ALLELOPATHIC EFFECTS OF *Albizia lebbeck, Leucaenea leucocephala, Melia azedarach* AND *Litchi chinensis* ON AGRICULTURAL CROPS

A THESIS

BY

ROZINA PARVIN
Student no. 0905042
Session: 2009-10
Thesis Semester: March-August, 2010

MASTER OF SCIENCE (M.S.)

IN

AGROFORESTRY

DEPARTMENT OF AGROFORESTRY
HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY, DINAJPUR

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Submitted to the Department of Agroforestry, Hajee Mohammad Danesh Science and Technology University, Dinajpur in Partial fulfillment of the requirements for the degree of

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August 2010

Dedicated to

MY BELOVED PARENTS

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Abstract

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, Leucaena leucocephala, Melia azedarach* and *Litchi chinensis* on two agricultural crops viz: mungbean and soybean. There were four experiments and each experiment had 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. Incase of *Albizia lebbeck* the 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); For *Leucaena leucocephala*: T_4 (soil watered with aqueous leaf extract)>T_1 (top soil)>T_3 (soil mulched with dry leaf) >T_5 (control / fresh garden soil) >T_2 (root zone soil); For *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; For *Litchi chinensis*:T_3 (soil mulched with dry leaf)>T_4 (soil watered with aqueous leaf extracts)>T_1 (top soil)>T_2 (root zone soil)>T_5 (control/fresh garden soil). Among the four tree species *Leucaena leucocephala* has little stimulatory effects on mungbean and soybean. In agroforestry system, *Leucaena leucochephala* is a better choice as compared to the other tree species like *Albizia lebbeck, Melia azedarach* and *Litchi chinensis.* Although, *Melia azedarach* is well-known for its biological activities in many countries, the inhibitory effects were also observed. However, the allelopathic effects of the trees on the tested crops were as the following the order: *Litchi chinensis* > *Albizia lebbeck* > *Melia azedarach*> *Leucaena leucocephala*. Among the different parts of the trees, fresh leaf extracts had more inhibitory effects as compared to the other parts of trees like root and dry leaf.

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INTRODUCTION

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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). Allelopathy has traditionally been considered only the negative chemical warfare of one organism upon another (Bansal, 1994). Modern research suggests that allelopathic effects can be both positive and negative, depending upon the dose and organism affected (Bansal and Bhene, 1977; Rice, 1984). Allelopathic is the active or passive effects of chemicals released into the environment, which influences the releaser, itself or other organs (Chou, 1986; Hale and Orcutt, 1987, Miller, 1983). Allelopathy signifies that interactions between plants might lead to either stimulation or inhibition of growth (Molisch, 1937).

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 practices 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). 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 promotory rather than inhibitory tree crop interaction.

Reduction in yield of agri-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).

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 (Koul *et al.*, 1992; 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; Hogue *et al*., 2003). So, the study was performed to fulfill the following objectives:

- To assess about the allelopathic effects of some commonly used tree species on agricultural crops.
- To identify the allelopathic potentiality of *Albizia lebbeck, Melia azedarach*, *Leucaena leucocephala*, and *Litchi chinensis* used in Agroforestry practices in Bangladesh.
- To identify which parts of trees possess more allelopathic potentiality.

CHAPTER II

REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

The research was carried out to observe the allelopathic effects of *Albizia lebbeck*, *Leucaena leucocephala*, *Melia azedarach*, and *Litchi chinensis* on agricultural crops. There are many research on allelopathy are available. Literatures some way linking to the subject of interest from home and abroad are reviewed and outlined below under the following headings:

2.1 Allelopathy of different multipurpose trees

2.2 Allelopathy of *Leucaena leucocephala*

2.3 Allelopathy of *Albizia lebbeck*

2.4 Allelopathy of *Melia azedarach*

2.1 Allelopathy of different multipurpose trees

Jose (2009) found that the allelochemical effects of the donor vary with the dose applied, and species respond differently to allelochemical released by the Eucalyptus.

A study was carried to observe the effect of the water extract from fresh leaves of Spina christi [*Ziziphus spina-christi*], *Sesbania sesban* and *Tamarindus indica*. A significant reduction in germination of seeds of maize (*Zea mays*) and sorghum (*Sorghum bicolor*) by 14-71%. Across all the extracts, the germination of seeds and seedlings survival of sorghum was significantly less affected than those of maize. Higher (compared to the control) survival of maize and sorghum seedlings were obtained in extracts from *Khaya senegalensis*, *Peltophorum pterocarpum*, *Prosopis africana*, *Eucalyptus camaldulensis* and Spina Christi. For both crops, extract from *Acacia nilotica* imposed the least effect on the hypocotyl length. The same extract significantly increased the radicle length of maize and sorghum seedlings by 47% and 55%, respectively. Extracts forced maize seeds to germinate earlier, while the opposite was observed for sorghum seeds. (Mubarak *et al.*, 2009).

Bhupendra-Singh *et al.* (2009) observed the allelopathic potential of the agroforestry trees *Ficus subincisa*, *Bauhinia purpurea* L., and *Toona hexandra* on *Triticum aestivum* L., *Brassica campestris* L., and *Hordeum vulgares* L. test crops. The leaf and bark leachates of trees were both toxic to the germination of the test crops. The inhibition of the germination of test crops was significant. The effects of leachates on test crops were concentration dependent. So, higher concentrations of leaf and bark leachates showed stimulatory effects on the radicle and plumule growth of all test crops. The acceptance of these multipurpose tree species as agroforestry trees in association with field crops decreased in the order *Ficus subincisa*, *Bauhinia purpurea*, and *Toona hexandra*.

Aqueous extracts of *Eucalyptus camaldulensis* L. at a concentration of 10, 15 and 20% had inhibitory effect on wheat germination and effect was found significantly higher than control treatment (Khan *et al.*, 2008). They also noted that fresh and dry weight of seedling was also reduced significantly over control. The inhibitory effects were increased as the extract concentration increased. These findings indicate that wheat sown in fields which had leaf litter of *E. camaldulensis* L. will be adversely affected regarding germination, growth and ultimately resulting in lower yields of wheat.

Sajjad-Hussain *et al.* (2007) studied the allelopathic effects of senna (*C. angustifolia*) on maize, rice, sorghum and wheat, and associated grassy weeds (*Avena fatua*, *Dactyloctenium aegyptium*, *Echinochloa colona*, *Phalaris minor*. The treatments were: incorporation of the whole plant material into the soil (10% w/w), mulching with the whole plant material (10% w/w), and application of the aqueous extract of the whole plant (10% w/v) to plants. Germination percentage, shoot length, root length, shoot fresh weight, root fresh weight, shoot dry weight, root dry weight, and number of leaves were evaluated. The senna treatments had significant effects on seed germination and seedling growth. The allelopathic effect was most pronounced in the senna-*Avena fatua* and senna-wheat interactions. Mulching with senna reduced the germination of *Avena fatua* by 11% over the control, and promoted wheat seedling growth. The allelopathic potential of senna can be used to control the invasive weeds of wheat.

Rama-Kant and Chakrabarti (2007) showed the allelopathic effect of Eucalyptus tree on the growth and survival of mulberry (*Morus sp.*). Results revealed that the survival of saplings was between 70-79%. These saplings were planted 9-12 m away from Eucalyptus, while 16-21% survival was recorded in saplings 3-9 m away from Eucalyptus. Seventy-nine percent buds of the cuttings did not sprout and dried under the shade of Eucalyptus, whereas 21% cuttings sprouted under the shade. Initially, cuttings sprouted but due to allelopathic effect, 79% buds died. The allelochemicals were released into the environment through leaching, volatilization or decomposition of fallen leaves or bark. The chlorophyll content was also found less in treated plants as compared to control. Saplings were disease free under the shade of Eucalyptus, but overall, it is concluded that mulberry nursery should not be raised under the shade of Eucalyptus due to their allelopathic effect.

A study was conducted to determine the influence of allelopathic effects of multipurpose trees, viz., *Acacia auriculiformis*, *Casuarina equisetifolia*, *Eucalyptus hybrid* and *Mangifera indica*, on the germination behaviour, and root and shoot growth on some important aromatic and medicinal plants, e.g., kasthuri bendi (*Abelmoschus moschatus*), sanka pushpa (*Clitoria ternatea*) and honey plant (*Ammi majus*). The adverse effect of the 4 multipurpose trees differed with each medicinal plant. However, maximum adverse effect for the parameters considered was recorded in the *M. indica* while minimum adverse effects were observed in *Eucalyptus hybrid*. Sanka pushpa showed the greatest sensitivity compared to the two other species tested. (Krishna *et al.*, 2005)

Sinha and Govind-Kumar (2005) found the allelopathic effects of mango and jackfruit leaf powder on early growth of *Cyperus rotundus* L. Leaf powder of mango and jackfruit suppressed the emergence of *Cyperus rotundus*. 250 g mango leaf powder+250 g jackfruit leaf powder showed maximum inhibition as compared to other sources however, glyphosate treatments also inhibit the early growth of *Cyperus rotundus* L.

Tanaka and Kato-Noguchi observed in 2005 that the highest inhibitory activity was found in peel of *C. junos* and followed by segment and seeds. A large amount of *C. junos* peel was extracted with aqueous methanol and an active compound responsible for the inhibitory effect involved in the growth inhibitory effect of *C. junos* waste. Therefore, *C. junos* waste may be useful as alternative materials for biological weed control.

Maryam-Nasr and Mansour-Shariati (2005) observed the effect of different concentrations of allelochemicals including ephedrin, vanillin, abscisic acid (ABA), *Eucalyptus comadulensis* and *Juglans ragia* leaf and *Onobrychis sativa* seed extracts on percentage germination, start of germination and seedlings growth of *Astragalus cycluphyllus*. All considered compounds delayed start of germination with respect to the control, but among these allelochemicals different concentrations of ABA and 33.3 mM of Vanillin delayed germination for a longer period than other allelopathic compounds. Ephedrin, Vanillin and *E. camadulensis* leaf extract reduced percentage of germination. In addition, in Ephedrine, *J. regia* compounds seedlings had abnormal growth and twisted form. Therefore, only ABA had no negative effect on percentage of germination and seedling growth.

A study was conducted by Krishna *et al.* (2005) to determine the influence of allelopathic effects of multipurpose trees, viz., *Acacia auriculiformis*, *Casuarina equisetifolia*, *Eucalyptus hybrid* and *Mangifera indica*, on the germination behaviour, and root and shoot growth on some important aromatic and medicinal plants, e.g., kasthuri bendi (*Abelmoschus moschatus*), sanka pushpa (*Clitoria ternatea*) and honey plant (*Ammi majus*). Generally, the adverse effect of the 4 multipurpose trees differed with each medicinal plant. However, maximum adverse effect for the parameters considered was recorded in the *M. indica* while minimum adverse effects were observed in Eucalyptus hybrid. Sanka pushpa showed the greatest sensitivity compared to the two other species tested.

Ercsl and Turkkal (2005) showed the effects of juglone (5-hydroxy-1,4-naphthoquinone) and walnut (*Juglans regia* L.) leaf extracts on yield, growth, chemical and plant nutrient element composition of short-day strawberry cultivars 'Camarosa' and 'Sweet Charlie'. Strawberry plants were treated with 1 mM juglone or walnut leaf extracts (undiluted or diluted 1:2, 1:4, and 1:8). Vegetative and generative plant growth was inhibited strongly by treatment with both juglone and undiluted walnut leaf extracts. Fruit yield per plant; numbers of fruit per plant, average fruit weight, crowns per plant, and numbers of leaves, leaf area, fresh root weight, total soluble solids, vitamin C, and acidity were all lower for juglone-treated plants compared to controls. All nutrient elements analysed in leaves were generally lower than in controls for all treatments except 1:8 diluted walnut extract. Results from this study should address concerns about growth inhibition of strawberry plants under walnut-based intercropping systems.

The allelopathic potential of Citrus junos fruit waste after juice extraction was investigated by Kato-Noguchi and Tanaka (2004). They found that aqueous methanol extracts of peel, inside and seeds separated from the fruit waste inhibited the growth of the roots and shoots of alfalfa (*Medicago sativa* L.), cress (*Lepidium sativum* L.), crabgrass (*Digitaria sanguinalis* L.), lettuce (*Lactuca sativa* L.), timothy (*Pheleum pratense* L.), and ryegrass (*Lolium multiflorum Lam.*). The inhibitory activity of the peel extract was greatest and followed by that of the inside and seed extracts in all bioassays. Significant reductions in the root and shoot growth were observed as the extract concentration was increased.

Reddy *et al.* (2004) observed the allelopathic effects of *E. grandiflora* on the growth and yield of castor beans (*R. communis*) cv. *Kranthi*. Plant height, dry matter, root length, number of spikes per plant, primary spike length, number of capsules per plant and seed yield of castor beans increased with increasing distance of the crop from the tree. Similarly, the density and dry weight of weeds infesting castor beans increased with increasing distance of the crop to the tree. Data are presented on the available nutrients in the soil after castor harvest, soil moisture at harvest and number of lateral roots of eucalyptus in relation to the distance from the trees and soil depth.

All the extracts of Eucalyptus (leaf extracts, soaked, crushed and boiled in tap water) significantly reduced seed germination, root and shoot length, fresh and dry weight of cotton compared to the control where no extract was used. The Eucalyptus boiled extract decreased the seed germination to 57% compared to 97% in the control. It also caused the highest decrease in the root length. The highest decrease in the cotton fresh and dry weights was obtained in the crushed extract. The soaked extract produced the highest decrease in cotton shoot length, shoot fresh and dry weights. The suppression of cotton seed germination and other growth parameters depicted an allelopathic effect. It is suggested that planting cotton close to Eucalyptus trees should be avoided due to likely adverse effects on germination and growth parameters. (Khan *et al*., 2004).

But Khan *et al*. (2003) found that extracts of boiled eucalyptus decreased seed germination to 66% compared to control with 99% germination. However, the extracts of soaked eucalyptus was the most toxic to root growth and caused higher decrease of maize root length, fresh and dry weight among the 3 extracts. The highest decrease in maize shoot length, shoot fresh and dry weight, was recorded by the extracts of crushed eucalyptus. The suppression of maize seed germination and other growth parameters indicates allelopathic effect.

Patil *et al*. (2003) conducted a study to determine the effects of eucalyptus (*Eucalyptus tereticornis*), casuarinas (*Casuarina equisetifolia*), and teak tree (*Tectona grandis*) leachates (each at 1.0, 2.5, and 5.0%) on wheat seeds. The germination percentage, shoot and root length, and shoot and root dry weight per plant were recorded. Eucalyptus showed the highest allelopathic inhibitory action followed by teak and *casuarina*. Irrespective of the leachate source, the inhibitory effect on the germination and growth of wheat seedlings increased with an increase in leachate concentration.

Eucalyptus microtheca aqueous extracts from different dried plant parts, soaked for 48 hours, inhibited radicle growth, splumule growth and seed germination of *Pennisetum glaucum* cv. BARI-Hairy due to allelopathic effect. However, no serious inhibition of seed germination occurred. The toxicity varied from part to part and was related to concentration and soaking duration. Root exudates were highly toxic to the radicle growth followed by leaves, stem and whole plant material. For the growth of plumule, leaves were found to be highly toxic followed by whole plant, roots and stem. Enhancing effect on the growth of radicle was not observed. However, it was observed on the growth of plumule by roots and stem extracts only. (Gilani *et al.*, 2003).

Reddy (2003) showed that bund plantation of *Eucalyptus grandifolia* adversely affected growth and yield of rice due to allelopathic effect. The reduction in yield was higher in rice planted 8-10 m from Eucalyptus trees.

Xu-YaoPing *et al.* (2003) found the allelopathic effects of walnut (*Juglans regia*) leaf extracts on three plant acceptors: lettuce, wheat and tomato by germination and growth experiments. Results showed that different concentrations of aquatic walnut leaf extracts had certain inhibitory and/or promotory effects on those acceptors, and major bioactive substances were found to be phenolics and flavonoids. This study can provide some basis for development of biorational pesticides.

Aqueous methanol extracts of *Citrus junos*, *C. unshiu* and *C. hassaku* fruit peel inhibited the growth of the roots and hypocotyls of lettuce (*Lactuca sativa* L.) seedlings (Kato-Noguchi and Tanaka, 2003). They found that significant reductions in the root and hypocotyl growth were observed as the extract concentration increased in all bioassays. The inhibitory activity of *C. junos* extract on the growth of lettuce roots and hypocotyls was about 13- and 24-fold greater than that of *C. unshiu* and *C. hassaku* extracts, respectively.

Satsangi *et al.* (2002) found that the aqueous extract of *P. hysterophorus* inhibited the growth of *C. cajan* seedlings. The maximum inhibition on germination was noticed in stem extract and minimum in root extract. In *S. vulgare* seeds, maximum inhibition in germination was observed from root extract of the weed. Root-shoot elongation was also inhibited by root extract of the weed. In *parthenium* weed, maximum phenolic content was present in basal parts and minimum in leaves. The germination of *P. hysterophorus* was inhibited most in *A. indica* and *E. tereticornis* and least in *D. alba*.

Hossain *et al.* (2002) observed that highest germination occurred in the topsoil+leaf-litter mixture (90:10) of *D. turbinatus*, whereas, the topsoil+leaf-litter mixture of *Acacia auriculiformis* caused maximum stimulation in the seedling growth and biomass production in *L. leucocephala*. Mixtures of topsoil+leaf-litter mixture (50:50) of *E. camaldulensis* caused greatest inhibition in germination and seedling growth of *L. leucocephala*. These results demonstrated the allelopathic effects of *E. camaldulensis* leaf-litter on *L. leucocephala*.

The allelopathic effects of juglone and leaf extracts of walnut on seed germination and seedling growth of 11 species was reported by Kocacalskan and Terz in 2001. They found that seed germination was less affected than root and shoot growth in all species. Both seed germination and seedling growth of tomato (cv. *Rio Grande*), cucumber (cv. *Cengelkoy*), garden cress (*Lepidium sativum* cv. *Bandirma*) and lucerne (cv. *Yerli*) were inhibited strongly by the treatments. However, seed germination of wheat, barley (cv. *Tokak*), maize (cv. *Pan*), watermelon (cv. *Crimson Sweet*), radish (cv. *Iri*) and bean (*Phaseolus vulgaris* cv. *Sarikiz*) was not affected, but their seedling growth was inhibited slightly. In muskmelon (*Cucumis melo* cv. *Kis kavunu*), interestingly, seedling growth was increased by both walnut leaf extracts and juglone. Positive correlation was found between the effects of juglone and the extracts.

Mashela (2001) reported that effects of beefwood (*Casuarina cunninghamiana*) leaf residues were evaluated on soil pH, soil electrical conductivity, growth and foliar nutrient ions of rough lemon (*Citrus jambhiri*) seedlings in two greenhouse experiments. *Casuarina*-amended soil reduced soil pH, root weight, shoot weight, plant length, shoot/root ratio, foliar Ca/Mg and Mg/K ratios of citrus seedlings, but increased soil electrical conductivity and imbalances of certain chemical nutrient ions. Because dried leaves were used, it was postulated that *Casuarina* effects were initiated by allelopathic chemical compounds leached out of leaves into the rhizosphere.

