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ALLELOPATHIC EFFECTS OF *Albizia lebbeck* ON AGRICULTURAL CROPS

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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 *Albizia lebbeck*, 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. *Albizia lebbeck* allelopathic effects of the treatments were as the following order: T_4 (soil watered with aqueous leaf extract)> T_2 (root zone soil) T_3 (soil mulched with dry leaf>T_1 (top soil)>T_4 (control / fresh garden soil).

Key words: *allelopathic effects, agricultural crops*

INTRODUCTION

The study of allelopathy (allelochemics) has only become a major thrust in tree biology in last 30 years. The term allelopathy is a Greek word meaning to suffer from each other. Allelopathy refers to the inhibition of growth of one plant by chemical compounds that are released into the soil from the neighboring plants. A large number of studies have been undertaken in recent years on such allelopathic interactions between the plants. Allelopathic properties have been reported for many species, especially trees. Although allelochemicals are present in practically all plant tissues, including leaves, flowers, fruits, stems, roots, rhizomes and seeds, information on the nature of active chemicals and their mode of action is lacking. The effects of these chemicals on other plants are known to be dependent principally upon the concentration as well as the combination in which one or more of these substances are released into the environment. Allelopathic effect is an interaction between different plants or between plants and microorganisms in which substances (allelochemicals) produced by one organism affect the growth of another (usually adversely). Agroforestry has been a collective term for land-use systems and practices in which woody perennials are deliberately integrated with crops and/or animals on.

The same land management unit, either in a spatial mixture or atemporal sequence. The trees in agroforestry pra ctices geneally fulfill multiple purposes, involving the protection of the soil or improvement of its fertility, as well as the production of one or more products (Cooper *et al*. 1996). Reduction in yield of agril-crops and or poorer growth of tree seedlings is often blamed on mismatching of crop combinations. Part of the problems, in fact, lies in the selection of tree and food crop combination, and inhibitory effects of some leaf leaches on agricultural crops. Allelopathy being a new and potential field, it is an emergent area of research in both developed and developing countries. Although farmers have observed problems related to allelopathy since the beginning of agriculture, concern and systematic research, however, started from 1940 in the field of agriculture and from 1970 in forestry (Rice 1984). *Albizia lebbeck*, *is* 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). So, the study was performed to fulfill the following objectives: to assess about the allelopathic effects of *Albizia lebbeck*, tree species used 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 88º23' 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 ^{0}C and the mean of minimum temperature 17.06 ^{0}C. 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 *Albizia lebbeck* on Mungbean (*Vigna radiata*)

Germination percentage

The germination percentage of mungbean varied notably due to the five treatments compared to control (Fig. 1). Significantly the maximum inhibition (-9.45) over control was found in the treatment T_4 (soil watered by aqueous leaf extracts) followed by the treatment T_2 (root zone soil) and T_3 (soil mulched with dry leaf). The minimum inhibition (-3.70) gained in the treatment T_1 (top soil).

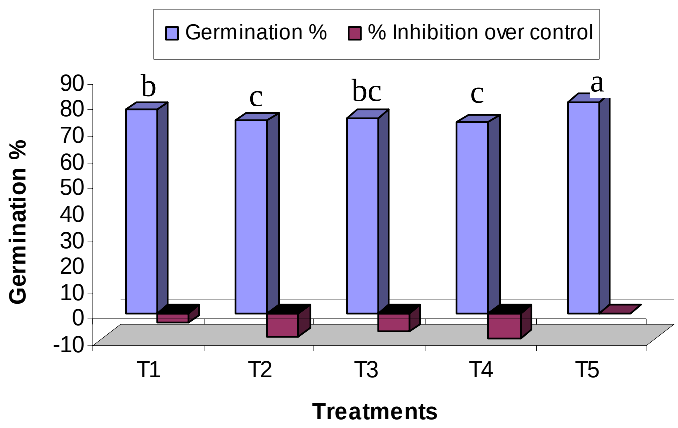

Fig.1. Allelopathic effects of *Albizia lebbeck* on germination of mungbean
Note: Mean followed by a common letter is not significantly different at the 5% level by DMRT

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 (-26.98 at 26 DAS; -21.73 at 36 DAS; -28.80 at 46 DAS and -22.41 at 56 DAS) was found in the treatment T_4 (soil watered with aqueous leaf extracts) and the minimum (-13.31 at 26 DAS; -13.39 at 36 DAS; -12.77 at 46 DAS and -8.09 at 56 DAS) was observed in the treatment T_1 (top soil).

