MSTAT to find out the statistical significance of the treatment effects. The means for all the treatments were calculated, and analysis of variance for all the characters were performed by the F-test. The significance of difference between the pair of means was evaluated by the Least Significant Difference (LSD) test (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

The results obtained from the present studies along with statistical analysis of data have been presented here.

Allelopathic effects of *Melia azedarach* on Mungbean (*Vigna radiata*)

Germination Percentage

Germination percentage of the crop significantly differs in all the treatments over control. Significantly the maximum inhibition (-7.44) was obtained in the treatment T_2 (root zone soil) followed by T_3 (soil mulched with dry leaf) and T_4 (soil treated with aqueous leaf extracts). But the lowest inhibition (-3.57) was in the treatment T_1 (top soil) (Fig. 1).
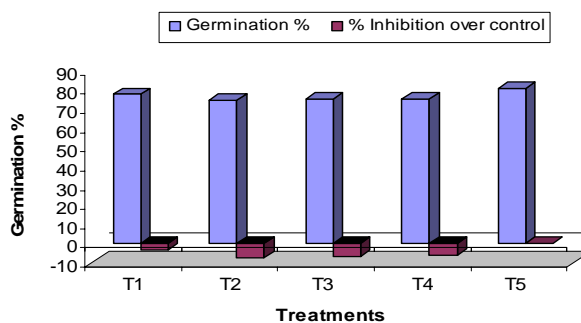

Fig.1. Allelopathic effects of *Melia azedarach* on germination of mungbean

Number of Leaf

No. of leaf of mungbean was varied significantly at different DAS in all the treatments in respects to control (Fig. 2). Significantly the maximum inhibition (- 31.07 at 26 DAS; -25.19 at 36 DAS; -20.25 at 46 DAS and -14.19 at 56 DAS) was found in the treatment T_2 (root zone soil) and the minimum (-15.32 at 26 DAS; -15.67 at 36 DAS; -14.44 at 46 DAS and -9.08 at 56 DAS) was observed in the treatment T_1 (top soil).
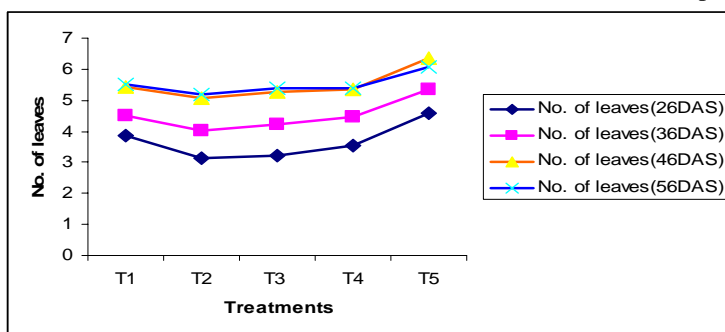

Fig.2. Allelopathic effects of *Melia azedarach* on no. of leaf of mungbean

Shoot Length (cm)

There was significant variation of shoot length of mungbean was found at different DAS in all the treatments in respects to control (Fig. 3). Significantly the maximum inhibition (-11.98 at 26 DAS; -15.49 at 36 DAS; -27.13 at 46 DAS and -16.22 at 56 DAS) was found in the treatment T_2 (root zone soil) and the lowest (-4.6 at 26 DAS; -5.38 at 36 DAS; -11.65 at 46 DAS and -9.41 at 56 DAS) was observed in the treatment T_1 (top soil).
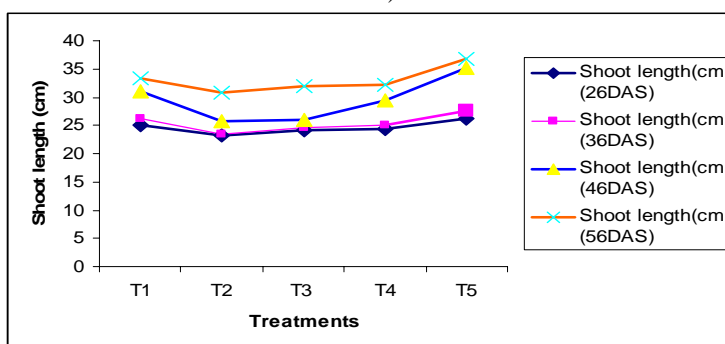