In 2001, the effects of 25, 50, 75 and 100% aqueous foliar leachates (1:10 and 1:15 w:v) and foliar extracts (1:10 w:v) of 14 leguminous plant species on the seed germination, seedling growth and vigour index of congress grass (*P. hysterophorus*) was observed by Dhawan. The foliar leachates of *Delonix regia* (1:10 w:v) and *Cassia fistula* (1:15 w:v), and the foliar extract of *C. occidentalis* at 100% gave the lowest seed germination, seedling growth and vigour index. The economic and social value/utility of *C. occidentalis*, *Tephrosia purpurea*, *Trifolium alexandrinum*, *Albizia procera*, *A. lebbeck*, *D. regia*, *Prosopis juliflora*, *P. cineraria*, *Bauhinia variegata*, *C. fistula*, *C. siamea* and *Acacia nilotica* are presented.

Dhawan *et al.* (2001) found the allelopathy towards *Parthenium hysterophorus*: chickpea cv. C-235, *Trifolium alexandrinum* cv. *Mescavi*, *Trigonella foenum graecum* cv. *Kasuri*, *Acacia nilotica*, *Albizia procera*, *Bauhinia variegata*, *Delonix regia*, *Moringa indica*, *Parkinsonia aculeata*, *Pithecellobium dulce*, *Prosopis cineraria*, *Tamarindus indica*, *Cassia occidentalis* and *Tephrosia purpurea*. Aqueous leachates (100%) from leaves of all tested species, except that of *Pithecellobium dulce*, decreased seed germination and vigour index of *Parthenium hysterophorus*. Allelopathy was strongest with leachates from D. *regia*, *Cassia occidentalis*, *Albizia procera*, *Tephrosia purpurea* and *M. indica*.

A field study was conducted by Oudhia in 2001.It was observed that the allelopathic effects of guava, mango, lemon and papaya [pawpaw] leaf extracts on the emergence and seedling vigour of *Lathyrus sativus* cv. *Biol-212. L. sativus* seeds were soaked in the extracts for 24 h and then sown in pots. Guava and mango extracts had the highest inhibitory effects on seedling emergence and growth. Lemon and papaya extracts did not have any inhibitory allelopathic effects on *L. sativus* seeds.

Latha *et al.* (2001) observed the allelopathic effects of the leachates of the leaves of *P. pinnata* against rice, wheat, *Cassia tora* and *C. occidentalis* were studied. The leachates inhibited the performance of both rice and wheat, but exerted no effect on the weeds. The leachates of *P. pinnata* contained allelochemicals such as vanillic acid, syringic acid, melilotic acid and derivatives of quercetin and kaempferol. The residual phenolics of the soil were more in the case of the weeds. The varieties of mycoflora below Pongamia were less compared to control.

Patil and Sukanya (2001) carried out a polybag study to determine the allelopathic effect of eucalyptus on some legume crops (groundnut, green gram and soyabean). Soil samples along with natural leaf fall from eucalyptus tree row site were collected from 3 m away from the tree row to 18 m distance (6 distance intervals), and 2 kg soil from each distance was put in polybags. Shoot length, root length and shoot dry weight per plant were significantly less in 3 and 6 m distance soils, while root dry weight was reduced up to 9 m distance soil, indicating more adverse effect on the root portion than on the shoot portion. Groundnut shoot length did not change over distances, while that of green gram was adversely affected up to 6 m and that of soyabean up to 3 m. Root growth of all the 3 crops was inhibited in 3 and 6 m distance soils, the greatest reduction being recorded with groundnut. Similar was the case with shoot weight.

Allolli *et al.* (2000) found that *Eucalyptus tereticornis* leaf, bark and root extracts at 4 concentration gradients (1.0, 2.5, 5.0 and 10.0%) has allelopathic potential on germination and growth of garlic. The lowest germination, and root and shoot length of garlic (73.20%, and 6.07 and 8.44 cm, respectively) was observed in treatments with leaf extract, while the highest germination was observed in the control. The extracts at 10% concentration resulted in the lowest germination percentage.

Einhellig (1995) showed that many new allelochemicals is important feature characterizing the interrelationships among organisms. Allelopathic inhibition typically results from a combination of allelochemicals, which interfere with several physiological processes in the receiving plant or microorganisms.

Panday and Singh (1984) demonstrated that, The aqueous extracts of fresh leaves, stems and roots of *Celossia argentea L.* inhibited shoot and root growth of bajra.

Harrington (1987) found that several hundred different organic compounds (Allelochemicals) released from plants and microbes are known to affect the growth or aspect of function of receiving species.

2.2 Allelopathy of *Leucaena leucocephala*

An experiment was conducted to investigate the allelopathic effects of different doses of *Eucalyptus camaldulensis* leaf litters (Ahmed *et al.* 2008). Three popular agricultural crops: Falen (*Vigna unguiculata*), Chickpea (*Cicer arietinum*), Arhor (*Cajanus cajan*) and two widely used plantation trees: Sada koroi (*Albizia procera*) and Ipil ipil (*Leucaena leucocephala*) were selected as bioassay species. The effects of different doses of leaf litter extracts were compared to the control. Results suggest that leaf litters of *E. camaldulesis* induced inhibitory effects. It was also found that the effect depend on concentration of extract and litterfall, type of receiver species. Higher concentration of the materials had the higher effect and vice versa. Though all the bioassay species were suppressed some of them showed better performance. *Vigna unguiculata*, *Cicer arietinum* are recommended in agroforestry based on this present Experiment output. In mixed plantation, *Leucaena leucochephala* is a better choice while compared to *Albizia procera*.

But Yatagai (2008) showed that simple vegetation and/or no vegetation are observed under Ipil-ipil (*Leucaena leucocephala*), which secrete an allelopathic amino acid, mimosine. Simple vegetation is also frequently observed under walnuts, eucalyptus and other species. It is known that eucalyptus has potent allelopathic activity. However, proven allelopathic eucalyptuses are only twenty species, including *E. camaldulensis*, *E. citriodora*, *E. globulus* and *E. baxteri*. Allelopathy is recognized not only in the terrestrial plants, but also in the aquatic plants, both in the fresh and sea water. Macrophytes which have allelopathic activity inhibit the abnormal growth of microalgae and control water pollution caused by microalgae.

An experiment was carried out by Hiwale *et al.* in 2007 to study allelopathic effect of leaf leachate of four tree species viz., Custard apple (*Annona squamosa*), Aonla (*Emblica officials*), Neem (*Azadirachta indica*) and Subabool (*Leucaena leucocephala*) on Soyabean (*Glycin max*), Maize (*Zea mays*), Okra (*Abelmoschus esculentus*), Sunhemp (*Crotolaria juntia*), Green gram (*Phaseolus aurus*), Pigeon pea (*Cajanus cajan*), Fodder jowar (*Sorghum vulgar*), Sesamum (*Sesamum indicum*) and Moth bean (*Phaseolus aconitifolius*). Seed germination was suppressed by leaf leachates of all tree species compared to control (seed treatment with distilled water). Observation on growth parameters indicated shoot and root length was significantly influenced by the leaf leachates of all the tree species. Root length was highly influenced compared to shoot length. Neem was found to suppress most of the growth parameters, whereas, Subabool, Custard apple and Aonla promoted them. Custard apple, Aonla and Subabool were found to have beneficial effect on Soya bean, Green gram, Pigeon pea and Sesamum and suppressing effect on Okra, Fodder jowar, Sunhemp, Maize and Moth bean.

Sahoo *et al.* (2007) conducted an experiment by using aqueous leaf, bark and seed extracts of two tree species viz. [subabul (*Leucaena leucocephala* (Lam.) de Wit) and teak (*Tectona grandis* L.)] to test the allelopathic effects in bioassay and pot culture on germination, radical length, growth and yield of maize (*Zea mays* L.). They reported that the leaf extract were more toxic than bark and seed and

Leucaena was more inhibitory to germination ($P<0.05$) than *Tectona*. On the contrary, the *Tectona* growth media was more harmful to growth and yield of maize than *Leucaena*. The toxic effects of *Leucaena* followed the order: crushed seeds > leaf litter > soil root zone, while *Tectona* followed the order: leaf litter > crushed seeds > soil root zone. Thus *Leucaena* was less harmful tree than *Tectona* for maize intercropping in agroforestry systems.

The highest total GM yield was obtained in the association with *G. sepium* and the monocrop (87.8 and 89.0 tonnes GM/ha, respectively) has significant difference from the rest of the treatments. The same performance was found in total DM. Sugarcane plus *L. leucocephala* was the treatment with the worst performance, with the lowest total GM and DM values (56.5 and 14.9 tonnes/ha, respectively). Sugarcane height did not show significant differences among treatments and the height of the trees was 3.7, 3.0 and 4.7 m for *A. lebbeck*, *G. sepium* and *L. leucocephala*, respectively. It is concluded that from the three species evaluated, *G. sepium* can be associated with sugarcane, because yield was not affected as compared to the monocrop. In the case of *L. leucocephala* and *A. lebbeck*, pruning is recommended because their growth is faster, which might limit sunlight penetration and affect sugarcane biomass production (Hernandez *et al.* 2004).

John and Narwal (2003) noted that *Leucaena leucocephala* is the most productive and versatile multipurpose legume tree in tropical agriculture and has several uses, thus called 'miracle tree'. It is a popular choice for intercropping with annuals in hedgerow or alley cropping systems. It has allelopathic effects on cereals, pulses, oilseeds, vegetables, folder crops, weeds, and trees.

A study was conducted in existing agrosilvicultural systems involving different tree species (*Acacia nilotica*, *Albizia lebbeck*, *Azadirachta indica*, *Cassia siamea*, *Dalbergia sissoo*, *Hardwickia binata* and *Leucaena leucocephala*) to assess the allelopathic effects of different tree crops on rabi sorghum (Devaranavadgi *et al.* 2003) . They observed that the control treatment produced the maximum grain and stover yield. Plant height was maximum with *L. leucocephala* while *H. binata* produced plants with the least height. Highest diameter at breast height (dbh) and crown diameter was recorded in *Acacia nilotica* while the lowest values for dbh and crown diameter was recorded in *D. sissoo* and *H. binata*, respectively. Total biomass was maximum in *Acacia nilotica* and was minimum in *H. binata*. The performance of rabi sorghum in terms of stover and grain yield was inversely proportional to the silvicultural parameters of tree species and as well as the total dry matter produced by them. Germination of sorghum with *H. binata* was 85% and a similar superiority was observed for root length, shoot length and dry weight of seedlings. Lower values, however, were recorded in *Acacia nilotica*. The results indicate that among the tree species studied, *H. binata* had the minimum allelopathic effect on rabi sorghum.

Nguyen *et al.* (2003) showed that the three species showing the greatest allelopathic potential were *Galactia pendula*, *Leucaena glauca* and *Melia azedarach*. Four other species including *Desmodium rezoni*, *Euphobia hirta*, *Manihot esculenta* and *Morus alba* were assessed to be the second most suppressive to radish germination and growth. Findings also indicated inhibitory exhibition of allelopathic plants were species dependent. Moreover, inhibitory effects varied among plant parts such as the leaves, stem and root.

P concentration of leaves showed a greater reduction with tree age than either stems or roots. Phosphorus uptake correlated significantly with plant DM across tree species, and had a steady increasing pattern up to at least 12 MAP. Over ages, *Gliricidia* outperformed other species in P uptake. However, *Leucaena* was the most efficient user of P followed by *Albizia* and *Gliricidia*. Further, *Leucaena* revealed an attractive feature for alley cropping; it stored up to 37% of the P accumulated in its leaves in contrast to only 24.1% for *Gliricidia* and 19.2% for *Albizia*. Therefore, the low P supply by trees into alley cropping is in part due to its unbalanced partitioning into stems to the expenses of leaves. The study showed that P concentration in perennials was lower than it is reported in annual crops (Kadiata and Lumpungu 2003).

Neelam and Bisaria (2002) studied that aqueous extract of fresh leaf, flower and pod of *Leucaena leucocephala* stimulated the seed germination and seedling growth of *Triticum aestivum* at lower concentrations and inhibited significantly at higher concentrations. The decomposed leaves extract also followed the same trend. Mimosine concentration was estimated in fresh leaves, flowers, pods and decomposed leaves and it was maximum in pods and minimum in decomposed leaves. The results revealed that maximum inhibition was due to aqueous extract in pods and least by decomposed leaves. It revealed that mimosine enhanced the seed germination and seedling growth in *T. aestivum* at low concentrations, but was inhibitory at higher concentrations.

Leucaena (*Leucaena leucocephala*) control weeds when used as soil mulch. It contains mimosine, which, among other allelochemicals, is responsible for the allelopathic effect. The inhibition of root growth and reduction of the mitotic index were proportional to the aqueous extract concentration. Cell division was not observed in maize treated with extract concentrations equal or above 1.6%. Increasing extract concentration increased peroxidase activity in roots and shoots, while no changes in peroxidase isoenzyme patterns were observed. The peroxidase activity in roots was positively correlated with the increase in anionic isoenzymes, pI 4.99 and 4.86, suggesting their participation in the thickening of roots and increasing dry weight (mg/cm). High concentrations of the allelochemical mimosine were detected in concentrated aqueous extracts, possibly influencing seedling development (Pires *et al.* 2001).

A field experiment was conducted by Samaiya *et al.* in 2001 to evaluate the growth of the agrosilvicultural model multipurpose tree species (MPTs) viz., subabul (*Leucaena leucocephala*), bakain (*Melia azedarach*) and siris (*Albizia lebbeck*) intercropped with soyabean under rainfed conditions for Sagar region. Results showed that the maximum tree height (524 cm) was recorded in subabul, while highest collar diameter (37.30 cm) and number of branches were recorded in bakain. Black siris showed slow growth in height, diameter at breast height, collar diameter and number of branches. The results also revealed that soyabean produced a maximum yield of 6.46 g per plant in control plot. Maximum yield reduction of 49% was observed with subabul association followed by bakain with 48% and 24% with siris association.

Neelam and Bisaria (2000) studied that the plant extracts of *Leucaena leucocephala* at 60% concentration had no significant effects on the root and shoot ratio of soyabeans. Seed germination, seedling growth and productivity of soyabeans were significantly enhanced by 20-40% extract concentration, were not significantly affected by 60% extract concentration and were inhibited by 80-100% extract concentration. Mimosine content was highest in the pod and lowest in the leaves. The results indicate that lower concentrations of mimosine enhance seed germination and seedling growth of soyabeans.

The differential toxicity of allelopathic substances among the species (*M. albicans*, *Lantana camara*, *Leucaena leucocephala* and *D. winteri*) was found by Gorla and Perez in 1997 according to the concentration (0, 25, 50, 75 and 100%) of aqueous leaf extracts; Tomato was more susceptible than cucumber. *M. albicans* and *D. winteri* extracts mainly inhibited the root growth of tomato and cucumber seeds. *Lantana camara* and *Leucaena leucocephala* extracts negatively or positively affected the seed germination according to the species and the ratio and percentage, root growth.

But Suresh and Rai (1987) reported that the allelopathic influence of *Leucaena* in pots on sorghum, cowpea and sunflower in top soil and rhizosphere soil from its plantation and in top soil from the field either mulched with dry leaves or irrigated with aqueous extracts. They also observed that seed germination, root length and dry matter production were depressed both in *Leucaena* top soil and in aqueous extracts of the plant.

The influences of litter on soil chemical status can be important because leaves of different species do not decay and reuse their nutrients at the same rate. Litter of different species has different chemical composition and they exert on soil differently. They exist that litters of some species, particularly the Eucalyptus, Ipil-ipil, *Acacia* species etc. exert allelopathic effects on site also (Ahmed *et al.*, 1982).

2.3 Allelopathy of *Albizia lebbeck*

Ashutosh *et al.* (2009) studied that *Grewia optiva*, *Bauhinia variegata* and *Albizia lebbeck* are the best suited tree species for plantations in the sub-tropical region of Garhwal Himalayas due to their high biomass production.

An experiment was conducted by Uddin *et al.* in 2007 to observe the inhibitory effects of the leaf extracts derived from *Albizia lebbeck* (L.) on germination and growth behavior of some popular agricultural crops (receptor) of Bangladesh. The effects of the different concentrations of aqueous extracts were compared to distil water (control.). The aqueous extracts of leaf caused significant inhibitory effect on germination, root and shoot elongation and development of lateral roots of receptor plants. Bioassays indicated that the inhibitory effect was proportional to the concentrations of the extracts and higher concentration (50%-100%) had the stronger inhibitory effect whereas the lower concentration (10%-25%) showed stimulatory effect in some cases. The study also revealed that, inhibitory effect was much pronounced in root and lateral root development rather than germination and shoot growth.

Gill and Gupta (2005) studied that maximum height was achieved under the sole shisham treatment while minimum values were recorded under the siris + barley treatment. Collar diameter and crown area had maximum values under the babul + barley treatment while minimum values were recorded in the siris + barley and sole neem treatment, respectively. In terms of biomass production, the average maximum values of fresh matter yield, dry matter yield and crude protein yield were recorded in the babul + chickpea treatment. The average minimum values of fresh matter yield, dry matter yield and crude protein yield were observed under the siris + barley treatment. Results indicated that babul was the most superior compared to the other species tested in terms of growth characteristics and biomass production.

Another experiment was observed that among the hedgerow species, *Gliricidia sepium* had significantly less allelopathic effect on rabi sorghum compared to other hedgerow crops (Devaranavadgi *et al*., 2004). They also found that the germination (79.00%), root length (9.95 cm), shoot length (11.20 cm) and seedling dry weight at 10 days (0.4 g) was least affected by *G. sepium* when compared with other hedgerow species. The allelopathic effect was found to be highest in *Albizia lebbeck* suggesting its incompatibility for alley cropping system.The results suggest that *G. sepium* had better compatibility with arable crops like rabi sorghum for alley cropping systems.

Jyoti and Saxena (2004) reported that soil collected from the rhizosphere of *A. lebbeck*, *E. equisetifolia* and *J. curcus* increased the shoot length of mustard, whereas those collected from the rhizosphere of *A. donax* and *P. roxburghii* reduced the shoot length of the crop. Soil collected from the rhizosphere of all plants except that of *E. equisetifolia* reduced the root length of the crop. The total dry weight of the seedlings decreased due to the allelopathic effects of the plants tested.

An experiment was conducted by Devaranavadgi *et al.* in 2004 to assess the allelopathic effects of different tree crops (*Acacia nilotica*, *Albizia lebbeck*, *Azadirachta indica*, *Cassia siamea*, *Dalbergia sissoo*, *Hardwickia binata* and *Leucaena leucocephala*) on chickpea. Among the tree species, *Hardwickia binata* had significantly less allelopathic effect on chickpea when compared to other tree species. The germination percentage (80%), root length (18.65 cm), shoot length (31.32 cm) and seedling dry weight at 10 days were least affected by *H. binata* as compared with other tree species. The maximum harmful effect was observed with *Acacia nilotica*. The allelopathic effect was found to be highest in *A. nilotica*, which had higher total biomass production (3688 kg/ha) and crown spread (8.2 m).

It is suggested that *H. binata* is compatible with arable crops like chickpea when grown in agrisilvicultural models in dry land ecosystems.

Gill (2000) established an experiment to study the effect of 12 species of multipurpose trees planted at different spacing on the productivity of intercropped chickpea (*Cicer arietinum*) grown in different crop rotations. Saplings were planted in 1988/89, and tree and crop growth were recorded in 1990-94. For all the years studied, there was no significant difference between spacing treatments in tree height, collar diameter, diameter at breast height (dbh), or plant canopy height. Among the twelve tree species, *Eucalyptus tereticornis* gave the maximum tree height, collar diameter and dbh each year while the highest canopy was found in *Albizia lebbeck*. Chickpea seed yield was highest when grown between *Madhuca latifolia* [*M. longifolia*], *Acacia cupressiformis* [*A. nilotica subsp. cupressiformis*] or *Hardwickia binata*. The widest spacing treatment (2 x 10 m in 1989-92 and 4 x 10 m in 1992-94) gave the highest chickpea seed and straw yield. Chickpea yield increased with increasing distance (1-5 rows) from the tree component. Straw yield was highest when grown with *Hardwickia binata* and lowest with *Eucalyptus tereticornis*. Chickpea yield was not significantly different between chickpea-sorghum and groundnut-chickpea rotations.