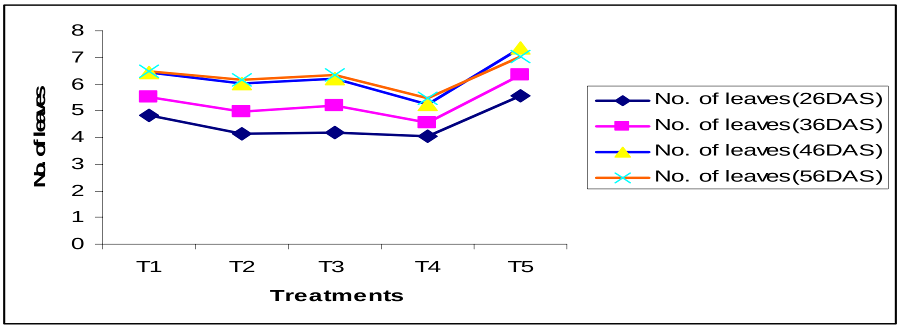

Fig. 2. Allelopathic effects of *Albizia lebbeck* on no. of leaf of mungbean

Shoot Length (cm)

At different DAS Shoot length of mungbean was varied significantly in all the treatments over control (Fig. 3). Significantly the highest inhibition (-12.55 at 26 DAS; -15.99 at 36 DAS; -27.22 at 46 DAS and -28.63 at 56 DAS) was found in the treatment T_4 (soil watered with aqueous leaf extracts) and the lowest (-4.79 at 26 DAS; -5.42 at 36 DAS; -11.76 at 46 DAS and -9.52 at 56 DAS) was observed in the treatment T_1 (top soil).

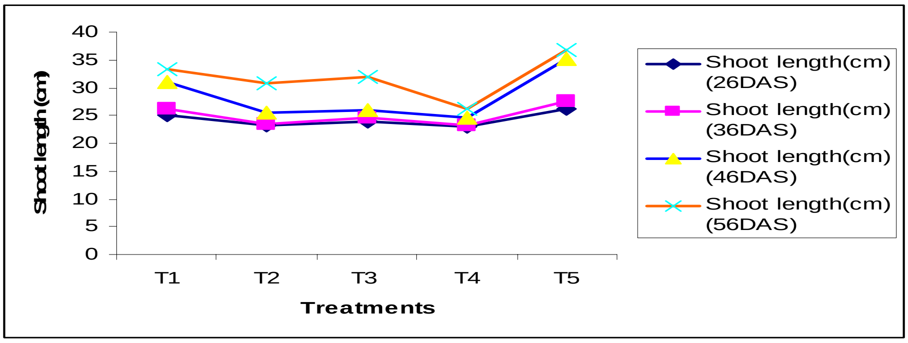

Fig. 3. Allelopathic effects of *Albizia lebbeck* on Shoot Length of mungbean

Leaf Length (cm)

All the treatments significantly influenced the leaf length of mungbean at different DAS in respects to control (Fig. 4). Significantly the highest suppression (-17.13 at 26 DAS; -17.13 at 36 DAS; -32.97 at 46 DAS and -15.54 at 56 DAS) was noted in the treatment T_4 (soil watered with aqueous leaf extracts) and the lowest (-11.50 at 26 DAS; -9.78 at 36 DAS; -13.55 at 46 DAS and -15.54 at 56 DAS) was observed in the treatment T_1 (top soil).