Fig.3. Allelopathic effects of *Melia azedarach* on Shoot Length of mungbean

Leaf Length (cm)

Leaf length of mungbean was varied significantly at different DAS in all the treatments over control (Fig. 4). Significantly the maximum suppression (-15.93 at 26 DAS; -21.70 at 36 DAS; -29.89 at 46 DAS and -29.93 at 56 DAS) was reported in the treatment T_2 (root zone soil) and the minimum (-11.33 at 26 DAS; -9.60 at 36 DAS; -13.41 at 46 DAS and -15.00 at 56 DAS) was observed in the treatment T_1 (top soil).
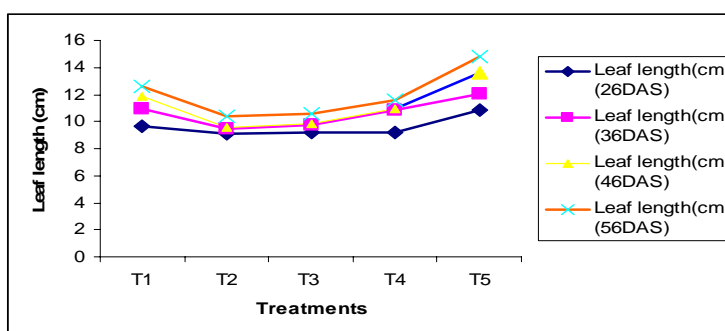

Fig.4. Allelopathic effects of *Melia azedarach* on Leaf Length of mungbean

Leaflet Breath (cm)

Leaflet breath of mungbean did not vary significantly at different DAS in all the treatments in comparism to control (Fig. 5). But the maximum suppression was found in the treatment T_2 (root zone soil) and the minimum was observed in the treatment T_1 (top soil) at all the DAS.
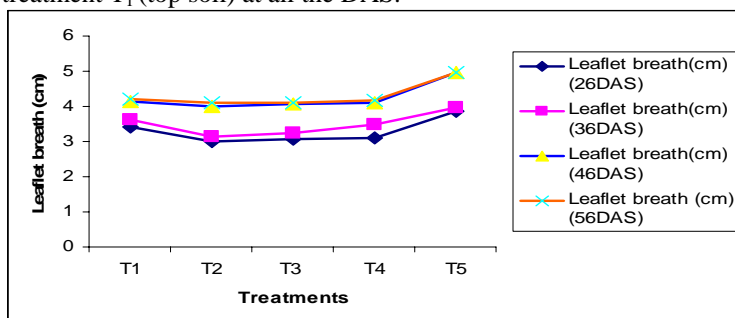

Fig.5. Allelopathic effects of *Melia azedarach* on Leaflet breath of mungbean

Shoot Diameter (cm)

All the treatments at 26 DAS, 36 DAS, 46 DAS and 56 DAS not significantly inhibit the shoot diameter of mungbean in comparison to control (Fig. 6). But the highest inhibition was reported in the treatment T_2 (root zone soil) and the lowest inhibition was observed in T_1 (top soil).
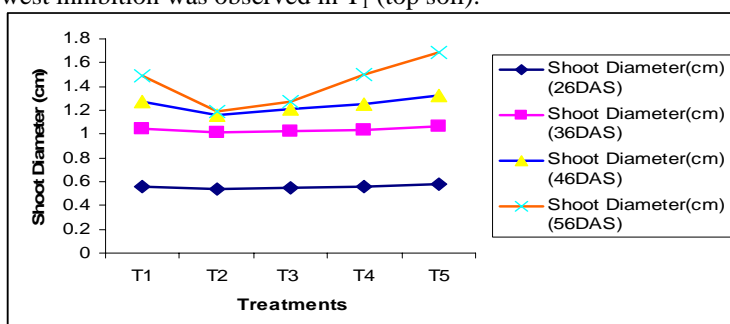

Fig.6. Allelopathic effects of *Melia azedarach* on Shoot diameter of mungbean

Table 1. Allelpoathic effects of *Melia Azedarach* on Germination and Growth of Mungbean