Joseph *et al.* conducted an experiment in 1999 to determine the effect of pruning on *Albizia lebbeck* and their influence on the yield of sunflower crop grown in a rainfed Alfisol (sandy loam). Results revealed that during the first year of experimentation, there was no significant yield loss in sunflower crop due to tree component. However, during the second, third and fourth years, the narrow spacing (4x4 m) adopted for trees had significant negative influence on crop growth. The results also proved that due to pollarding of trees at a height of 1.5 m from the ground, the negative impact of trees could be avoided and sustainable advantage can be derived from *A. lebbeck* based agrosilvicultural system. The yield reduction of 20% that occurred due to tree interference could be well compensated by the value realized (Rs. 1808) from pollarded portions (36.15 q/ha). The benefit-cost ratio (2.68) was marginally high with pure crop, as compared to the ratio (2.40) obtained in tree pollarding. In view of the indirect benefits provided by the trees, the benefit-cost ratio of 2.40 can be rated as high.

2.4 Allelopathy of *Melia azedarach*

The efficacy of aqueous extracts of twenty plants was observed by Bhardwaj and Laura in 2009 for their antifungal activity against *Chaetomium globosum*, causal organism of decay of cotton and other cellulose materials. The maximum inhibitory effect was shown by stem extracts of Aloevera (85.72%), while leaf extracts of *Camellia sinensis* (79.69%), bark extracts of *Acacia arabicae* (79.06%) and bark extracts of *Callistemon lanceolatus* (58.34%) showed strong inhibitory effect. Some of the other plants showed moderate inhibition against the mycelium growth of test fungi i.e. *Azadirachta indica* > *Albizia lebbeck* > *Aegle marmelos* > *Acacia catechu*.

Al-Charchafchi *et al.* (2007) found that germination percentage and seedling growth of *Vigna radiata* significantly decreased gradually as the concentration of the aqueous leaves extracts of *Azadirachta indica* increased in comparison with water control. Severe toxicity was observed at high concentrations and moderate toxicity at low concentrations in comparison with water control. Aqueous leaves extract significantly inhibited root length more than shoot. These results indicated that some kind of inhibitor(s) was the responsible agent for the phytotoxic effect of *A. indica* on germination and seedling growth of *V. radiata*.

Although *Azadirachta indica*, the so-called Neem or Nim, is well-known for its biological activities in many countries, the inhibitory effects of this extract on *Phaseolus vulgaris* germination and growth were also evaluated, indicating that both seed germination and radicle growth were affected in a concentration-dependent manner. It was studied by Silva *et al.* (2007).

The effect of 2, 4 and 8% (w/v) aqueous extracts of dry leaves of *Alstonia scholaris* (L.), *Azadirachta indica* (L.), *Eucalyptus citriodora*, *Mangifera indica* L. and *Syzygium cumini* (L.) Skeels against germination and seedling growth of one of the most serious weeds of wheat viz. *Phalaris minor* was observed by Arshad-Javaid *et al*. in 2006. Aqueous extracts of all the employed concentrations of *A. scholaris*, *A. indica* and *E. citiodora* proved highly effective resulting in significant reduction of 43-100% in final germination of the target weed species. Aqueous extracts of *M. indica* and *S. cumini* proved less effective where only highest concentration of 8% exhibited significant negative impact against the germination of P. minor. Generally, not always, the higher concentrations of 4 and 8% significantly reduced the seedling root and shoot growth of the target weed species.

Rathinasabapathi *et al*. (2005) reported that eluates of wood chips from red maple (*Acer rubrum* L.), swamp chestnut oak (*Quercus michauxii Nutt.*), red cedar (*Juniperus silicicola* L. *H. Bailey*), neem (*Azadirachta indica A. Juss.*), and magnolia (*Magnolia grandiflora* L.) highly inhibited germinating lettuce seeds, as assessed by inhibition of hypocotyl and radicle growth. The effects of wood chip eluates from these five species were more than that found for eluates from wood chips of black walnut (*Juglans nigra* L.,) a species previously identified to have weed-suppressing allelochemicals. Tests on red cedar, red maple, and neem showed that water-soluble allelochemicals were present not only in the wood but also in the leaves. In greenhouse trials, red cedar wood chip mulch significantly inhibited the growth of florida beggarweed (*Desmodium tortuosum* DC.), compared to the gravel-mulched and no-mulch controls.

Although the neem (*Azadirachta indica*) tree has been known to be useful in soil enrichment and for insect, pest and disease control was reported by Tran-Dang-Xuan *et al*. in 2004. Its allelopathic potential strongly inhibits germination and growth of several specific crops: alfalfa (*Medicago sativa* L.), bean (*Vigna angularis*), carrot (*Daucus carota* L.), radish (*Raphanus sativus* L.), rice (*Oryza sativa* L.), and sesame (*Sesamum indicum* L.) and weeds: *Echinochloa crus-galli*, *Monochoria vaginalis*, and *Aeschynomene indica* L. in a bioassay and in soil. The sensitivity of weeds varied between bioassay and soil. In all culture conditions, inhibition from neem bark was greater than from leaves. Six phenolic compounds including gallic acid, benzoic acid, p-coumaric acid, p-hydroxybenzoic acid, vanillic acid, and trans-cinamic acid were isolated and identified in both neem bark and leaves. Ferulic acid was found in the bark. Concentration of these phenolic compounds in bark was higher than in the leaves.

Hong *et al.* (2004) reported that *Datura stramonium* L., *Desmodium triflorum* L and *Melia azedarach* L. exhibited similar inhibitory magnitude at 1 t ha-1 achieving more than 90% weed control. *Clerodendrum trichotomum* L. achieved about 70% weed reduction at 2 t ha-1. In paddy fields, *D. triflorum* was the most promising material for weed control and attained the highest rice yield among treatments, at the concentration of 2 t ha-1, whereas the inhibition of *D. stramonium* and *M. azedarach* was weakened. No injury of rice plants was observed. These plants might be used as natural herbicides to reduce the dependence on synthetic herbicides.

But Amit-Walia and Bisla in 2003 observed that the germination and seedling growth parameters of radish decreased significantly over the control at all concentrations (5, 10 and 15%) of neem leaf extract all. Significant inhibition in germination parameters and root length of onion was observed while shoot length and dry weight per seedling exhibited no significant changes. The magnitude of reduction in germination was more prominent in onion than in radish and the reverse was observed for seedling growth.

Nguyen *et al.* (2003) stated that the greatest allelopathic potential were *Galactia pendula*, *Leucaena glauca* and *Melia azedarach*. Four other species including *Desmodium rezoni*, *Euphobia hirta*, *Manihot esculenta* and *Morus alba* were assessed to be the second most suppressive to radish germination and growth. Findings also indicated inhibitory exhibition of allelopathic plants were species dependent. Moreover, inhibitory effects varied among plant parts such as the leaves, stem and root.

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. Among the four test crops, cowpea was least affected in terms of growth and yield compared to the other test crops. It is recommended that cowpea could be an ideal crop component for *A. indica* under rainfed conditions (Divya and Yassin , 2003).

Channal *et al.* (2002) Studies on the allelopathic effect of seven tree leaf extracts, viz. *Syzygium cumini*, *Acacia arabica* [*Acacia nilotica*], *Tectona grandis*, *Eucalyptus tereticornis*, *Tamarindus indica*, *Samanea saman* and *Azadirachta indica* each at 5 and 10% concentration on sunflower and soyabean indicated that germination of sunflower was increased by *Tectona grandis*, *Tamarindus indica* and *Samanea saman* each at 5 and 10% concentration, while it was suppressed by *E. tereticornis* and *Acacia arabica*. Soyabean germination was increased by *Acacia arabica*, *Tectona grandis*, *Samanea saman* and *Azadirachta indica* at both concentrations, while it was decreased by *Tamarindus indica*. Similarly, seedling length, vigour index and seedling dry matter was also influenced by tree leaf extracts at different concentrations. The seedling length of sunflower was significantly increased by *Syzygium cumini*, *Azadirachta indica*, *Acacia arabica* and *Samanea saman*, while that of soyabean was increased by all tree leaf extracts, though the effect was not that significant compared to sunflower. Almost all the leaf extracts enhanced vigour index in sunflower, while only *Tectona grandis*, *Acacia arabica* and *Azadirachta indica* increased the vigour index in soyabean. The seedling dry matter was markedly decreased by *Acacia arabica*, *E. tereticornis*, *Tamarindus indica* and *Azadirachta indica* in sunflower, while all leaf extracts except *E. tereticornis* decreased the seedling dry matter of soyabean.

An experiment was studied by Amit-Walia *et al.* (2002a) found that seed germination, seedling growth, and root and shoot length of radish and onions significantly decreased with increasing concentrations of neem leaf leachate, with onion recording higher reductions in the values of the parameters measured, indicating that radishes are more tolerant of the allelochemicals than onions.

Reductions in the dry weight of seedlings were significant for radishes and non-significant for onions.

Amit-Walia *et al.* (2002b) performed a study to characterize the allelopathic effect of different concentrations (5, 10, and 15%) of neem (*Azadirachta indica*) leaf leachate and extract on germination and early seedling growth of rabi crops, namely wheat and barley. The germination and early seedling growth of both test crops were reduced significantly over control at all the concentrations of leachate and extract. The inhibitory effect of leachate and extract was found more on barley in comparison of wheat and concentration dependent on both test crops.

A pot study was investigated by using field soil amended with 5 g/kg oilseed cakes of *Azadirachta indica* (neem), *Madhuca indica* [*Madhuca longifolia*] (mahua) and *Gossypium indicum* [*Gossypium sp.*] (Cotton). The soil around the root zone was sampled to study the rhizosphere mycoflora of A. lebbeck 30, 60 and 90 days after sowing. A total of 24 fungal species (saprophytic and parasitic) were isolated from the soil. Soil amended with mahua oilseed cake had the highest rate of reduced fungal frequency followed by cotton and neem seed cake (Yasmeen and Shamim, 2000).

Channal *et al.* (2000) conducted a study to evaluate the allelopathic effect of leaf extracts from *Azadirachta indica*, *Acacia arabica* [*Acacia nilotica*], *Eucalyptus tereticornis*, *Tamarindus indica*, *Tectona grandis*, *Samanea saman* and *Syzygium cumini*, all applied 5 and 10% concentration, on seed germination, vigour index, seedling length, and seedling dry matter of sorghum and rice. Irrespective of concentration, all tree leaf extracts promoted germination in sorghum (15-32% over the control), while only *Azadirachta indica* and *Acacia arabica* increased germination in rice (3.50-3.81% over the control). Seedling length was considerably decreased in sorghum due to *Syzygium cumini*, *Tectona grandis* and *E. tereticornis* and in rice due to *E. tereticornis* and *Tamarindus indica*. Seedling length was markedly increased in sorghum due to *Acacia arabica* and in rice due to *Azadirachta indica*, *Samanea saman* and *Acacia arabica*. Leaf extracts from

Acacia arabica, *Samanea saman* and *Azadirachta indica* at 5 and 10% enhanced vigour index in sorghum, while *Acacia arabica* and *Samanea saman* at either concentration increased vigour index in rice. Vigour index was markedly decreased in sorghum due to *Eucalyptus tereticornis* and *Syzygium cumini* and in rice due to *Syzygium cumini*, *Tamarindus grandis* and *Eucalyptus tereticornis*. Leaf extracts decreased the seedling dry matter in sorghum and rice irrespective of concentrations.

CHAPTER III

MATERIALS AND METHODS

CHAPTER III

MATERIALS AND METHODS

In this section, the materials and methods have been presented which include brief description of location of the experimental site, climate, materials used and methodology followed in the experiment. To attain in the objectives of the research, total four experiments were conducted. The details of these sections are described below. These are:

3.1: Allelopathic Effects of *Albizia lebbeck* on Agricultural Crops

3.2: Allelopathic Effects of *Leucaena leucocephala* on Agricultural Crops

3.3: Aallelopathic Effects of *Melia Azedarach* on Agricultural Crops

3.4: Allelopathic Effects of *Litchi chinensis* on Agricultural Crops

3.1 Experiment no.1

Allelopathic Effects of *Albizia lebbeck* on Agricultural Crops

3.1.1 Location

Agroforestry research field, Department of Agroforestry, HSTU, Dinajpur, located between 25°13' latitude and 88º23' longitude and about 37.5m above sea level.

3.1.2 Climate and Weather

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.

3.1.3 Duration

Duration of the experimental period was from **May** 2009 to **July** 2009.

3.1.4 Design

The experiment was conducted with single factor. RCBD (Randomized Complete Block Design) were applied with four replications.

3.1.5 Factor and Treatments

The Experiment was conducted with single factor (*Albizia lebbeck*)

5 (Five) treatments were applied. These are

i) T_1=Top soil of *Albizia lebbeck* (depth of top soil is 15 cm.)

ii) T_2=Root zone soil of *Albizia lebbeck* (depth of root zone soil is 2 feet

iii) T_3=Soil mulched with dry leaves of *Albizia lebbeck* (sun dry)

iv) T_4=Soil watered with aqueous Leaf extract of *Albizia lebbeck* (5% fresh aqueous leaf extract).

v) T_5=Ordinary/Fresh garden soil

3.1.6 The selected test crops

Mungbean (*Vigna radiata*) and Soybean (*Glycine max*)

3.1.7 Preparation and application of the treatments

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 gs) 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 32 pots were filled with root zone soil in 7th May. 64 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 32 pots which containing garden soil. Leaves of the trees were sun dried for 5 days. 20 gs crushed

3.2 Experiment no. 2

Allelopathic Effects of *Leucaena leucocephala* on Agricultural crops

Materials and Methods were same as Experiment no.1. But, instead of *Albizia lebbeck* in this experiment, *Leucaena leucocephala* tree was used.

3.3 Experiment no. 3

Allelopathic Effects of *Melia azedarach*on on Agricultural crops

Materials and Methods were same as Experiment no.1. But, instead of *Albizia lebbeck* in this experiment, *Melia azedarach*on tree was used.

3.4 Experiment no. 4

Allelopathic Effects of *Litchi chinensis* on Agricultural crops

Materials and Methods were same as Experiment no.1 but, instead of *Albizia lebbeck* in this experiment, *Litchi chinensis* tree was used.

Some plates on Research work

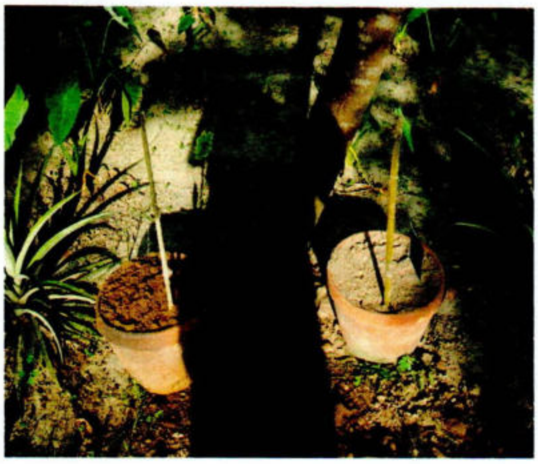

Plate 1.Collection and filling of pot with top soil.

Plate 2. Collection and filling of pot with root zone soil

Plate 3. Pot mulched with dry leaf

Plate 4. Pot watered with aqueous leaf extracts

Plate 5. Overall view of pot arrangement

Plate 6. Seed germination in treated pot

CHAPTER IV

RESULTS AND DISCUSSION

CHAPTER IV

RESULTS AND DISCUSSION

The results obtained from the present studies along with statistical analysis of data have been presented and discussed in this chapter. The present studies regarding allelopathic effects of some selected tree species on the germination and growth of mungbean and soybean were observed. The summaries of analysis of variance for germination and growth parameters studied have been presented here.

4.1 Experiment no.1: Allelopathic Effects of *Albizia lebbeck* on Agricultural Crops

4.1.1 Results

4.1.1.1 Allelopathic effects of *Albizia lebbeck* on Mungbean (*Vigna radiata*)

4.1.1.1.1 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).

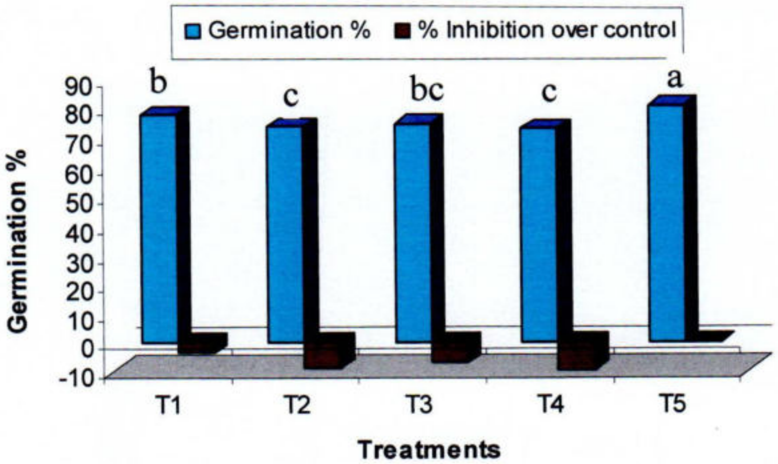

Fig.1. Allelopathic effects of *Albizia lebbeck* on germination of mungbean

Note: Mean followed by a common letter is not significantly different at the 5% level by DMRT

4.1.1.1.2 No. 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) (Appendix I).

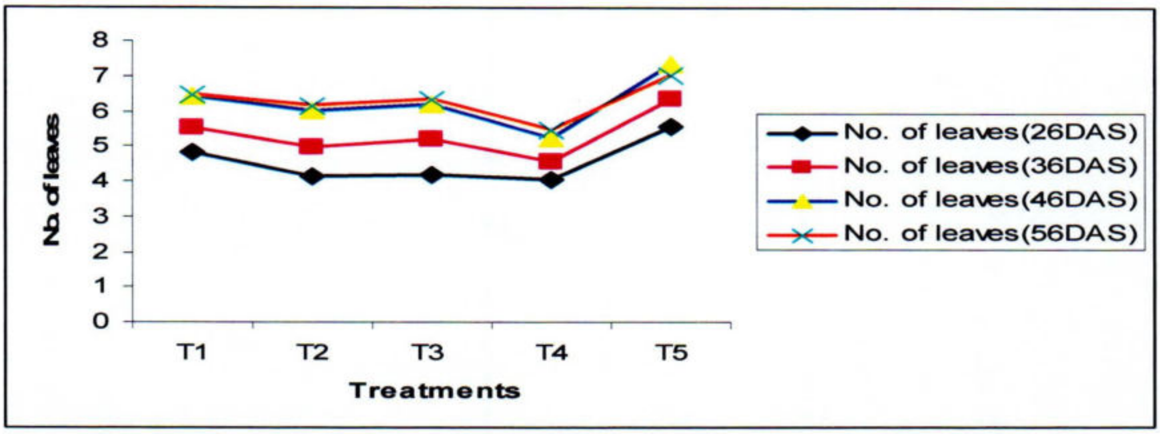

Fig.2. Allelopathic effects of *Albizia lebbeck* on no. of leaf of mungbean

4.1.1.1.3 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).