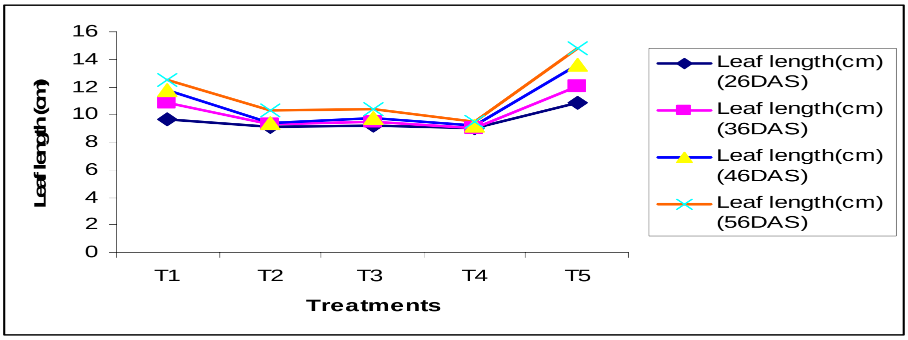

Fig. 4. Allelopathic effects of *Albizia lebbeck* on Leaf Length of mungbean

Leaflet Breath (cm)

Leaflet breath of mungbean was varied significantly at different DAS in all the treatments in respects to control (Fig. 5).At 26 and 36 DAS there was no significant variation among the treatments. Significantly the highest inhibition(-33.74 at 46 DAS and -29.18 at 56 DAS) was found in the treatment T_4 (soil watered with aqueous leaf extracts) and the lowest (-16.36 at 46 DAS and -15.49 at 56 DAS) was reported in the treatment T_1 (top soil).

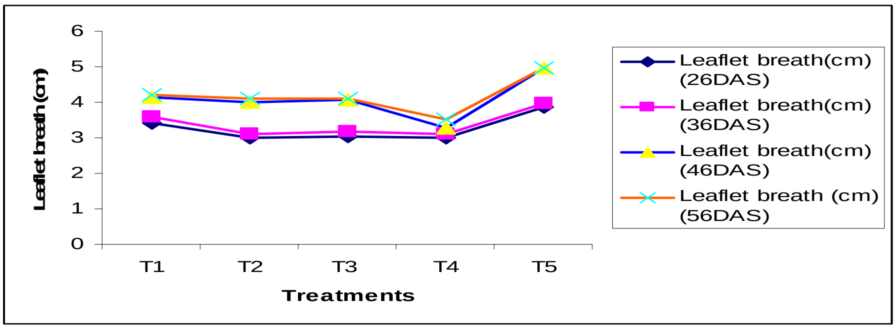

Fig. 5. Allelopathic effects of *Albizia lebbeck* on Leaflet breath of mungbean

Shoot Diameter (cm)

Shoot diameter of mungbean was varied significantly at different DAS except 26 DAS in all the treatments in respects to control (Fig. 6). Significantly the maximum inhibition (-35.51 at 36 DAS; -25.00 at 46 DAS and -40.23 at 56 DAS) was observed in the treatment T_4 (soil watered with aqueous leaf extracts) and the minimum (-3.74 at 36 DAS; -7.32 at 46 DAS and -15.98 at 56 DAS) was noted in the treatment T_1 (top soil).

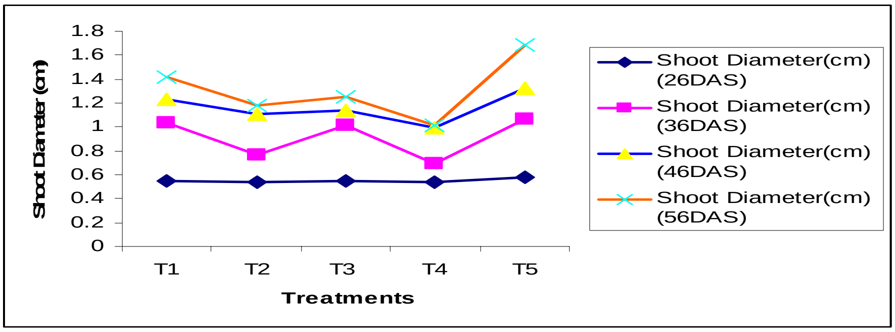

Fig. 6. Allelopathic effects of *Albizia lebbeck* on Shoot diameter of mungbean

Table 1. Allelpoathic effects of *Albizia lebbeck* 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	42.22b (-9.00)	6.16bc (-25.60)	4.45a (-11.25)	5.84b (-24.65)	3.72b (-32.73)	8.17b (-14.27)
T_2	34.85c (-24.90)	4.55c (-45.05)	2.75b (-31.25)	4.42c (-42.97)	2.33c (-57.87)	5.08c (-46.69)
T_3	35.45c (-23.60)	4.97c (-39.98)	2.98b (-25.50)	4.95c (-36.13)	3.10b (-43.94)	6.08b (-36.20)
T_4	34.27c (-26.14)	4.00c (-51.70)	2.50b (-37.50)	4.12c (-46.84)	2.25c (-59.31)	4.75c (-50.16)
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%	12.32	8.25	12.27	6.35	16.53	9.38

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

Root length (cm)

The root length of the test crop varied notably (table 1) due to the five treatments compared to control. The treatment T_4 (soil watered with aqueous leaf extract) has highest inhibitory effect (-26.14) on root length of mungbean over control whereas, the lowest inhibitory effect (-9.00) was gained in the treatment T_1 (top soil).