Treatments	Root Length (cm)	Shoot Fresh Weight(g)	Shoot Dry Weight(g)	Root Fresh Weight(g)	Root Dry Weight(g)	Total Dry Matter(g)
T_1	43.35b (-6.57)	6.25bc (-24.52)	3.50b (-12.5)	5.99b (-22.71)	3.73b (-32.56)	7.23b (-24.13)
T_2	35.12c (-24.31)	4.98c (-39.86)	2.24c (-44.00)	4.62c (-40.39)	2.39c (-56.78)	4.63c (-51.42)
T_3	35.86c (-22.72)	5.00c (-39.61)	3.00b (-25.00)	5.00b (-35.48)	3.15b (-43.03)	6.15b (-35.47)
T_4	36.00c (-22.41)	5.50c (-33.57)	3.10b (-22.50)	5.65b (-28.19)	3.28b (-40.69)	6.38b (-33.05)
T_5	46.40a (0.00)	8.28a (0.00)	4.00a (0.00)	7.75a (0.00)	5.53a (0.00)	9.53a (0.00)
Level of sig.	*	*	*	*	*	*
CV%	13.24	5.37	15.38	7.18	15.61	6.18

Note: Mean followed by a common letter is not significantly different at the 5% level by DMRT
    * = Significant at 5% level of probability; NS = Not Significant 4.3.1.1.7 Root length (cm)

Root Length

Root length was varied notably due to the all treatments. Among five treatments T_2 (root zone soil) shows the highest inhibitory effect (-24.31) on root length over control which was statistically similar to that of treatments T_3 (soil mulched with dry leaf) and T_4 (soil treated with aqueous leaf extracts) whereas the lowest inhibitory effect (-6.57) was found in the treatment T_1 (top soil) (Table 1).

Shoot Fresh Weight (g)

Shoot fresh weight of mungbean significantly suppressed under all the treatments in comparison to control (Table 1). The highest inhibition (-39.86) was observed in the treatment T_2 (root zone soil) followed by T_3 (soil

treated with dry leaf) and T_4 (soil watered with aqueous leaf extract). The lowest suppression (-24.52) was in T_1 (top soil).

Shoot Dry Weight (g)

All the treated treatments significantly inhibit the shoot dry weight of mungbean. Shoot dry weight inhibition (-44.00) was high in the treatment T_2 (root zone soil). Significantly the lowest inhibition (-12.50) was reported in the treatment T_1 (top soil) which was statistically similar to that of T_4 (soil with aqueous leaf extract) and T_3 (soil mulched with dry leaf) (Table 1).

Root Fresh Weight (g)

All the treatments significantly varied the root fresh weight of mungbean in comparison to control (Table 1). The highest inhibition (-40.39) of root fresh weight was observed in the treatment T_2 (root zone soil). Significantly the lowest inhibition (-22.71) was found in the treatment T_1 (top soil) followed by T_4 (soil with aqueous leaf extracts) and T_3 (soil with dry leaf).

Root Dry Weight (g)

Root dry weight significantly inhibited for all treatments (Table 1). Significantly the highest suppression (-56.78) of root dry weight was studied in the treatment T_2 (root zone soil) in respects to control and lowest (-32.56) was found in the treatment T_1 (top soil) followed by T_4 (soil with aqueous leaf extract) and T_3 (soil mulched with dry leaf).

Total Dry Matter (g)

All the treatments significantly inhibit the shoot dry weight of mungbean (Table 1). Mungbean total dry matter (-51.42) was highly suppressed by the treatment T_2 (root zone soil). Significantly the lowest inhibition (-24.13) was reported in the treatment T_1 (top soil) followed by T_4 (soil with aqueous leaf extract) and T_3 (soil mulched with dry leaf) over control.