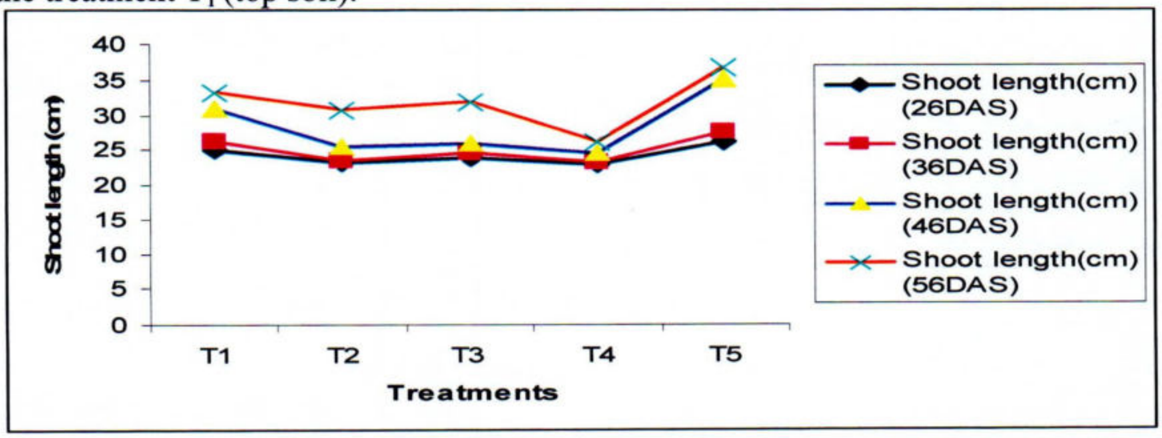

Fig.3. Allelopathic effects of *Albizia lebbeck* on Shoot Length of mungbean

4.1.1.1.4 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).

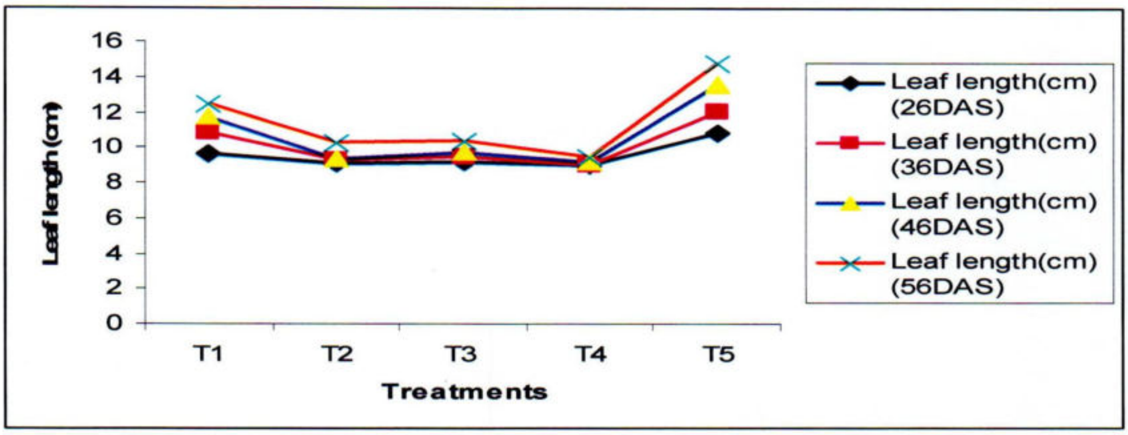

Fig.4. Allelopathic effects of *Albizia lebbeck* on Leaf Length of mungbean

4.1.1.1.5 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) (Appendix I).

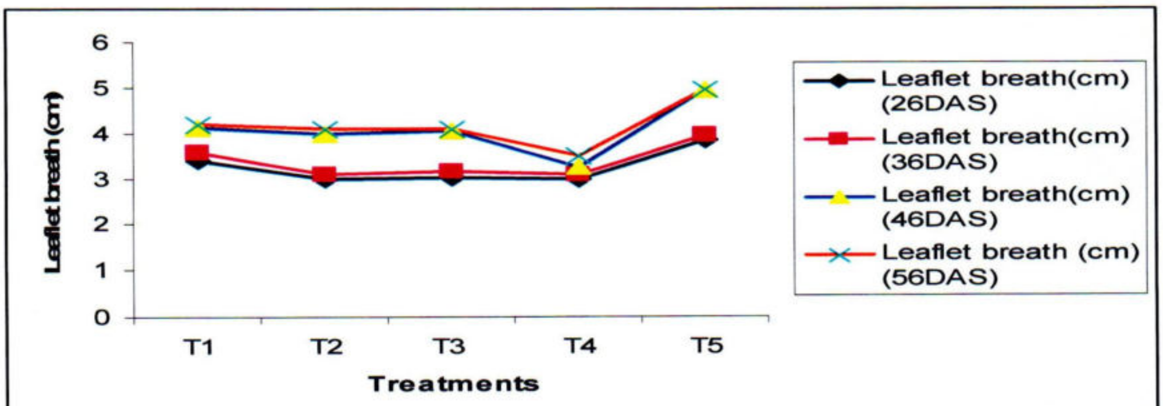

Fig.5. Allelopathic effects of *Albizia lebbeck* on Leaflet breath of mungbean

4.1.1.1.6 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).

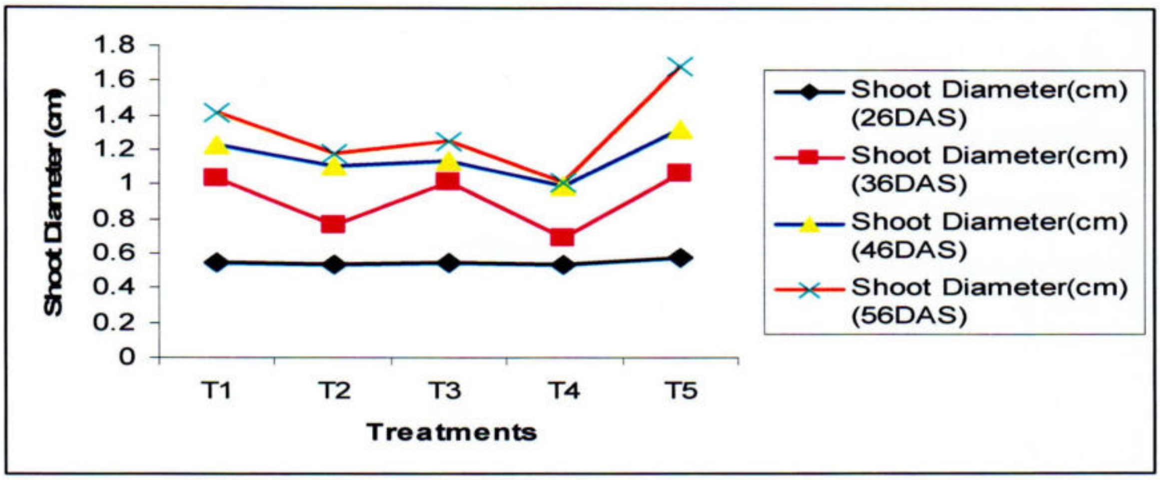

Fig.6. Allelopathic effects of *Albizia lebbeck* on Shoot diameter of mungbean

Table 1. Allelpoathic effects of *Albizia lebbeck* on 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**

4.1.1.1.7 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).

4.1.1.1.8 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).

4.1.1.1.9 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).

4.1.1.1.10 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).

4.1.1.1.11 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).

4.1.1.1.12 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).

Plate 7. Vegetative growth of mungbean as influnced by *Albizia lebbeck*

Plate 8. Vegetative growth of soybean influnced by *Albizia lebbeck*

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

4.1.1.2.1 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).

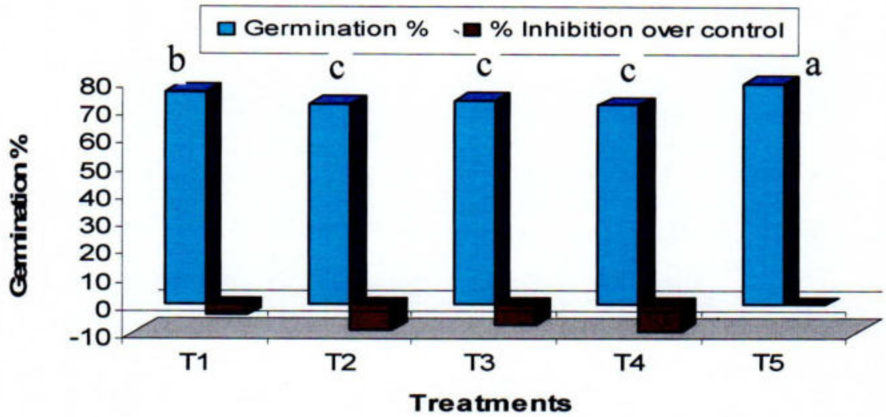

Fig.7. Allelopathic effects of *Albizia lebbeck* on germination of Soybean

Note: Mean followed by a common letter is not significantly different at the 5% level by DMRT

4.1.1.2.2 No. 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) (Appendix II).

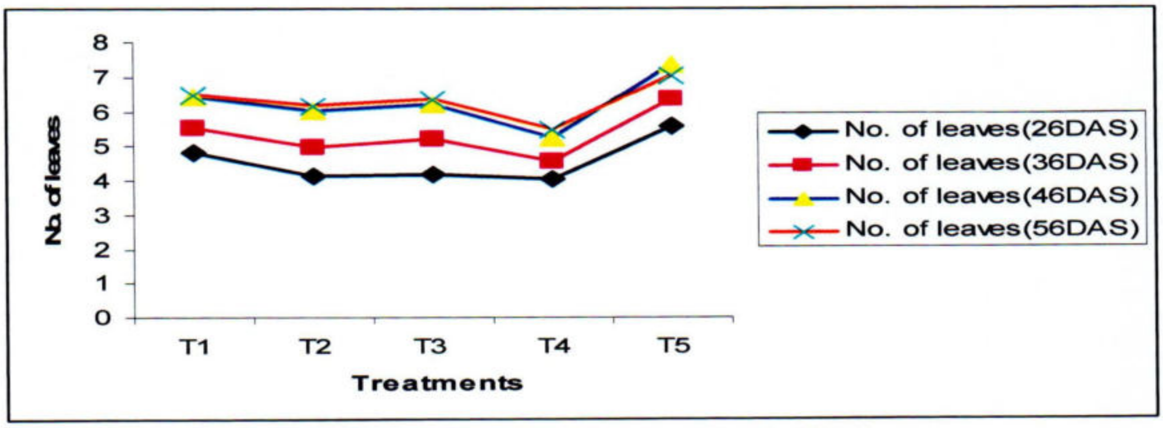

Fig.8. Allelopathic effects of *Albizia lebbeck* on no. of leaf of Soybean

4.1.1.2.3 Shoot Length (cm)

At different DAS in all the treatments shoot length of soybean influnced 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).

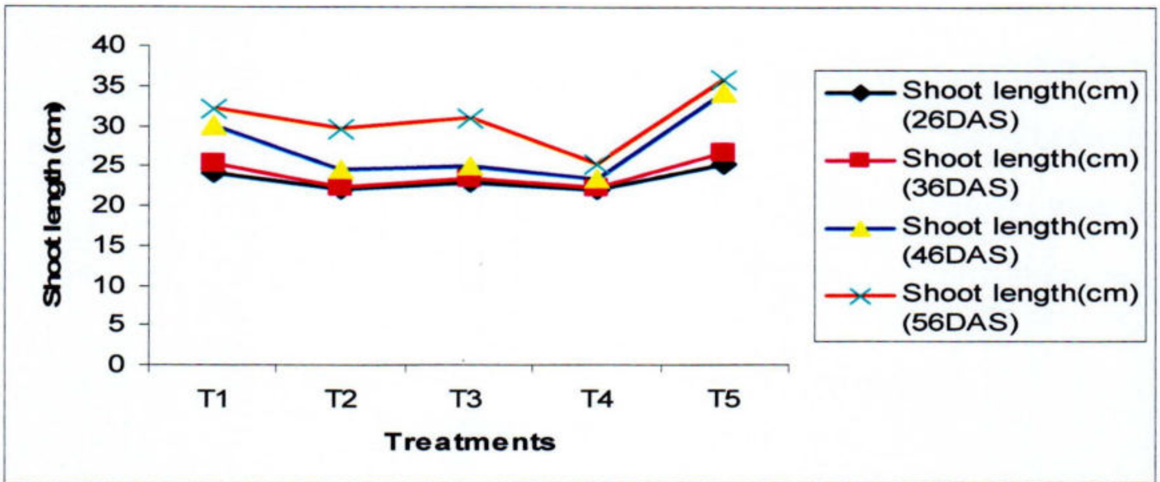

Fig.9. Allelopathic effects of *Albizia lebbeck* on Shoot Length of soybean

4.1.1.2.4 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) (Appendix II).

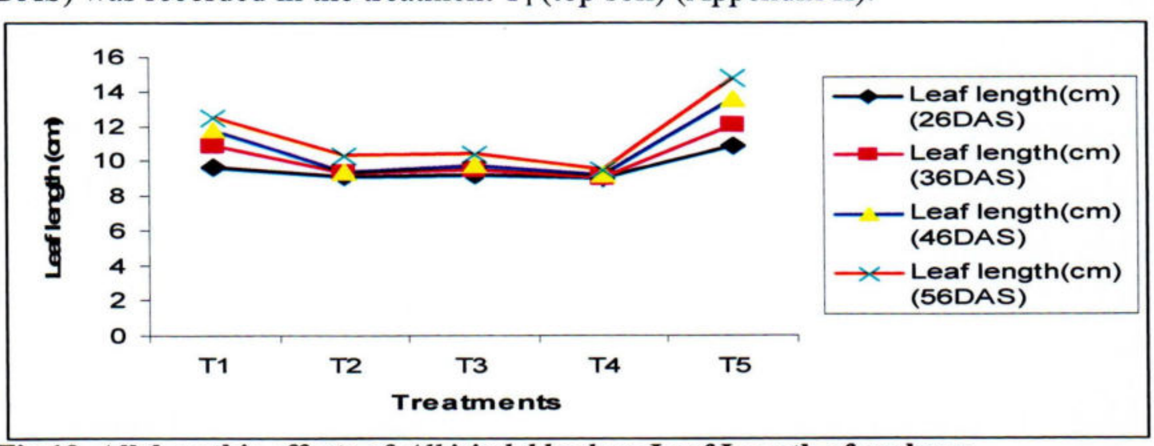

Fig.10. Allelopathic effects of *Albizia lebbeck* on Leaf Length of soybean

4.1.1.2.5 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) (Appendix II).

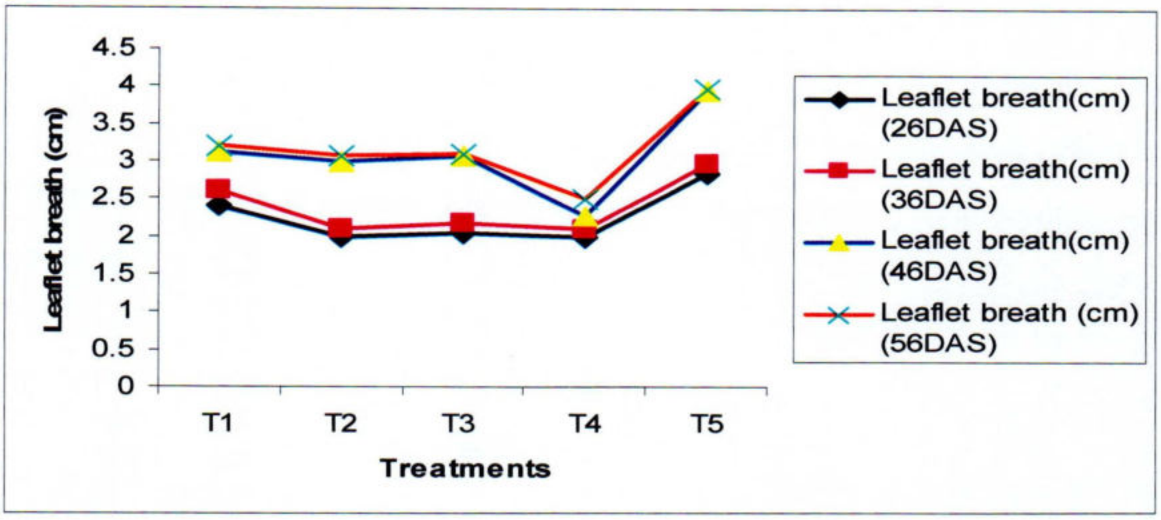

Fig.11. Allelopathic effects of *Albizia lebbeck* on Leaflet breath of soybean

4.1.1.2.6 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).

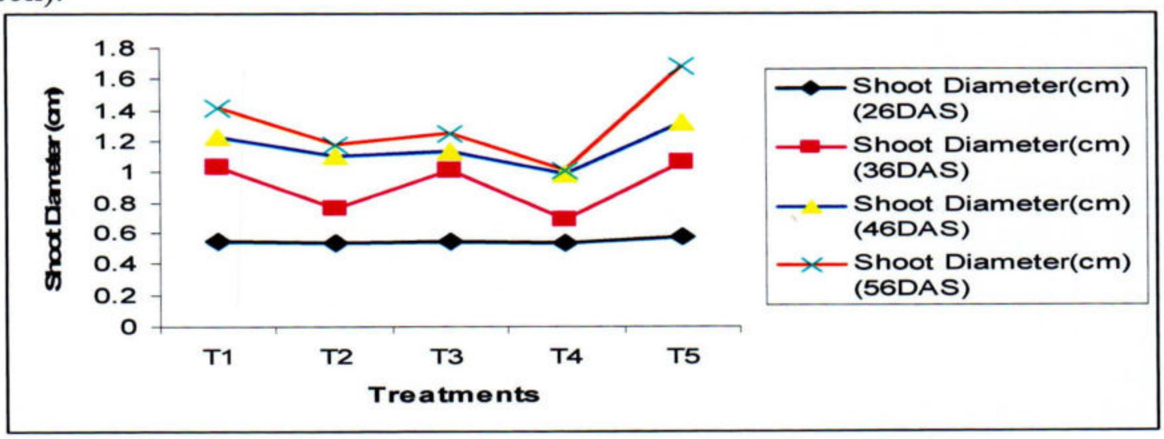

Fig.12. Allelopathic effects of *Albizia lebbeck* on Shoot diameter of soybean

4.1.1.2.7 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).

4.1.1.2.8 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 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**

4.1.1.2.9 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).

4.1.1.2.10 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).

4.1.1.2.11 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).

4.1.1.2.12 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).

4.1.2 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, 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 synergistic effects become significant even at low concentratios (Uddin *et al.*, 2007).

4.2 Experiment no.2: Allelopathic effects of *Leucaena leucophala* on agricultural crops

4.2.1 Results

4.2.1.1 Allelopathic effects of *Leucaena leucophala* on Mungbean (*Vigna radiata*)

4.2.1.1.1 Germination percentage

The germination percentage significantly varied in all the treatments over control (Fig. 13). Among the five treatments, the maximum inhibition (-5.47) was found in the treatment T_4 (soil with aqueous leaf extracts) followed by the treatment T_1 (top soil) and T_3 (soil mulched with dry leaf). A little stimulatory effect (+7.14) was gained in the treatment T_2 (root zone soil).