Shoot Fresh Weight (g)

Shoot fresh weight of mungbean significantly suppressed in all the treatments in comparison to control (Table 1). Significantly the highest inhibition (-51.7) was obtained in the treatments T_4 (soil with aqueous leaf extract) followed by T_2 (root zone soil), T_3 (soil mulched with dry leaf) and T_1 (top soil).

Shoot dry weight (g)

All the treatments significantly inhibit the shoot dry weight of mungbean over control (Table 1). Significantly mungbean shoot dry weight inhibition (-37.5) was high in the treatment T_4 (soil with aqueous leaf extract) followed by T_2 (root zone soil) and T_3 (soil mulched with dry leaf). The lowest inhibition (-4.45) was gained in the treatment T_1 (top soil) followed by T_5 (fresh garden soil).

Root Fresh Weight (g)

Significantly the highest inhibition (-46.84) of root fresh weight was observed in the treatment T_4 (soil with aqueous leaf extracts) followed by T_2 (root zone soil) and T_3 (soil mulched with dry leaf). All the treatments significantly suppressed the root fresh weight of mungbean in respects to control. The lowest inhibition (-24.65) was found in the treatment T_1 (top soil) (Table 1).

Root dry weight (g)

It was observed that root dry weight significantly varied in all treatments over control (Table 1). The highest suppression (-59.31) of root dry weight was gained in the treatment T_4 (soil with aqueous leaf extract) followed by T_3 (root zone soil) in comparison to control and lowest (-32.73) was found in the treatment T_1 (top soil) followed by T_3 (soil mulched with dry leaf).

Total Dry Matter (g)

Total dry matter of the test crop was affected significantly in all the treatments (Table 1) over control. Among the five treatments, total dry matter inhibition (-50.16) was large in the treatment T_4 (soil with aqueous leaf extract) followed by T_2 (root zone soil). The shortest inhibition (-14.27) was reported in the treatment T_1 (top soil) followed by T_3 (soil mulched with dry leaf).

Allelopathic effects of *Albizia lebbeck* on soybean (*Glycine max*)

Germination percentage

The germination percentage of soybean varied notably due to the five treatments compared to control (Fig. 7). Significantly the maximum inhibition (-9.57) over control was found in the treatment T_4 (soil watered by aqueous leaf extracts) followed by the treatment T_2 (root zone soil) and T_3 (soil mulched with dry leaf). The minimum inhibition (-3.75) gained in the treatment T_1 (top soil).

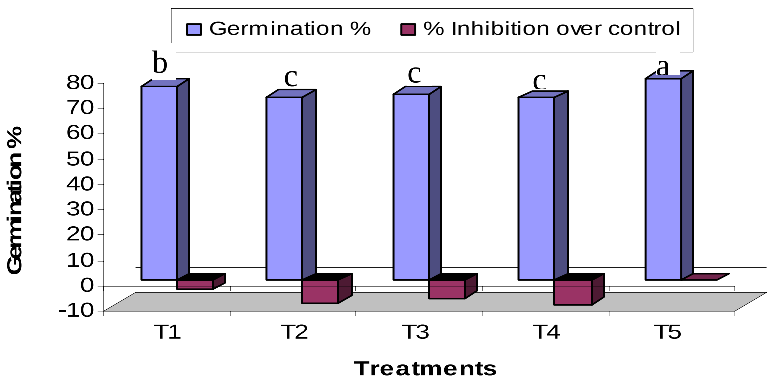

Fig. 7. Allelopathic effects of *Albizia lebbeck* on germination of Soybean
Note: Mean followed by a common letter is not significantly different at the 5% level by DMRT

Number of Leaf

No. of leaf of soybean was varied significantly at different DAS in all the treatments in respects to control (Fig. 8). Significantly the maximum inhibition (-32.89 at 26 DAS; -33.83 at 36 DAS; -33.33 at 46 DAS and -26.12 at 56 DAS) was found in the treatment T_4 (soil watered with aqueous leaf extracts) and the minimum (-16.22 at 26 DAS; -15.89 at 36 DAS; -14.78 at 46 DAS and -9.42 at 56 DAS) was observed in the treatment T_1 (top soil).