Allelopathic effects of *Melia azedarach* on Soybean (*Glycine max*)

Germination Percentage

Germination percentage of the crop significantly varied in all treatments in comparison to control (Fig. 7). The highest inhibition (-7.55) was found in the treatment T_2 (root zone soil) followed by T_3 (soil mulched with dry leaf). The lowest inhibition (-3.61) was recorded in T_1 (top soil) followed by T_4 (soil with aqueous leaf extracts).
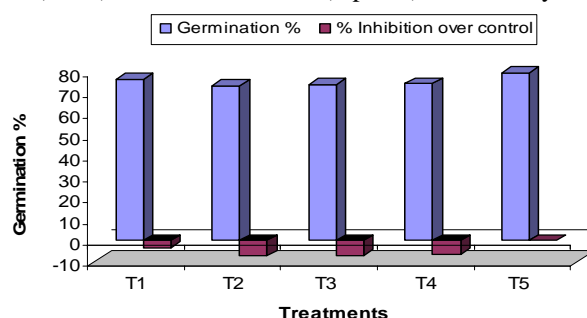

Fig.7. Allelopathic effects of *Melia azedarach* on germination of Soybean

Number of Leaf

No. of leaf of soybean varied significantly at different DAS in all the treatments over control. Significantly the maximum inhibition (-31.14 at 26 DAS; -25.23 at 36 DAS; -20.28 at 46 DAS and -14.21 at 56 DAS) was noted in the treatment T_2 (root zone soil) and the minimum (-15.35 at 26 DAS; -15.70 at 36 DAS; -14.46 at 46 DAS and -9.09 at 56 DAS) was found in the treatment T_1 (top soil) (Fig. 8).
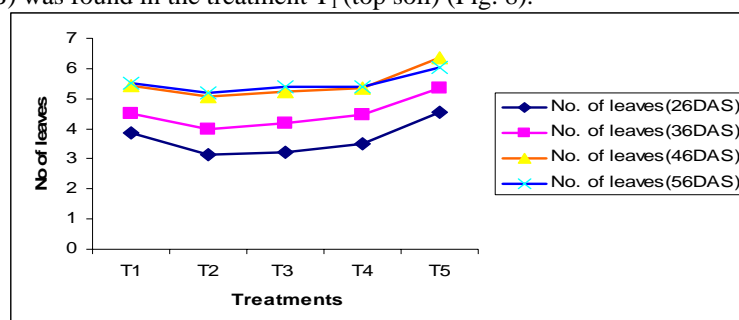

Fig. 8. Allelopathic effects of *Melia azedarach* on no. of leaf of Soybean

Shoot Length (cm)

There was significant variation was recorted of shoot length of soybean in all the treatments over control (Fig. 9). Significantly the maximum inhibition (-12.45 at 26 DAS; -16.06 at 36 DAS; -27.92 at 46 DAS and -16.67 at 56 DAS) was found in the treatment T_2 (root zone soil) and the minimum (-4.78 at 26 DAS; -5.58 at 36 DAS; -11.99 at 46 DAS and -9.68 at 56 DAS) was observed in the treatment T_1 (top soil).
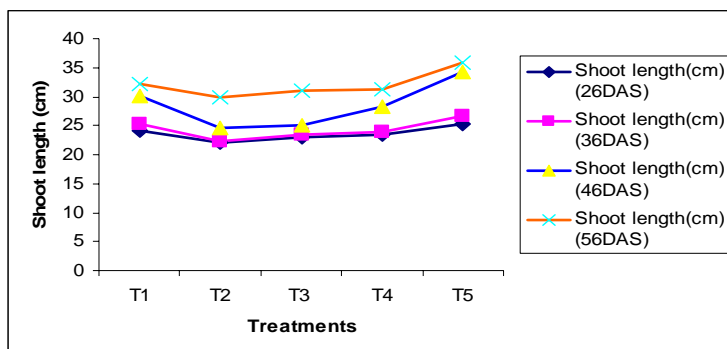

Fig.9. Allelopathic effects of *Melia azedarach* on Shoot Length of Soybean

Leaf Length (cm)

There was significant variation was noted at different DAS in all the treatments over control. Significantly the highest inhibition (-16.94 at 26 DAS; -23.67 at 36 DAS; -32.25 at 46 DAS and -32.10 at 56 DAS) was found in the treatment T_2 (root zone soil) and the lowest (-12.47 at 26 DAS; -10.48 at 36 DAS; -14.47 at 46 DAS and -16.09 at 56 DAS) was observed in the treatment T_1 (top soil) (Fig. 10).
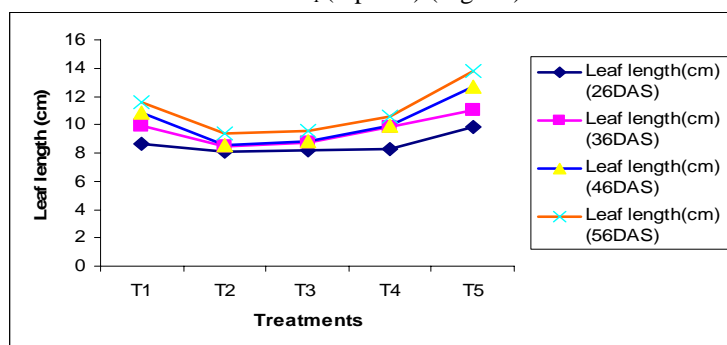