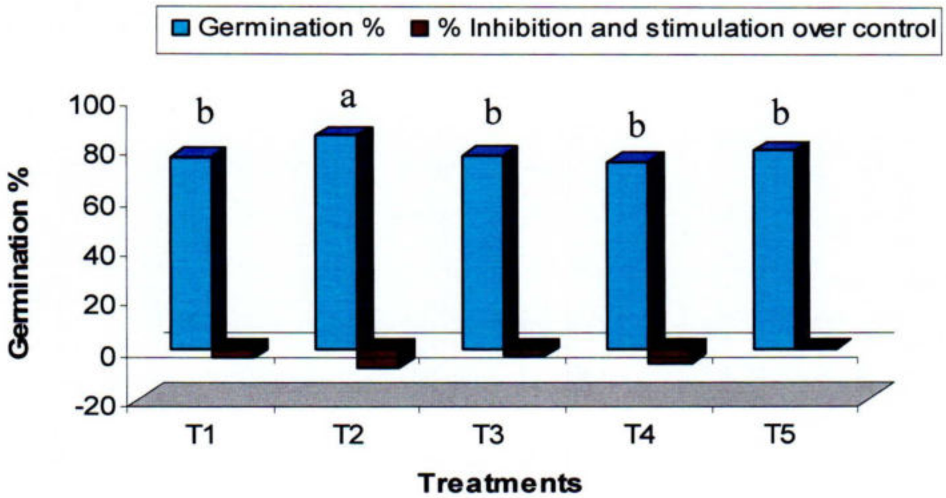

Fig.13. Allelopathic effects of *Leucaena leucocephala* on germination of Mungbean

Note: Mean followed by a common letter is not significantly different at the 5% level by DMRT

4.2.1.1.2 No. of Leaf

No. of leaf of mungbean was significantly influenced in all the treatments in respects to control (Fig. 14). Significantly the maximum suppression (-17.80 at 26 DAS; -7.24 at 36 DAS; -16.44 at 46 DAS and -12.06 at 56 DAS) was recorded in the treatment T_4 (soil watered with aqueous leaf extracts) and the minimum was observed (-5.94 at 26 DAS; -2.36 at 36 DAS; -1.49 at 46 DAS and -0.71 at 56 DAS) in T_3 (soil mulched with dry leaf). Significantly stimulatory effect (+23.02 at 36 DAS; +18.74 at 36 DAS; +14.80 at 46 DAS and +16.88 at 56 DAS) was found in the T_2 treatment (root zone soil) (Appendix III).

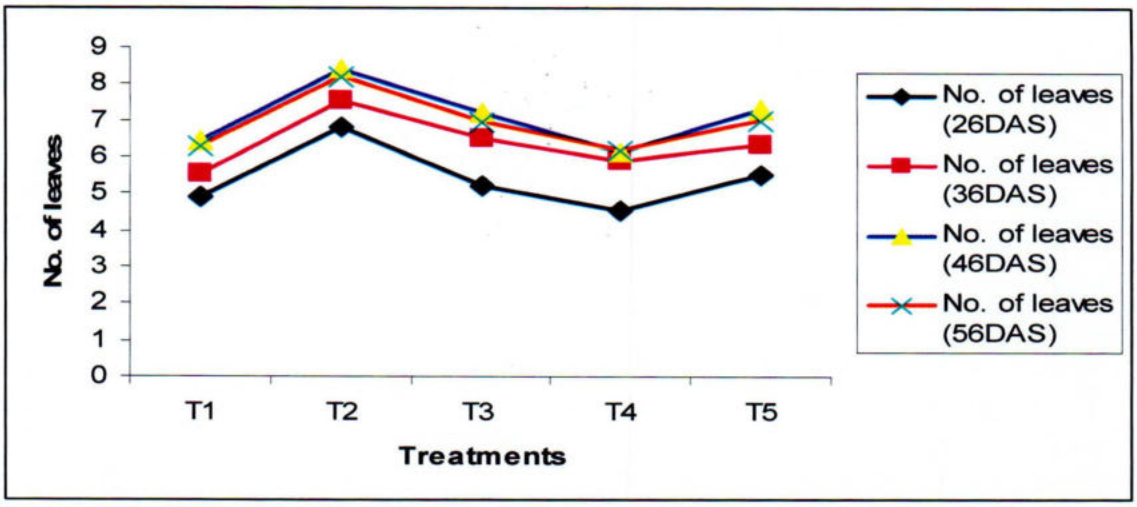

Fig.14. Allelopathic effects of *Leucaena leucocephala* on no. of leaf of Mungbean

4.2.1.1.3 Shoot Length (cm)

In respects to control shoot length of mungbean was significantly varied in all the treatments (Fig. 15). Significantly the maximum suppression (-7.03 at 26 DAS; -9.6 at 36 DAS; -16.08 at 46 DAS and -12.33 at 56 DAS) was observed in the treatment T_4 (soil watered with aqueous leaf extracts) and the minimum was noted (-0.8 at 26 DAS; -4.12 at 36 DAS; -6.02 at 46 DAS and -4.84 at 56 DAS) in T_3 (soil mulched with dry leaf). Significantly stimulatory effect (+9.9 at 36 DAS; +9.78 at 36 DAS; +12.64 at 46 DAS and +8.27 at 56 DAS) was found in the T_2 treatment (root zone soil).

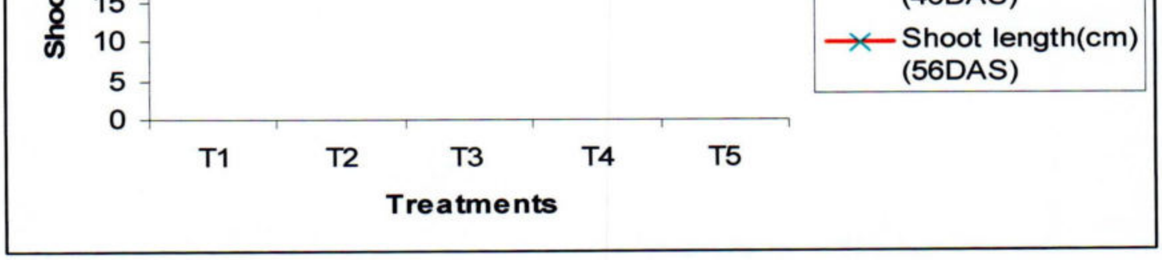

Fig.15. Allelopathic effects of *Leucaena leucocephala* on Shoot Length of Mungbean

4.2.1.1.4 Leaf Length (cm)

Leaf length of mungbean was significantly influenced in all the treatments in comparism to control (Fig.16). Significantly the maximum suppression (-14.83 at 26 DAS; 10.93 at 36 DAS; -18.02 at 46 DAS and -16.09 at 56 DAS) was observed in the treatment T_4 (soil watered with aqueous leaf extracts) and the minimum was reported (-2.58 at 26 DAS; -1.79 at 36 DAS; -10.36 at 46 DAS and -12.32 at 56 DAS) in T_3 (soil mulched with dry leaf). Significantly stimulatory effect (+14.46 at 36 DAS; +17.89 at 36 DAS; +12.02 at 46 DAS and +16.67 at 56 DAS) was found in the T_2 treatment (root zone soil) (Appendix III).

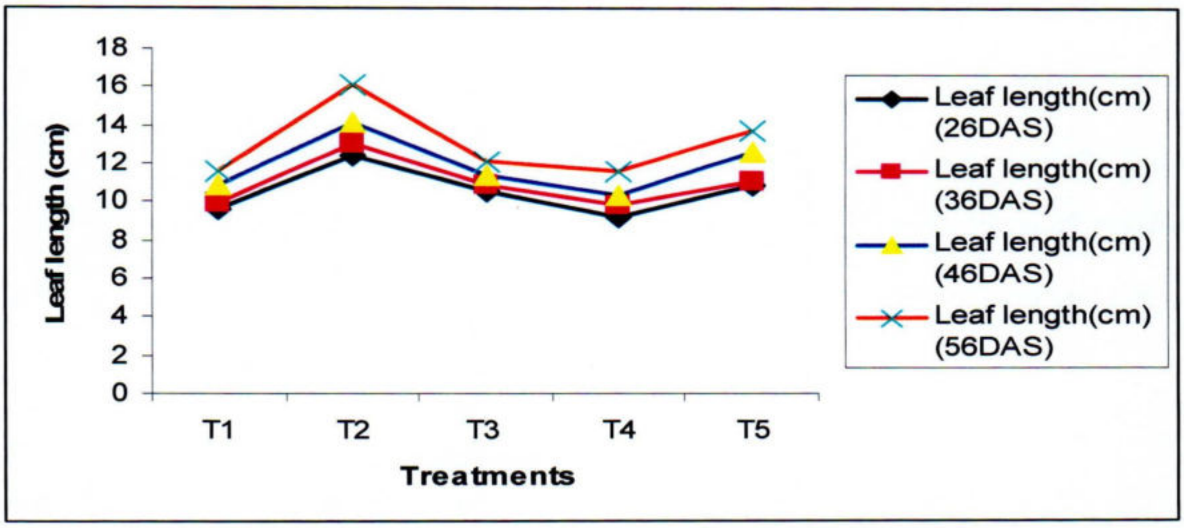

Fig.16. Allelopathic effects of *Leucaena leucocephala* on Leaf Length of Mungbean

4.2.1.1.5 Leaflet Breath (cm)

All the treatments significantly influenced the leaflet breath of mungbean in respects to control (Fig.17). Significantly the highest suppression (-18.96 at 26 DAS; -12.06 at 36 DAS; -16.97 at 46 DAS and -5.23 at 56 DAS) was observed in the treatment T_4 (soil watered with aqueous leaf extracts) and the lowest was found (-1.81 at 26 DAS; -2.51 at 36 DAS; -14.14 at 46 DAS and -6.44 at 56 DAS) in T_3 (soil mulched with dry leaf). Significantly stimulatory effect (+9.09 at 36 DAS; +12.06 at 36 DAS; +16.36 at 46 DAS and +20.93 at 56 DAS) was reported in the T_2 treatment (root zone soil).

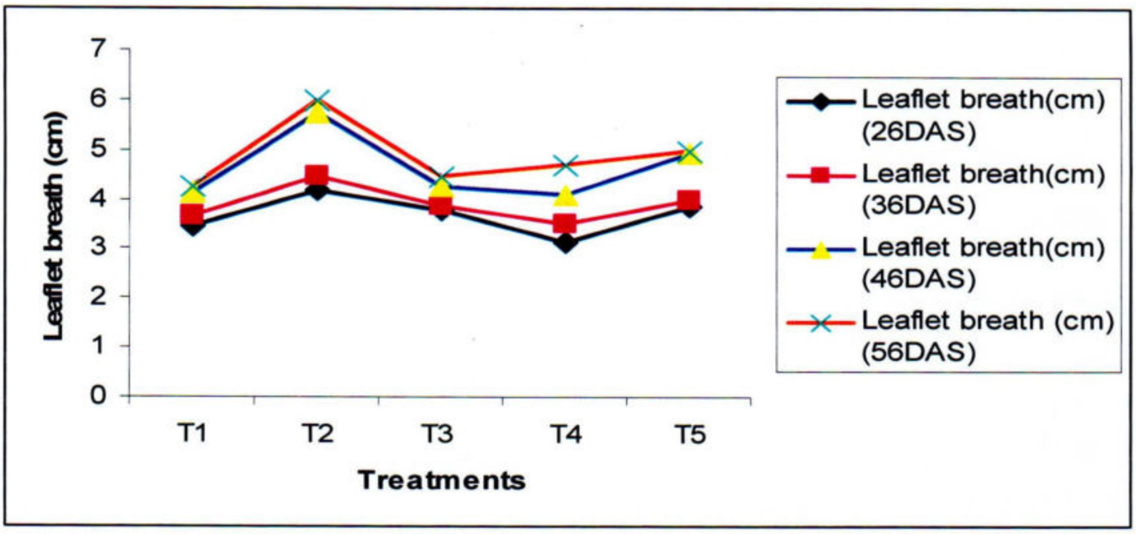

Fig.17. Allelopathic effects of *Leucaena leucocephala* on Leaflet breath of Mungbean

4.2.1.1.6 Shoot Diameter (cm)

Shoot diameter of mungbean was significantly influenced in all the treatments over control (Fig.18). Significantly the maximum suppression (-1.72 at 26 DAS; -1.87 at 36 DAS; -4.55 at 46 DAS and -7.69 at 56 DAS) was observed in the treatment T_4 (soil watered with aqueous leaf extracts) and the minimum was observed (-0.00 at 26 DAS; -0.93 at 36 DAS; -2.27 at 46 DAS and -1.78 at 56 DAS) in T_3 (soil mulched with dry leaf). Significantly stimulatory effect (+5.17 at 36 DAS; +0.93 at 36 DAS; +0.76 at 46 DAS and +0.59 at 56 DAS) was found in the T_2 treatment (root zone soil) (Appendix III).

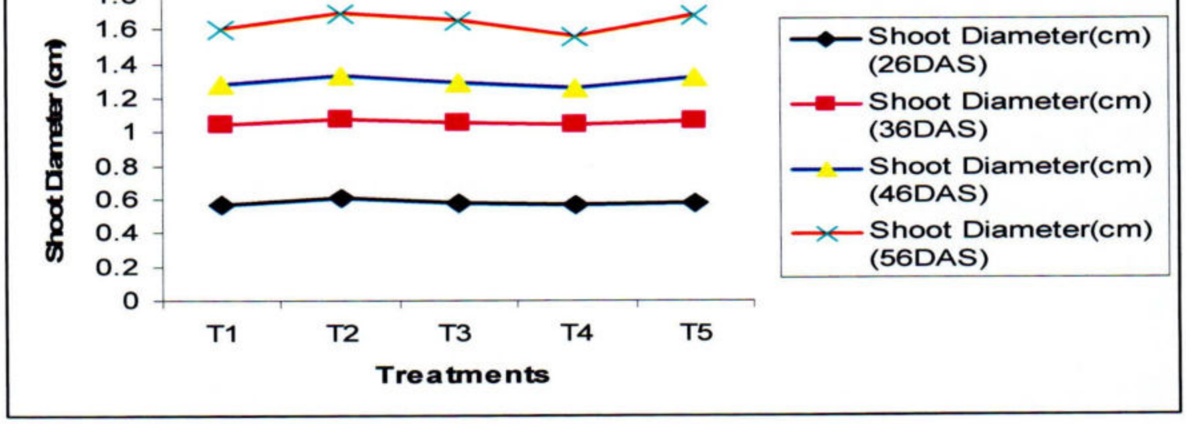

Fig.18. Allelopathic effects of *Leucaena leucocephala* on Shoot diameter of Mungbea

Table 3. Allelpoathic effects of *Leucaena leucophala* on 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	44.50b (-4.09)	6.36bc (-23.19)	3.56b (-11.00)	6.00b (-22.58)	3.75bc (-32.10)	7.31bc (-23.29)
T_2	49.52a (+6.72)	9.57a (+15.57)	6.39a (+59.75)	9.76a (+25.94)	6.53a (+18.08)	12.92a (+35.57)
T_3	45.04b (-2.93)	7.78b (-6.04)	3.98b (-0.50)	6.67b (-13.94)	4.48b (-18.99)	8.46b (-11.23)
T_4	36.54c (-21.25)	5.58c (-32.61)	3.10c (-22.5)	5.78c (-25.42)	3.30c (-40.33)	6.40c (-32.84)
T_5	46.40b (0.00)	8.28a (0.00)	4.00b (0.00)	7.75b (0.00)	5.53a (0.00)	9.53b (0.00)
Level of sig.	*	*	*	*	*	*
CV%	14.36	8.69	16.38	7.59	14.52	10.25

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**

4.2.1.1.7 Root length (cm)

It was showed that all the treatments significantly suppress the root length of that crop (Table 3). Among five treatments, only T_2 (root zone soil) shows little stimulatory effect (+6.72) on root length of mungbean. The longest inhibitory effect (-21.25) was obtained in soil treated with T_4 treatment (aqueous leaf extract) over control whereas, the shortest inhibitory effect (-2.93) was found in the treatment T_3 (soil with dry leaf).

4.2.1.1.8 Shoot Fresh Weight (g)

Shoot fresh weight of mungbean significantly suppressed under all the treatments in comparison to control (Table 3). Significantly the highest inhibition (-32.61) was recorded in the treatments T_4 (soil with aqueous leaf extract) which was statistically similar to that of T_1 (top soil). The treatment T_2 (root zone soil) promotes (+15.57) the shoot fresh weight over control of that crop.

4.2.1.1.9 Shoot dry weight (g)

The highest suppression (-22.5) of shoot dry weight was obtained in the treatment of T_4 (soil with aqueous leaf extract). But the lowest inhibition (-0.50) was reported in the treatment T_3 (soil with dry leaf) which statistically followed by top soil over control. All the treatments significantly inhibit the shoot dry weight of mungbean except root zone soil (Table 3).

4.2.1.1.10 Root Fresh Weight (g)

Significantly the highest inhibition (-25.42) of root fresh weight was observed in the treatment T_4 (soil with aqueous leaf extract). But the lowest inhibition (-13.94) was found in the treatment T_3 (soil with dry leaf) followed by top soil. Stimulatory effect (+25.94) was gained in the treatment T_2 (root zone soil). It was observed that all the treatments show significant different (Table 3).

4.2.1.1.11 Root dry weight (g)

Root dry weight significantly inhibited in all treatments except root zone soil (Table 3). The highest suppression (-40.33) of root dry weight was observed in the treatment T_4 (soil with aqueous leaf extract) which was statistically similar to treatment T_1 (top soil) in respects to control. But the lowest suppression (-11.23) was recorded in the treatment T_3 (soil treated with dry leaf). The treatment T_2 (root zone soil) significantly promoted (+18.08) the root dry weight of mungbean.

4.2.1.1.12 Total Dry Matter (g)

All the treatments significantly inhibit the shoot dry weight of mungbean except T_2 (soil collected from root zone) which promoted the total dry matter. Mungbean total dry matter inhibition (-32.84) was high in the treatment T_4 (soil watered with aqueous leaf extract) followed by T_1 (top soil). But the lowest inhibition (-11.23) was reported in the treatment T_3 (soil treated with dry leaf) in comparison to control (Table 3).