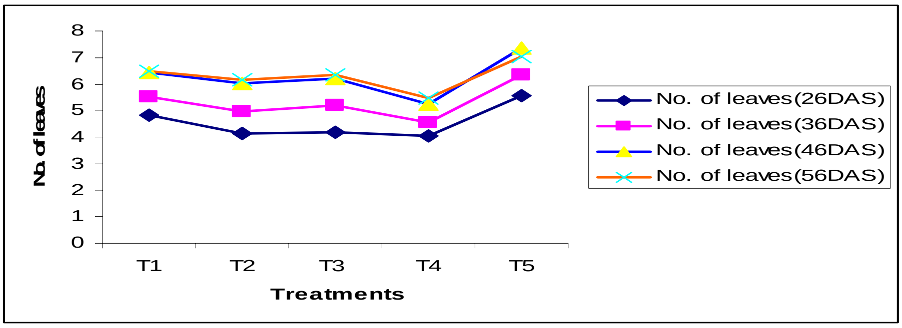

Fig. 8. Allelopathic effects of *Albizia lebbeck* on no. of leaf of Soybean

Shoot Length (cm)

At different DAS in all the treatments shoot length of soybean influenced significantly in respects to control (Fig. 9). Significantly the highest inhibition (-12.77 at 26 DAS; -16.59 at 36 DAS; -31.14 at 46 DAS and -29.43 at 56 DAS) was noted in the treatment T_4 (soil watered with aqueous leaf extracts) and the lowest (-4.98 at 26 DAS; -5.62 at 36 DAS; -12.11 at 46 DAS and -9.79 at 56 DAS) was observed in the treatment T_1 (top soil).

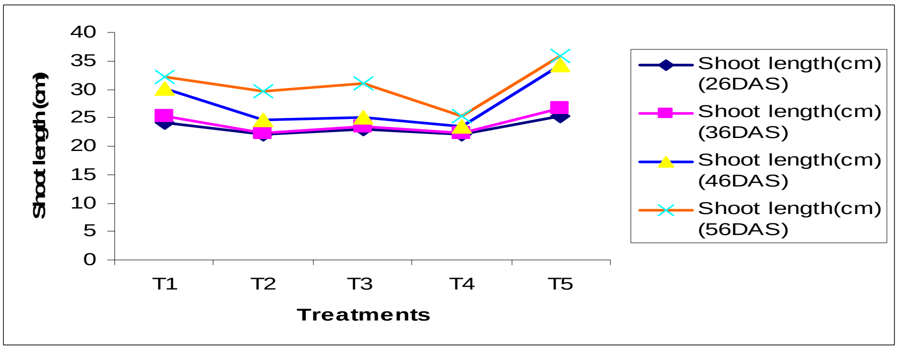

Fig. 9. Allelopathic effects of *Albizia lebbeck* on Shoot Length of soybean

Leaf Length (cm)

Leaf length of soybean was varied significantly at different DAS in all the treatments in respects to control (Fig. 10). Significantly the highest inhibition (-18.87 at 26 DAS; -25.47 at 36 DAS; -35.57 at 46 DAS and -38.55 at 56 DAS) was found in the treatment T_4 (soil watered with aqueous leaf extracts) and the lowest (-12.68 at 26 DAS; -10.66 at 36 DAS; -14.55 at 46 DAS and -16.67 at 56 DAS) was recorded in the treatment T_1 (top soil).