Fig.10. Allelopathic effects of *Melia azedarach* on Leaf Length of Soybean

Leaflet Breath (cm)

Leaflet breath of mungbean did not vary significantly at different DAS in all the treatments in comparism to control (Fig. 11). Significantly the maximum inhibition was found in the treatment T_2 (root zone soil) and the minimum was observed in the treatment T_1 (top soil) at all the DAS.
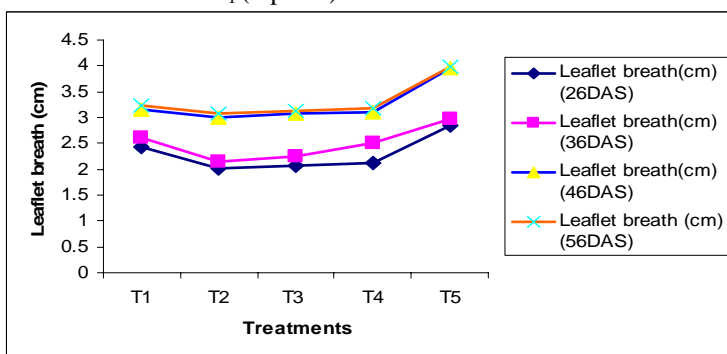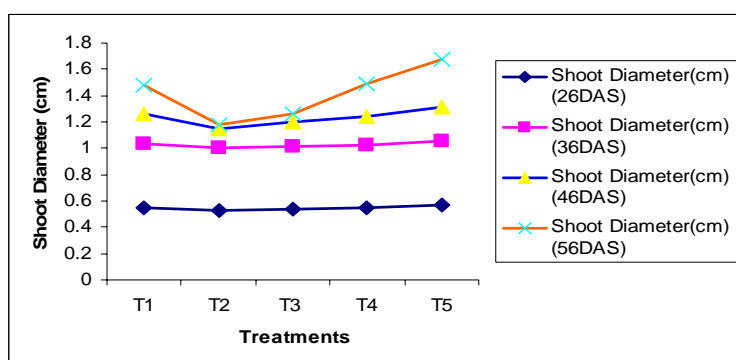

Fig.11. Allelopathic effects of *Melia azedarach* on Leaflet breath of soybean

Shoot Diameter (cm)

All the treatments at 26DAS, 36DAS, 46DAS and 56DAS did not significantly inhibit the shoot diameter of soybean in respect to control (Fig. 12). But the highest inhibition was reported in the treatment T_2 (root zone soil) and the lowest inhibition was gained in T_1 (top soil).

Fig.12. Allelopathic effects of *Melia azedarach* on Shoot diameter of Soybean

Root Length (cm)

From table 2, it was revealed that treatments were significantly suppressed the root length of that crop. The highest inhibitory effect of root length of soybean (-24.85) was observed in the treatment T_2 (root zone soil) over control which was stititically similar to that of T_3 treatment (soil mulched with dry leaf) and T_4 (soil with aqueous leaf extracts) whereas the lowest inhibitory effect (-6.72) was found in the treatment T_1 (top soil).

Shoot Fresh Weight (g)

Shoot fresh weight of soybean were significantly suppressed under all the treatments over control (Table 2). The highest inhibition (-45.33) was observed in the treatments T_2 (root zone soil) followed by T_3 (soil mulched with dry leaf) and T_4 (soil watered with aqueous leaf extract). The lowest suppression (-27.88) was in T_1 (top soil).