Plate 9. Vegetative growth of mungbean influnced by *Leucaena leucocephala*

Plate 10. Vegetative growth of soybean influnced by *Leucaena leucocephala*

4.2.1.2 Allelopathic effects of *Leucaena leucophala* on Soybean (*Glycine max*)

4.2.1.2.1 Germination percentage

The germination percentage significantly varied in all the treatments over control (Fig. 19). Among the five treatment, the maximum inhibition (-5.53) was found in the treatment T_4 (soil with aqueous leaf extracts) followed by the treatment T_1 (top soil) and T_3 (soil mulched with dry leaf).There was a little stimulatory effect (+7.23) was gained in the treatment T_2 (root zone soil) (Appendix IV)

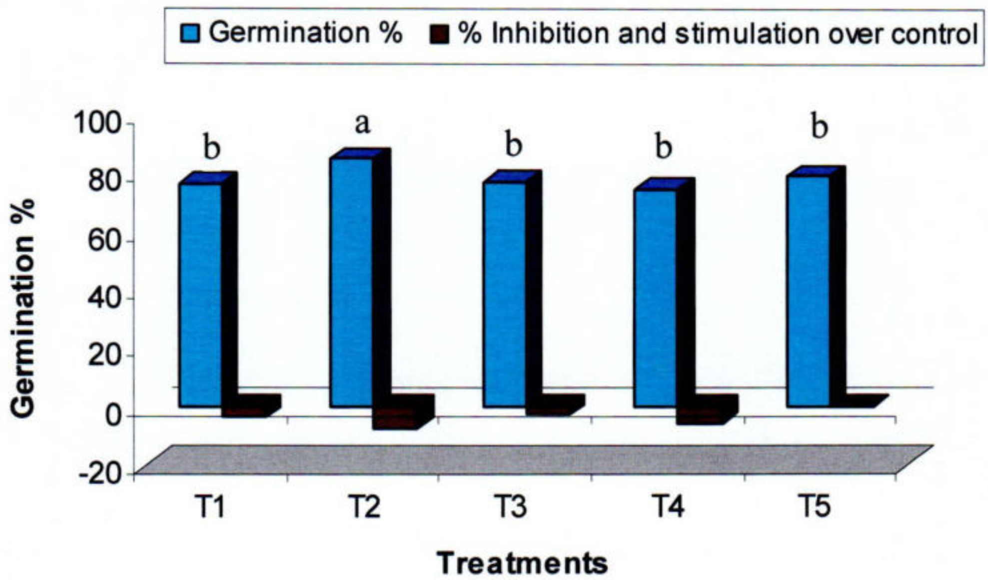

Fig.19. Allelopathic effects of *Leucaena leucocephala* on germination of Soybean

Note: Mean followed by a common letter is not significantly different at the 5% level by DMRT

4.2.1.2.2 No. of Leaf

No. of leaf of soybean was significantly influenced in all the treatments in respects to control (Fig.20). Significantly the maximum suppression (-21.71 at 26 DAS; -8.6 at 36 DAS; -19.03 at 46 DAS and -14.05 at 56 DAS) was observed in the treatment T_4 (soil watered with aqueous leaf extracts) and the minimum was observed (-7.24 at 26 DAS; -2.80 at 36 DAS; -1.73 at 46 DAS and -0.83 at 56 DAS) in T_3 (soil mulched with dry leaf). Significantly stimulatory effect (+28.07 at 36 DAS; +22.24 at 36 DAS; +17.14 at 46 DAS and +19.67 at 56 DAS) was found in the T_2 treatment (root zone soil) (Appendix IV).

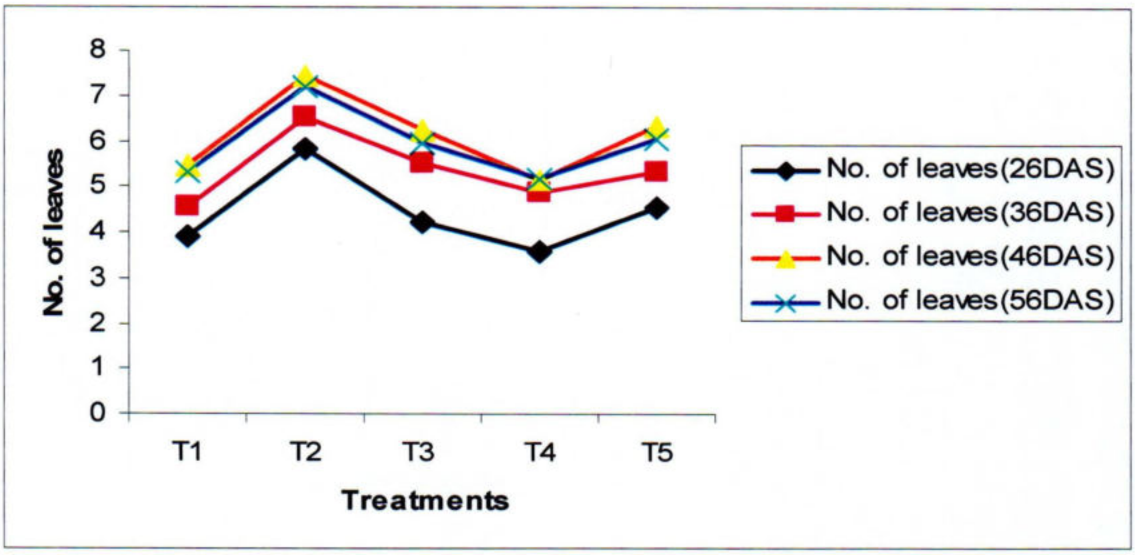

Fig.20. Allelopathic effects of *Leucaena leucocephala* on no. of leaf of Soybean

4.2.1.2.3 Shoot Length (cm)

All the treatments significantly influenced the shoot length of soybean in comparism to control (Fig. 21). Significantly the highest suppression (-7.31 at 26 DAS; -9.96 at 36 DAS; -16.55 at 46 DAS and -12.67 at 56 DAS) was reported in the treatment T_4 (soil watered with aqueous leaf extracts) and the lowest was observed (-0.83 at 26 DAS; -4.27 at 36 DAS; -6.20 at 46 DAS and -4.98 at 56 DAS) in T_3 (soil mulched with dry leaf). Significantly stimulatory effect (+11.46 at 36 DAS; +10.15 at 36 DAS; +13.01 at 46 DAS and +8.50 at 56 DAS) was found in the T_2 treatment (root zone soil) (Appendix IV).

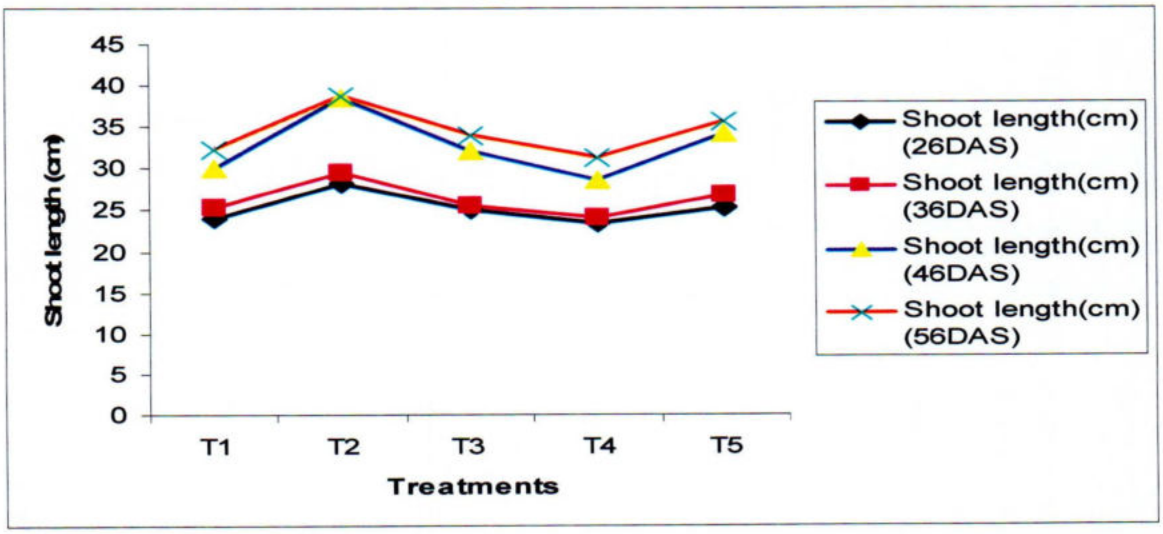

Fig.21. Allelopathic effects of *Leucaena leucocephala* on Shoot Length of Soybean

4.2.1.2.4 Leaf Length (cm)

Leaf length of soybean was significantly influenced in all the treatments in respects to control (Fig. 22). Significantly the maximum suppression (-16.33 at 26 DAS; -11.47 at 36 DAS; -18.02 at 46 DAS and -16.09 at 56 DAS) was observed in the treatment T_4 (soil watered with aqueous leaf extracts) and the minimum was noted (-2.84 at 26 DAS; -1.63 at 36 DAS; -10.36 at 46 DAS and -12.32 at 56 DAS) in T_3 (soil mulched with dry leaf). Significantly stimulatory effect (+15.92 at 36 DAS; +17.89 at 36 DAS; +12.02 at 46 DAS and +16.67 at 56 DAS) was found in the T_2 treatment (root zone soil) (Appendix IV).

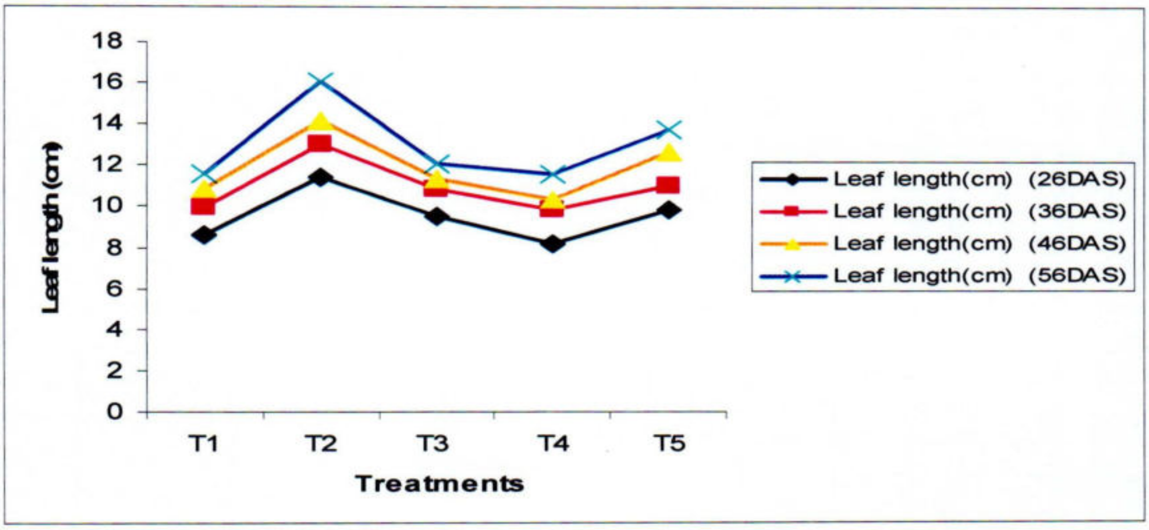

Fig.22. Allelopathic effects of *Leucaena leucocephala* on Leaf Length of Soybean

4.2.1.2.5 Leaflet Breath (cm)

Leaflet breath of soybean was significantly influenced in all the treatments over control (Fig. 23). Significantly the maximum suppression (-25.61 at 26 DAS; -16.11 at 36 DAS; -21.27 at 46 DAS and -6.55 at 56 DAS) was reporded in the treatment T_4 (soil watered with aqueous leaf extracts) and the minimum was observed (-2.46 at 26 DAS; -3.36 at 36 DAS; -17.72 at 46 DAS and -12.59 at 56 DAS) in T_3 (soil mulched with dry leaf). Significantly stimulatory effect (+12.28 at 36 DAS; +16.11 at 36 DAS; +20.51 at 46 DAS and +25.44 at 56 DAS) was found in the T_2 treatment (root zone soil) (Appendix IV).

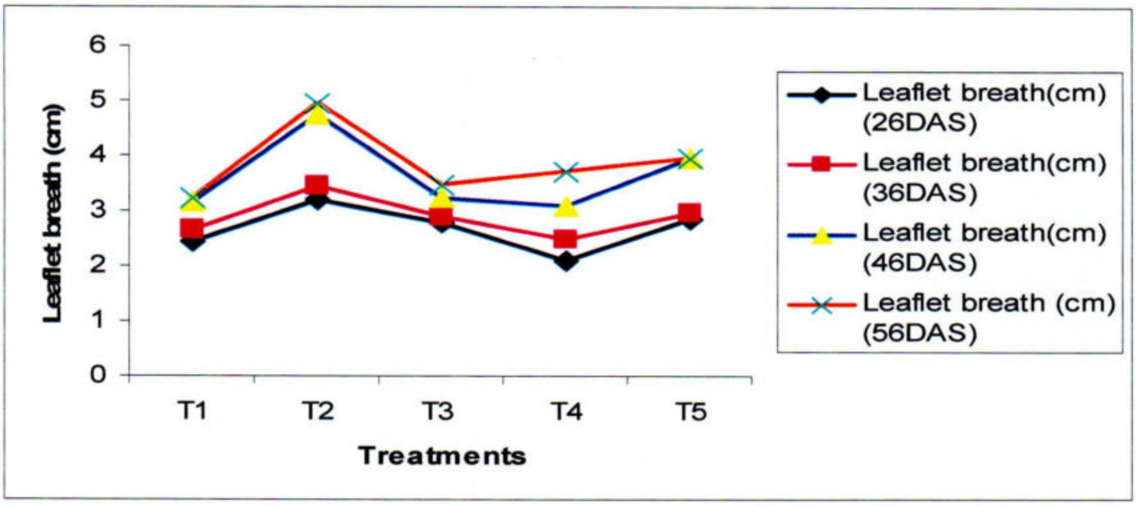

Fig.23. Allelopathic effects of *Leucaena leucocephala* on Leaflet Breath of Soybean

4.2.1.2.6 Shoot Diameter (cm)

There was significant variation was ovserved of shoot diameter of soybean in all the treatments (Fig. 24). Significantly the maximum inhibition (-1.75 at 26 DAS; -1.89 at 36 DAS; -2.29 at 46 DAS and -7.74 at 56 DAS) was observed in the treatment T_4 (soil watered with aqueous leaf extracts) and the minimum was reported (-0.90 at 26 DAS; -0.95 at 36 DAS; -2.29 at 46 DAS and -1.79 at 56 DAS) in T_3 (soil mulched with dry leaf). Significantly stimulatory effect (+5.26 at 36 DAS; +0.94 at 36 DAS; +0.76 at 46 DAS and +0.69 at 56 DAS) was found in the T_2 treatment (root zone soil) (Appendix IV).

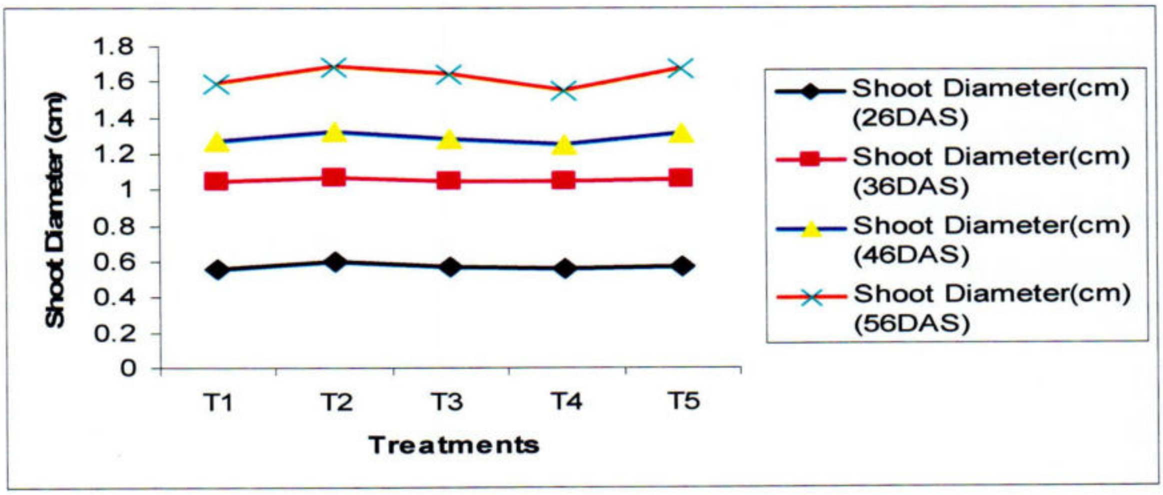

Fig.24. Allelopathic effects of *Leucaena leucocephala* on Shoot diameter of soybean

Table 4. Allelpoathic effects of *Leucaena leucocephala* on 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	43.50b (-4.19)	5.36bc (-26.37)	2.56b (-14.67)	5.00b (-25.93)	2.75bc (-39.29)	5.31bc (-29.48)
T_2	48.52a (+6.87)	8.57a (+17.72)	5.39a (+79.67)	8.76a (+29.78)	5.53a (+22.08)	10.92a (+45.02)
T_3	44.04b (-3.00)	6.78b (-6.87)	2.98b (-0.67)	5.67b (-16.00)	3.48b (-23.18)	6.46b (-14.21)
T_4	35.54c (-21.93)	4.58c (-39.09)	2.10c (-30.00)	4.78c (-29.19)	2.30c (-49.23)	4.40c (-41.57)
T_5	45.40b (0.00)	7.28a (0.00)	3.00b (0.00)	6.75b (0.00)	4.53a (0.00)	7.53b (0.00)
Level of sig.	*	*	*	*	*	*
CV%	10.52	7.58	15.85	6.63	15.79	9.68

Note: Mean followed by a common letter is not significantly different at the 5% level by DMRT

4.2.1.2.7 Root length (cm)

Among the five treatments, T_2 (soil collected from root zone soil) revealed the stimulatory effect (+6.87) on root length of soybean (Table 4). The treatment T_4 (soil with aqueous leaf extract) has largest inhibitory effect (-21.93) on root length of soybean over control whereas, the shortest inhibitory effect (-3.00) was found in the treatment T_3 (soil mulched with dry leaf). It was showed that all the treatments significantly suppressed the root length of that crop.

4.2.1.2.8 Shoot Fresh Weight (g)

Shoot fresh weight of soybean significantly suppressed under the three treatments in respects to control (Table 4). Significantly the highest inhibition (-37.09) was observed in the treatment T_4 (soil with aqueous leaf extract) which was statistically similar to that of T_1 top soil. Treatment T_2 (root zone soil) promoted (+17.72) the shoot fresh weight over control of that crop.

4.2.1.2.9 Shoot dry weight (g)

All the treatments significantly inhibit the shoot dry weight of soybean except root zone soil (Table 4). Soybean shoot dry weight inhibition (-30.00) was high in the treatment T_4 (soil with aqueous leaf extract). Significantly the lowest inhibition (-0.67) was reported in the treatment T_3 (soil mulched with dry leaf) followed by T_1 (top soil) over control.

4.2.1.2.10 Root Fresh Weight (g)

All the treatments have significant allelopathic on root fresh weight (Table 4). The highest inhibition (-29.19) of root fresh weight was observed in the treatment T_4 (soil with aqueous leaf extract). But the lowest inhibition (-16.00) was found in the treatment T_3 (soil mulched with dry leaf) which was significantly followed by top soil. Stimulatory effect (+29.78) was showed in the treatment T_2 (root zone soil).

4.2.1.2.11 Root dry weight (g)

Root dry weight significantly inhibited in all treatments except root zone soil. The highest suppression (-49.23) was recorded in the treatment T_4 (soil watered with aqueous leaf extract) followed by top soil in comparison to control and lowest (-23.18) was found in the treatment T_3 (soil mulched with dry leaf). The treatment T_2 (root zone soil) promote (+22.08) the root dry weight of soybean (Table 4).

4.2.1.2.12 Total Dry Matter (g)

All the treatments significantly inhibit total dry matter of soybean except T_2 (root zone soil) which shows promotory effects (+45.02) (Table 4). Soybean total dry matter inhibition (-41.57) was high in the treatment T_4 (soil with aqueous leaf extract) which was statically similar to that of T_1 (top soil). But the lowest inhibition (-14.21) was reported in the treatment T_3 (soil treated with dry leaf) in respects to control.