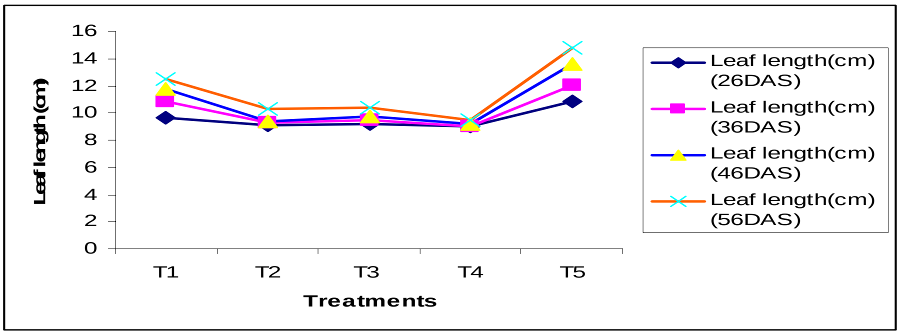

Fig. 10. Allelopathic effects of *Albizia lebbeck* on Leaf Length of soybean

Leaflet Breath (cm)

Leaflet breath of soybean did not vary significantly at 26 and 36 DAS for all the treatments in respects to control (Fig.11). But significantly the highest inhibition (-42.27 at 46 DAS and -37.02 at 56 DAS) was found in the treatment T_4 (soil watered with aqueous leaf extracts) and the lowest (-20.50 at 46 DAS and -22.16 at 56 DAS) was observed in the treatment T_1 (top soil).

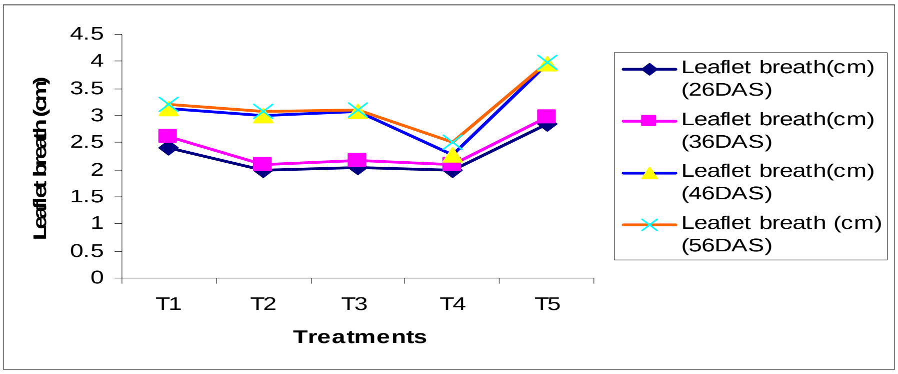

Fig. 11. Allelopathic effects of *Albizia lebbeck* on Leaflet breath of soybean

Shoot Diameter (cm)

All the treatments did not influence significantly the shoot diameter of soybean at 26 DAS in respects to control (Fig.12). But significantly the maximum inhibition (-35.84 at 36 DAS; -27.27 at 46 DAS and -40.47 at 56 DAS) was observed in the treatment T_4 (soil watered with aqueous leaf extracts) and the lowest (-3.77 at 36 DAS; -6.87 at 46 DAS and -16.07 at 56 DAS) was found in the treatment T_1 (top soil).

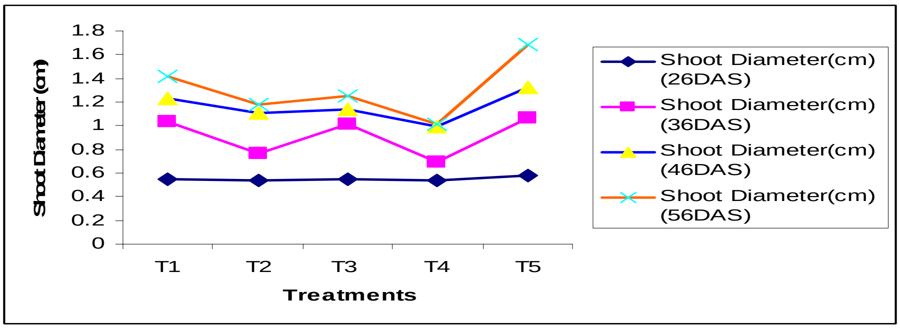

Fig. 12. Allelopathic effects of *Albizia lebbeck* on Shoot diameter of soybean

Root length (cm)

The root length of the test crop varied notably (table 2) due to the five treatments compared to control. The treatment T_4 (soil watered with aqueous leaf extract) has highest inhibitory effect (-26.72) on root length of mungbean over control followed by the treatments T_2 (root zone soil) and T_3 (soil mulched with dry leaf). Whereas, the lowest inhibitory effect (-7.00) was gained in the treatment T_1 (top soil).