Table 2. Allelpoathic effects of *Melia azedarach* on Germination and Growth of Soybean

Treatments	Root Length (cm)	Shoot Fresh Weight(g)	Shoot Dry Weight(g)	Root Fresh Weight(g)	Root Dry Weight(g)	Total Dry Matter(g)
T_1	42.35b (-6.72)	5.25bc (-27.88)	2.50b (-16.67)	4.99b (-26.07)	2.73b (-39.74)	5.23b (-30.54)
T_2	34.12c (-24.85)	3.98c (-45.33)	1.24c (-58.67)	3.62c (-46.37)	1.39c (-69.32)	2.63c (-65.07)
T_3	34.86c (-23.22)	4.00c (-45.06)	2.00b (-33.33)	4.00b (-40.74)	2.15b (-52.54)	4.15b (-44.89)
T_4	35.00c (-22.91)	4.50c (-38.19)	2.10b (-30)	4.65b (-31.11)	2.28b (-49.67)	4.38b (-41.83)
T_5	45.40a (0.00)	7.28a (0.00)	3.00a (0.00)	6.75a (0.00)	4.53a (0.00)	7.53a (0.00)
Level of sig.	*	*	*	*	*	*
CV%	12.63	6.38	14.52	6.35	13.42	8.96

Note: Mean followed by a common letter is not significantly different at the 5% level by DMRT
    * = Significant at 5% level of probability; NS = Not Significant

Shoot Dry Weight (g)

All the treatments significantly inhibit the shoot dry weight of soybean (Table 2). Soybean shoot dry weight inhibition (-58.67) was high in the treatment T_2 (root zone soil). The lowest inhibition (-16.67) was reported in the treatment T_1 (top soil) followed by T_4 (soil with aqueous leaf extract) and T_3 (soil mulched with dry leaf).

Root Fresh Weight (g)

All the treatments significantly suppress the root fresh weight of soybean over control. The highest inhibition (-46.37) of root fresh weight was observed in the treatment T_2 (root zone soil). The lowest inhibition (-26.07) was found in the treatment T_1 (top soil) followed by T_4 (soil with aqueous leaf extracts) and T_3 (soil mulched with dry leaf) (Table 2).

Root Dry Weight (g)

Root dry weight was significantly inhibited in all treatments (Table 2). The highest suppression (-69.32) of root dry weight was showed in the treatment T_2 (root zone soil) in respect to control and lowest (-39.74) was found in the treatment T_1 (top soil) followed by T_4 (soil with aqueous leaf extract) and T_3 (soil mulched with dry leaf).

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Total Dry Matter (g)

All the treatments significantly inhibit the shoot dry weight of soybean (Table 2). Soybean total dry matter inhibition (-65.07) was high in the treatment T_2 (root zone soil). The lowest inhibition (-30.54) was reported in the treatment T_1 (top soil) followed by T_4 (soil with aquous leaf extract) and T_3 (soil mulched with dry leaf) over control.

DISCUSSION

The present study suggests that *Melia azedarach* contains some phytotoxic effects on germination and growth of test plants. From the experiment, among the five treatments, root zone soil of *Melia azedarach* cotain more allelochemicals. It is aggred in accordance Divya and Yassin (2003). They observed that *Azadirachta indica* reduced the germination, shoot length, root length, dry matter, and number of leaves and grain yield of cowpea, sesame, horse gram and sorghum. Maximum reduction in shoot and root length was recorded under rhizosphere soil. Maximum reduction in dry matter production and maximum suppression of grain yield was observed in the soil mulched with crushed dry leaves. The results of the experiment are similar to Divya and Yassin (2003), experiment. As *Melia azedarach* is in the same family of *Azadirachta indica,* so the experimental results may be accepted. The germination and seedling growth of both test crops in this experiment were reduced significantly over control at all the pot soil of leachate and extract of the tree. It is similar to the experiment of Amit-Walia *et al*. (2002).

CONCLUSION

The adverse effects of allelochemicals from trees and crops may reduce production and managed agroforestry ecosystem. The result of the present studies showed that inhibition of germination and growth parameters of mungbean and soybean were varied according to different parts of plants and soil from different place. *Melia azedarach*: T_2 (root zone soil)>T_3 (soil mulched dry leaf)>T_4 (soil watered with aqueous leaf extract)>T_1 (top soil)>T_5 (control/fresh garden soil). *Melia azedarach* is well-known for its biological activities in many countries, the inhibitory effects of this plant on germination and growth were also found.

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