4.2.2 Discussion

The present study suggests that phytotoxic effects were observed in *Leucaena* on germination and growth of test plants. From the experiment, among the five treatments, leaf extracts of *Leucaena* cotain more allelochemicals e.g. phenolic compounds and mimosine as well as unknown flavanoids (Pires *et al*., 2001). It is aggred in accordance Sahoo *et al*. (2007). They reported that the leaf extract were more toxic than bark and seed and *Leucaena* was more inhibitory to germination. The toxic effects of *Leucaena* followed the order: crushed seeds > leaf litter > soil root zone. Root zone soil had little stimulatory effect over control because it contain small amount of mimosine and small amount of mimosine stimulate the germination and growth of test crops (Neelam and Bisaria, 2002) wherease dry leaf and top soil had inhibitory effects on germination and growth of mungbean and soybean (Suresh and Rai, 1987). They also observed that seed germination, root length and dry matter production were depressed both in *Leucaena* top soil and in aqueous extracts of the plant.

4.3 Experiment no.3: Allelopathic effects of *Melia Azedarach* on agricultural crops

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

4.3.1.1 Results

4.3.1.1.1 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. 25).

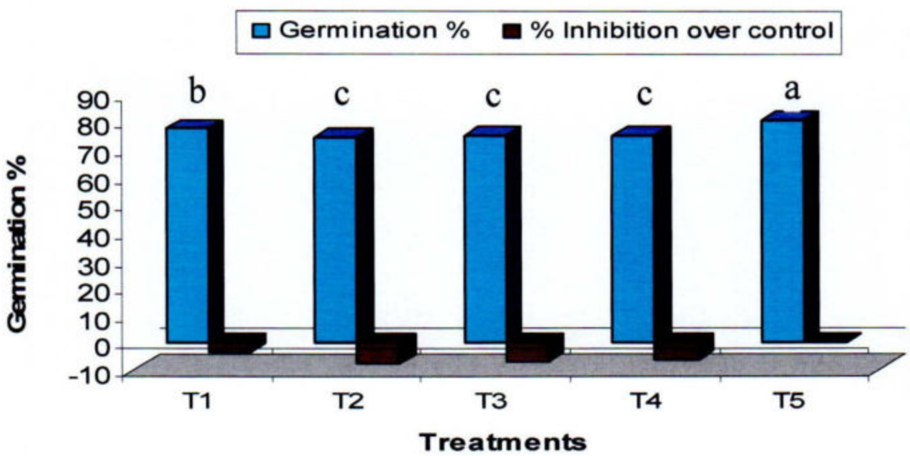

Fig.25. Allelopathic effects of *Melia azedarach* on germination of mungbean

Note: Mean followed by a common letter is not significantly different at the 5% level by DMRT

4.3.1.1.2 No. of Leaf

No. of leaf of mungbean was varied significantly at different DAS in all the treatments in respects to control (Fig. 26). 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) (Appendix V).

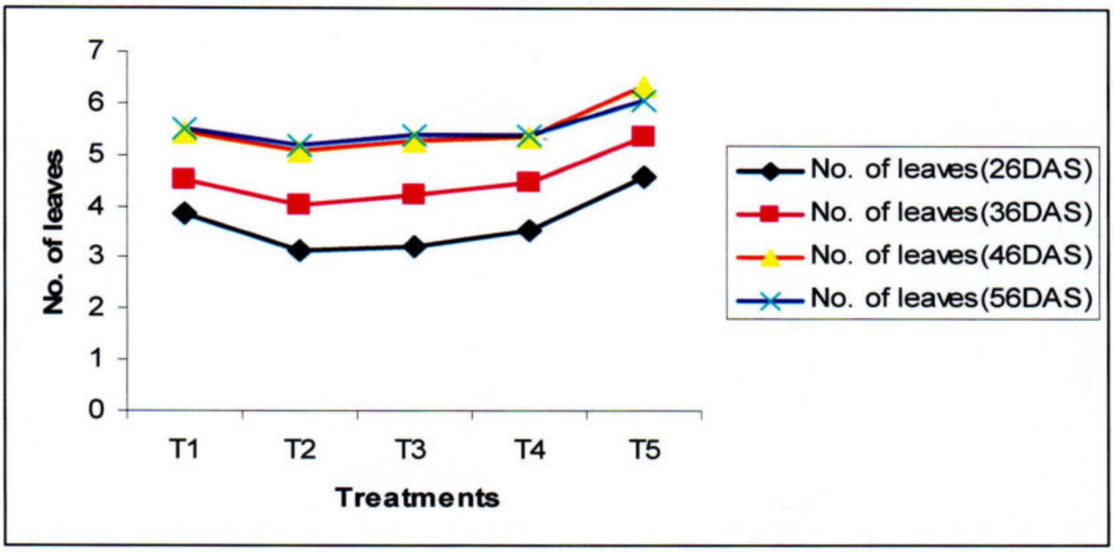

Fig.26. Allelopathic effects of *Melia azedarach* on no. of leaf of mungbean

4.3.1.1.3 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. 27). 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).

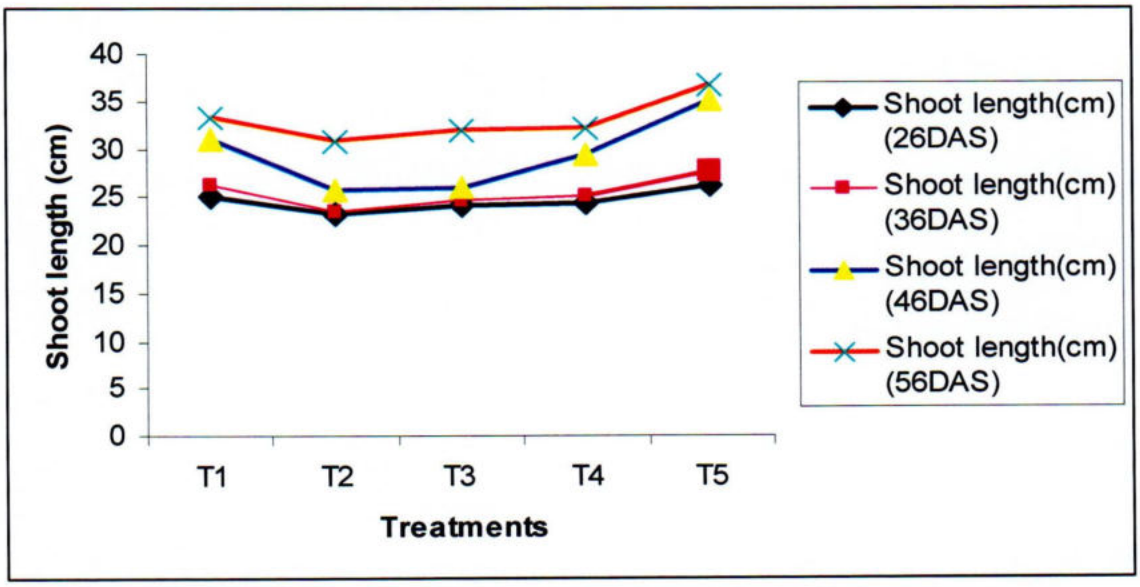

Fig.27. Allelopathic effects of *Melia azedarach* on Shoot Length of mungbean

4.3.1.1.4 Leaf Length (cm)

Leaf length of mungbean was varied significantly at different DAS in all the treatments over control (Fig. 28). 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) (Appendix V).

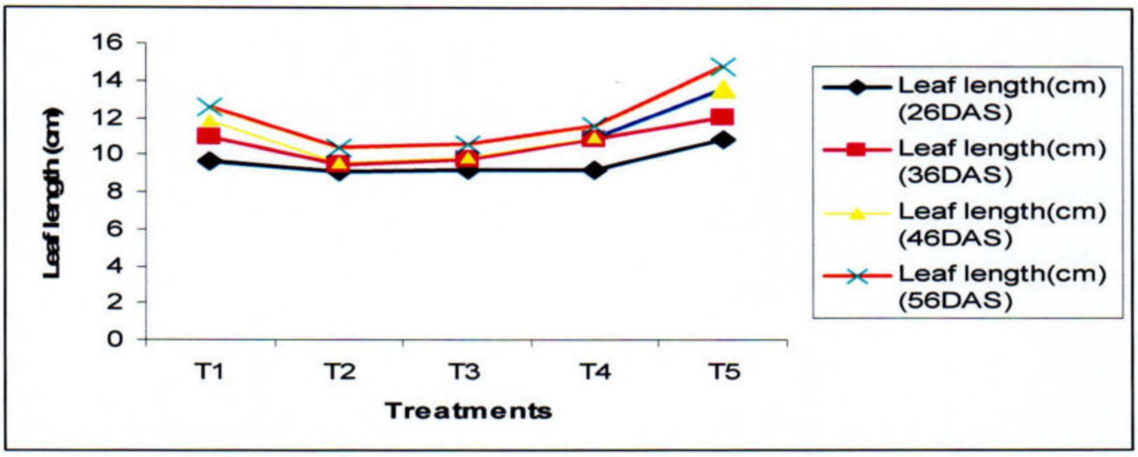

Fig.28. Allelopathic effects of *Melia azedarach* on Leaf Length of mungbean

4.3.1.1.5 Leaflet Breath (cm)

Leaflet breath of mungbean did not vary significantly at different DAS in all the treatments in comparism to control (Fig. 29). 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.

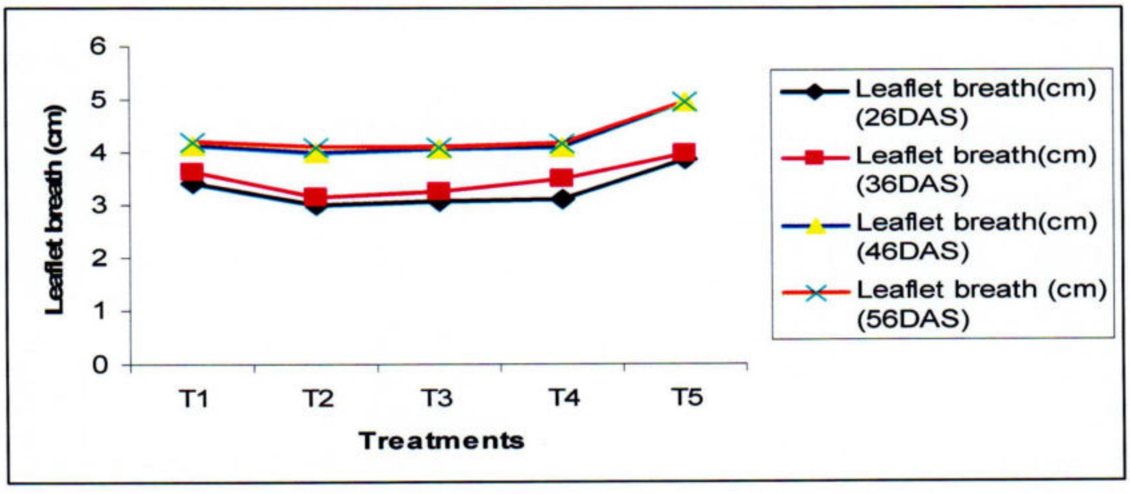

Fig.29. Allelopathic effects of *Melia azedarach* on Leaflet breath of mungbean

4.3.1.1.6 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. 30). 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).

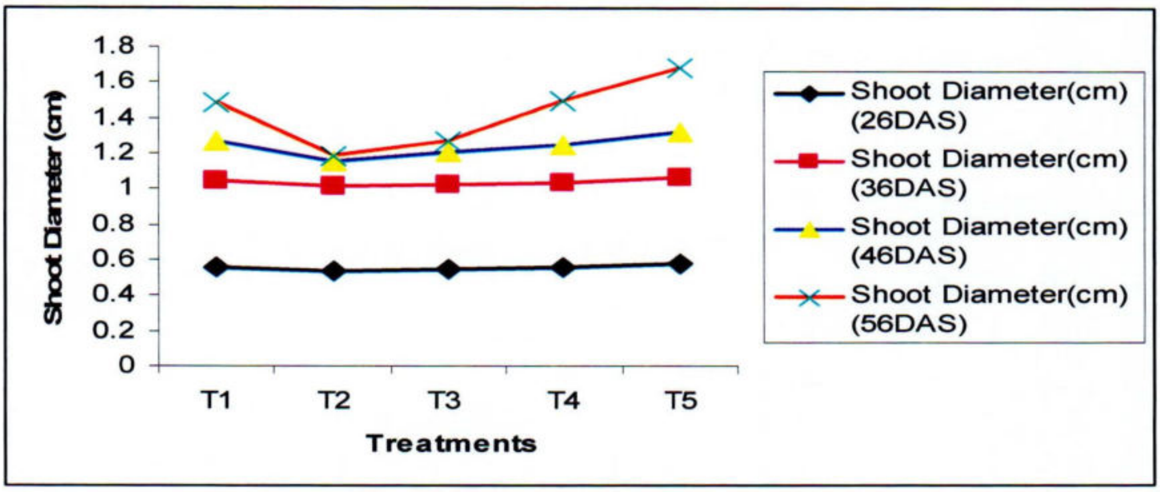

Fig.30. Allelopathic effects of *Melia azedarach* on Shoot diameter of mungbean

Table 5. Allelpoathic effects of *Melia Azedarach* on 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 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 5).

4.3.1.1.8 Shoot Fresh Weight (g)

Shoot fresh weight of mungbean significantly suppressed under all the treatments in comparison to control (Table 5). 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).

4.3.1.1.9 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 5).

4.3.1.1.10 Root Fresh Weight (g)

All the treatments significantly varied the root fresh weight of mungbean in comparison to control (Table 5). 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).

4.3.1.1.11 Root dry weight (g)

Root dry weight significantly inhibited for all treatments (Table 5). 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).

4.3.1.1.12 Total Dry Matter (g)

All the treatments significantly inhibit the shoot dry weight of mungbean (Table 5). 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.

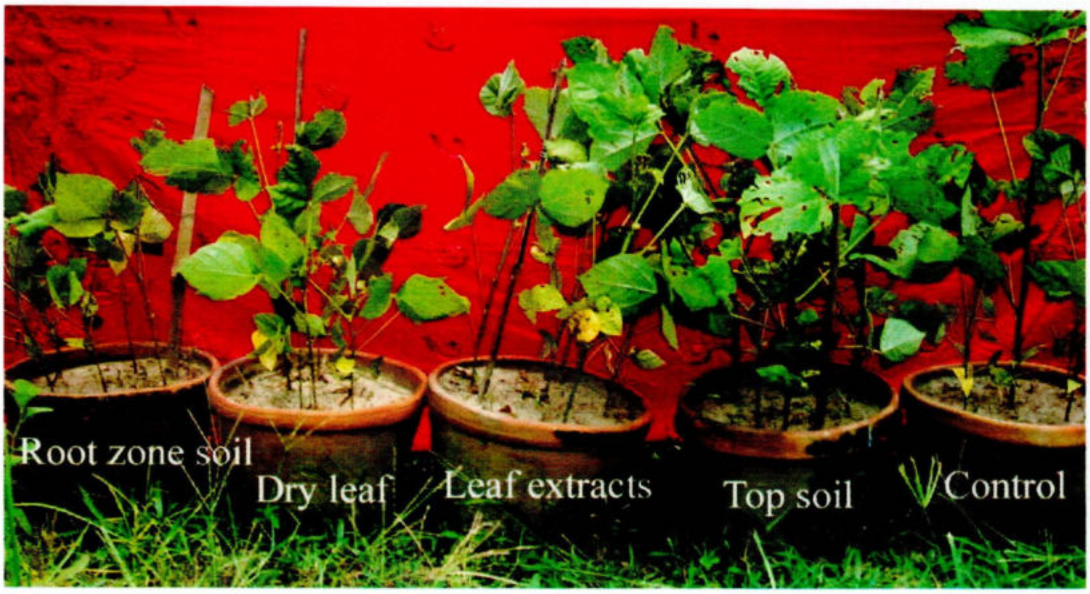

Plate 11. Vegetative growth of mungbean influnced by *Melia azedarach*

Plate 12. Vegetative growth of soybean influnced by *Melia azedarach*

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

4.3.1.2.1 Germination percentage

Germination percentage of the crop significantly varied in all treatments in comparison to control Fig. 31). 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).

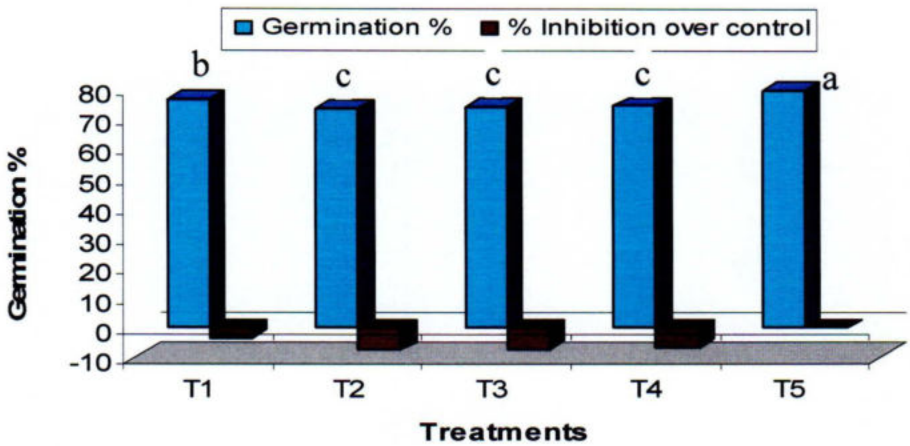

Fig.31. Allelopathic effects of *Melia azedarach* on germination of Soybean

Note: Mean followed by a common letter is not significantly different at the 5% level by DMRT

4.3.1.2.2 No. 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. 32).

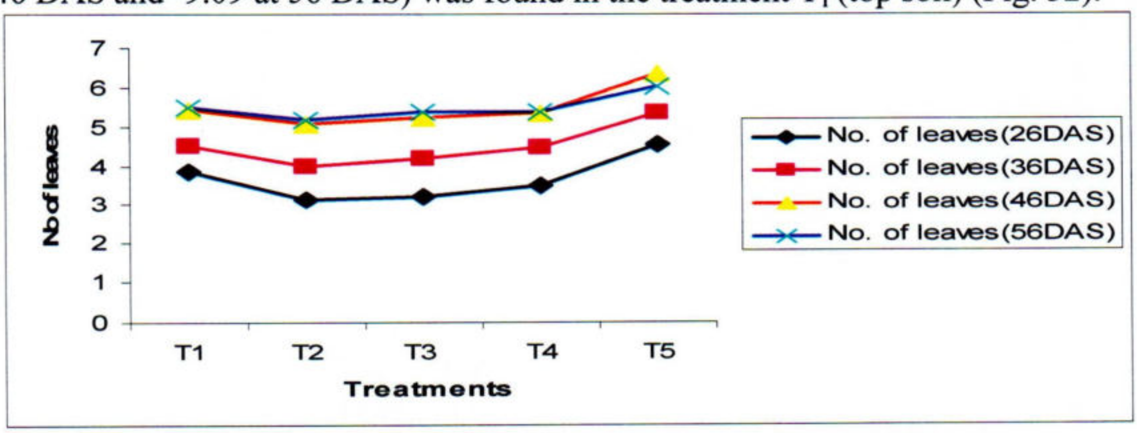

Fig. 32. Allelopathic effects of *Melia azedarach* on no. of leaf of Soybean

4.3.1.2.3 Shoot Length (cm)

There was significant variation was recorted of shoot length of soybean in all the treatments over control (Fig. 33). 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) (Appendix VI).