Shoot Fresh Weight (g)

Shoot fresh weight of soybean significantly suppressed in all the treatments in comparison to control (Table 2). Significantly the highest inhibition (-58.79) was obtained in the treatments T_4 (soil with aqueous leaf extract) followed by T_2 (root zone soil), T_3 (soil mulched with dry leaf) and T_1 (top soil).

Table 2. Allelpoathic effects of *Albizia lebbeck* 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	42.22b (-7.00)	5.16bc (-29.12)	2.45a (-18.33)	4.84b (-28.3)	2.72b (-39.96)	5.17b (-31.34)
T_2	33.85c (-25.44)	3.55c (-51.24)	1.75b (-41.67)	3.42c (-49.33)	1.33c (-70.64)	3.08c (-59.10)
T_3	34.45c (-24.12)	3.97c (-45.47)	1.98b (-34.00)	3.95c (-41.48)	2.10b (-53.64)	4.08b (-45.82)
T_4	33.27c (-26.72)	3.00c (-58.79)	1.50b (-50)	3.12c (-53.78)	1.25c (-72.40)	2.75c (-63.48)
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%	13.26	5.37	15.54	5.85	14.55	7.76

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 over control (Table 2). Significantly shoot dry weight inhibition (-50.00) was high in the treatment T_4 (soil with aqueous leaf extract) followed by T_2 (root zone soil) and T_3 (soil mulched with dry leaf). The lowest inhibition (-18.33) was gained in the treatment T_1 (top soil) followed by T_5 (fresh garden soil).

Root Fresh Weight (g)

All the treatments significantly suppressed the root fresh weight of soybean in respects to control. Significantly the highest inhibition (-53.78) of root fresh weight was observed in the treatment T_4 (soil with aqueous leaf extracts) followed by T_2 (root zone soil) and T_3 (soil mulched with dry leaf). The lowest inhibition (-28.30) was found in the treatment T_1 (top soil) (Table 2).

Root dry weight (g)

It was observed that root dry weight significantly varied in all treatments over control (Table 2). The highest suppression (-72.40) of root dry weight was gained in the treatment T_4 (soil with aqueous leaf extract) followed by T_3 (root zone soil) in comparison to control and lowest (-39.96) was found in the treatment T_1 (top soil) followed by T_3 (soil mulched with dry leaf).

Total Dry Matter (g)

Total dry matter of the test crop was affected significantly in all the treatments over control (Table 2). Among the five treatments, total dry matter inhibition (-63.48) was large in the treatment T_4 (soil with aqueous leaf extract) followed by T_2 (root zone soil). The shortest inhibition (-31.34) was reported in the treatment T_1 (top soil) followed by T_3 (soil mulched with dry leaf).

DISCUSSION

Responses of the test crops to different treatments were significantly different. The inhibition of seed germination and seedling growth of both crops was different parts of plant. Inhibition was more in leaf extracts. These finding agreed with the report of Uddin *et al.* (2007) who also found that the aqueous extracts of leaf caused significant inhibitory effect on germination, root and shoot elongation and development of lateral roots of receptor plants. The root zone soil and dry leaf as mulch of *Albizia lebbeck* also reduce the germination and growth of the test crops compared to control.These results were also similar to report from Jyoti and Saxena (2004) and Rathinasabapathi *et al*. (2005). From the experiment it was concluted that the aqueous leaf extracts and roots of *Albizia lebbeck* had highest allelopathic effects on germination, growth and development of mungbean and soybean. Allelopathics are often due to synergistic activity of allelochemicals rather than to single compounds. Under field conditions, additive or

CONCLUSION

The phenomenon of allelopathy arises because growth inhibiting or stimulating, plant and microbial produce and release chemicals into the environment. Allelopathy is a component of most natural communities and agroecosystems. 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. Albizia lebbeck the allelopathic effects of the treatments were as the following the order: T4 (soil watered with aqueous leaf extract) > T2 (root zone soil) > T3 (soil mulched with dry leaf) >T1 (top soil) >T4(control/fresh garden soil).

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