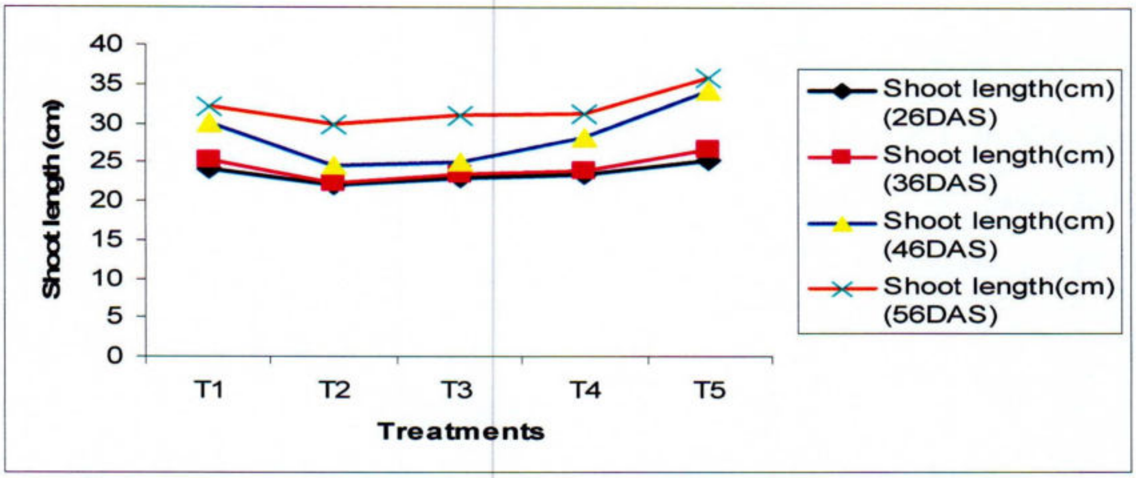

Fig.33. Allelopathic effects of *Melia azedarach* on Shoot Length of Soybean

4.3.1.2.4 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. 34).

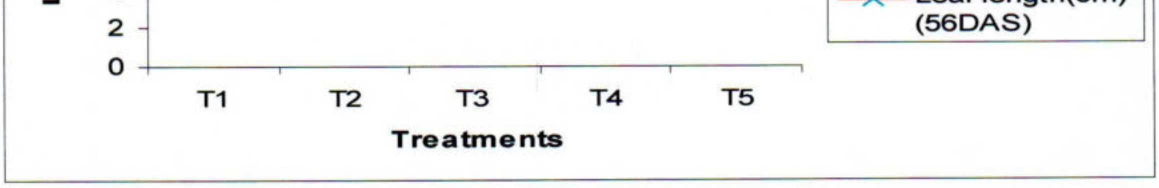

Fig.34. Allelopathic effects of *Melia azedarach* on Leaf Length of Soybean

4.3.1.2.5 Leaflet Breath (cm)

Leaflet breath of mungbean did not vary significantly at different DAS in all the treatments in comparism to control (Fig. 35). 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 (Appendix VI).

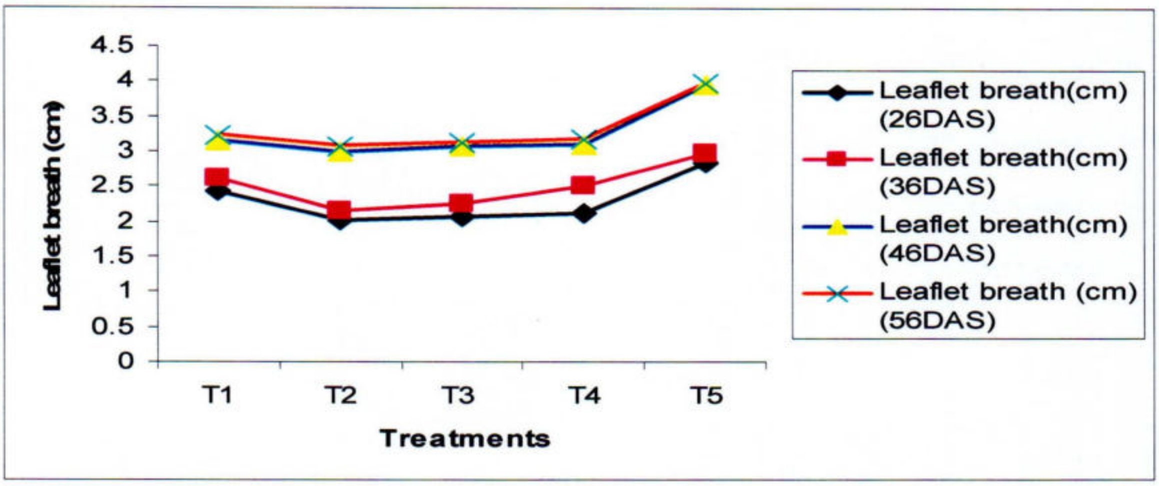

Fig.35. Allelopathic effects of *Melia azedarach* on Leaflet breath of soybean

4.3.1.2.6 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. 36). 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) (Appendix VI).

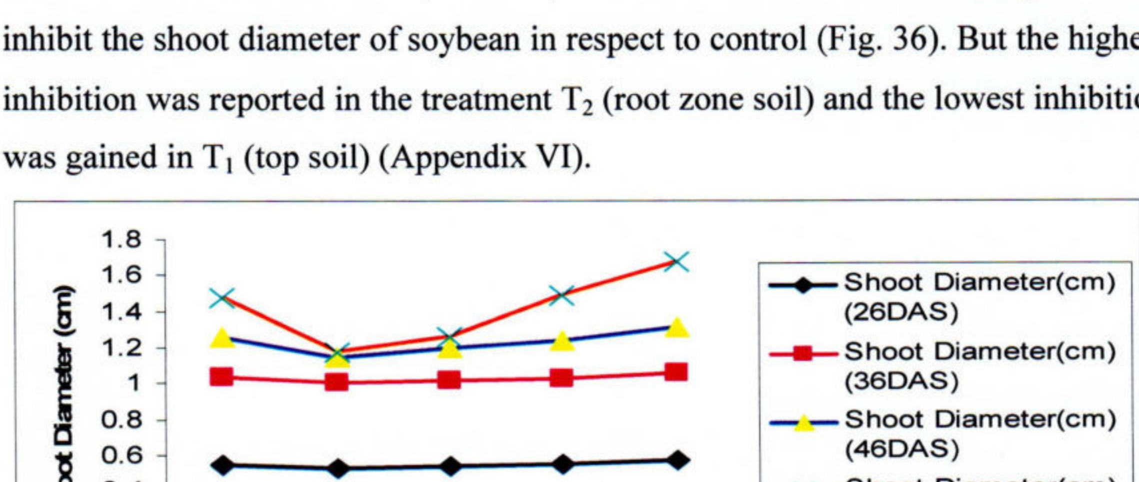

Fig.36. Allelopathic effects of *Melia azedarach* on Shoot diameter of Soybean

4.3.1.2.7 Root length (cm)

From table 6, 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 stitistically similar to that of T_3 treatment (soil mulched with dry leaf) and T_4 (soil with aqueous leaf extracts) wherease the lowest inhibitory effect (-6.72) was found in the treatment T_1 (top soil).

4.3.1.2.8 Shoot Fresh Weight (g)

Shoot fresh weight of soybean were significantly suppressed under all the treatments over control (Table 6).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 6. Allelpoathic effects of *Melia azedarach* on 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**

4.3.1.2.9 Shoot dry weight (g)

All the treatments significantly inhibit the shoot dry weight of soybean (Table 6). 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).

4.3.1.2.10 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 6).

4.3.1.2.11 Root dry weight (g)

Root dry weight was significantly inhibited in all treatments (Table 6). 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).

4.3.1.2.12 Total Dry Matter (g)

All the treatments significantly inhibit the shoot dry weight of soybean (Table 6). 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.

4.3.2 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).

4.4 Experiment no.4: Allelopathic effects of *Litchi chinensis* on Agricultural crops

4.4.1 Results

4.4.1.1 Allelopathic effects of *Litchi chinensis* on Mungbean (*Vigna radiata*)

4.4.1.1.1 Germination percentage

Germination percentage of the crop was significantly varied over control (Fig. 37). Significantly the highest inhibition (-11.14) was found by the treatment T_3 (soil mulched with dry leaf) which was stitistically similar to that of treatments T_4 (soil watered with aqueous leaf extracts), T_1 (top soil) and T_2 (root zone soil) (Appendix VII).

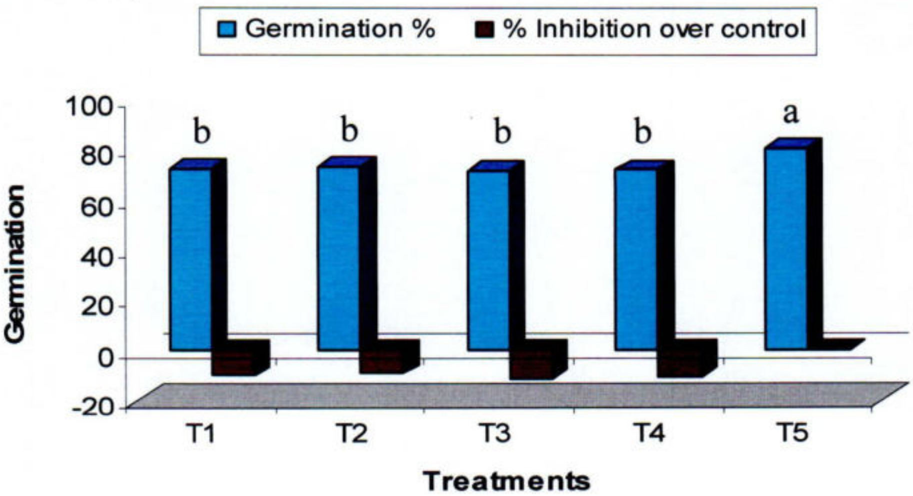

Fig.37. Allelopathic effects of *Litchi chinensis* on germination of mungbean

Note: Mean followed by a common letter is not significantly different at the 5% level by DMRT

4.4.1.1.2 No. of Leaf

No. of leaf of mungbean was varied significantly at different DAS in all the treatments in respects to control (Fig. 38). Significantly the maximum inhibition (-28.06 at 26 DAS; -34.96 at 36 DAS; -41.17 at 46 DAS and -41.28 at 56 DAS) was found in the treatment T_3 (soil mulched with dry leaf) and the lowest (-26.08 at 26 DAS; -29.92 at 36 DAS; -29.89 at 46 DAS and -12.91 at 56 DAS) was observed in the treatment T_2 (root zone soil) (Appendix VII).

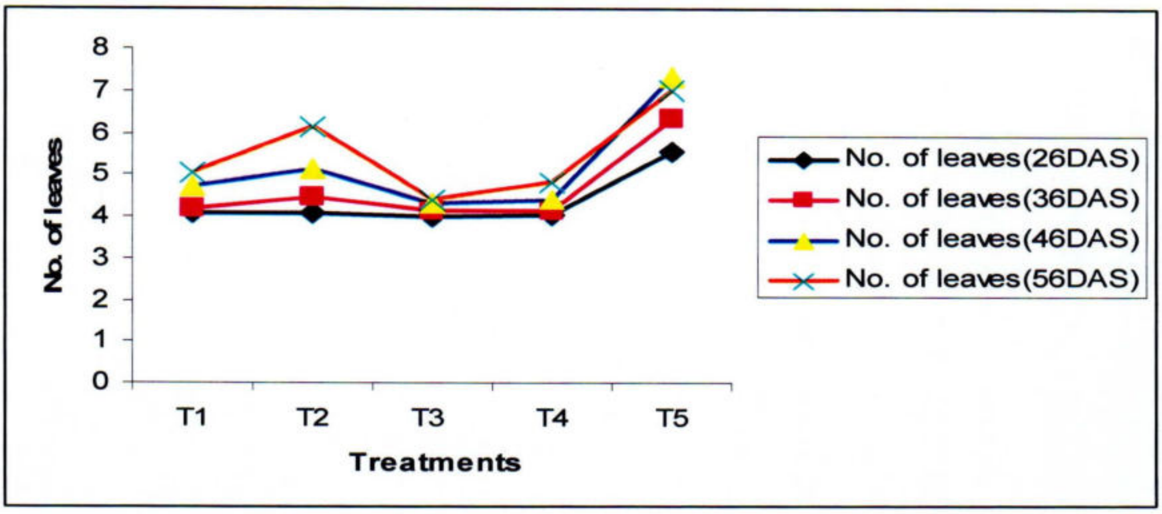

Fig.38. Allelopathic effects of *Litchi chinensis* on no. of leaf of mungbean

4.4.1.1.3 Shoot Length (cm)

Shoot length of mungbean was varied significantly at different DAS in all the treatments over control (Fig. 39). Significantly the maximum suppression (-12.55 at 26 DAS; -16.79 at 36 DAS; -34.09 at 46 DAS and -33.47 at 56 DAS) was observed in the treatment T_3 (soil mulched with dry leaf) and the minimum (-12.09 at 26 DAS; -15.60 at 36 DAS; -27.27 at 46 DAS and -25.41 at 56 DAS) was noted in the treatment T_2 (root zone soil).

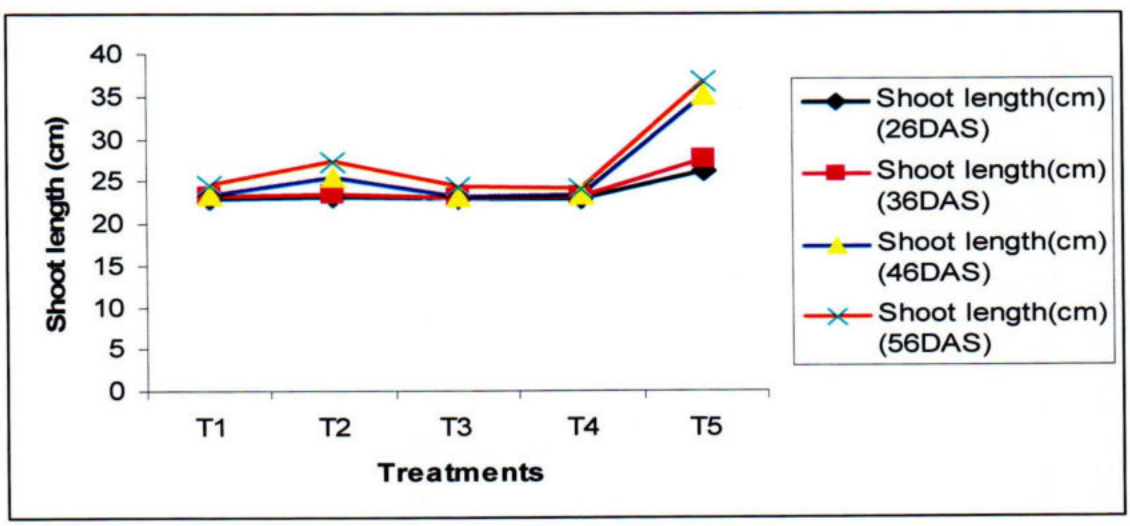

Fig.39. Allelopathic effects of *Litchi chinensis* on Shoot Length of mungbean

4.4.1.1.4 Leaf Length (cm)

Leaf length of mungbean was varied significantly at different DAS in all the treatments in respects to control (Fig. 40). Significantly the highest inhibition (-24.95 at 26 DAS; -26.84 at 36 DAS; -34.07 at 46 DAS and -35.81 at 56 DAS) was recorded in the treatment T_3 (soil mulched with dry leaf) and the lowest (-16.30 at 26 DAS; -23.45 at 36 DAS; -31.79 at 46 DAS and -30.74 at 56 DAS) was observed in the treatment T_2 (root zone soil).

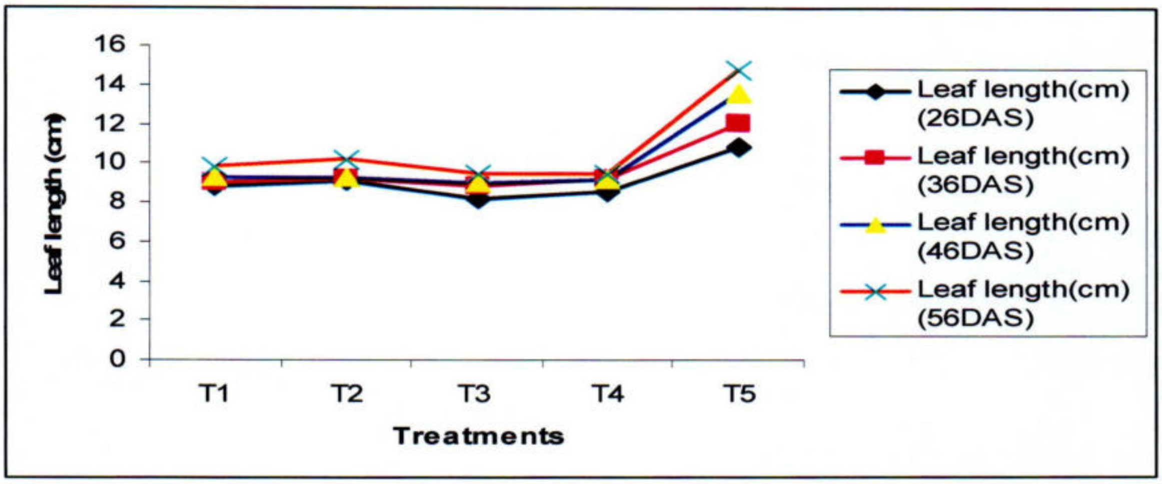

Fig.40. Allelopathic effects of *Litchi chinensis* on Leaf Length of mungbean

4.4.1.1.5 Leaflet Breath (cm)

Leaflet breath of mungbean was varied significantly at different DAS in all the treatments over control (Fig. 41). Significantly the maximum suppression (-38.44 at 26 DAS; -37.19 at 36 DAS; -39.39 at 46 DAS and -30.38 at 56 DAS) was found in the treatment T_3 (soil mulched with dry leaf) and the minimum (-23.12 at 26 DAS; -22.36 at 36 DAS; -27.68 at 46 DAS and -17.90 at 56 DAS) was observed in the treatment T_2 (root zone soil).

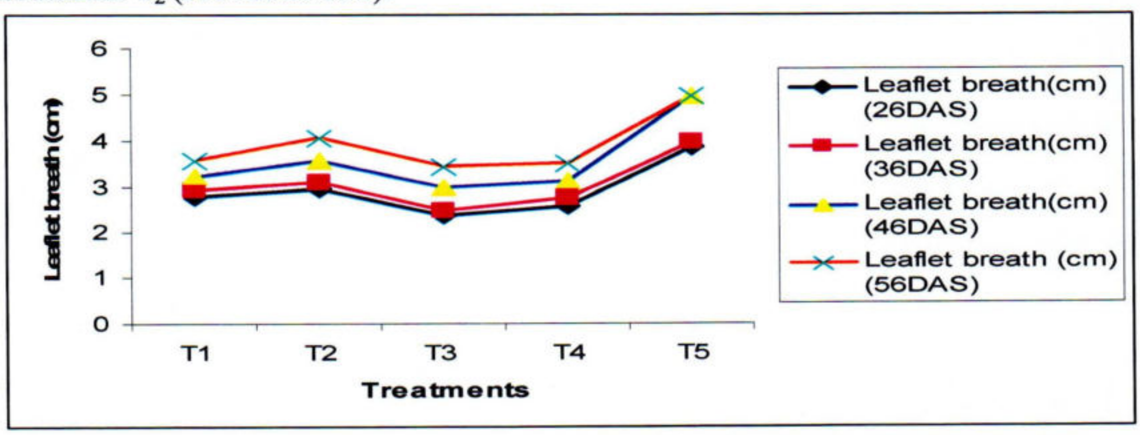

Fig.41. Allelopathic effects of *Litchi chinensis* on Leaflet breath of mungbean

4.4.1.1.6 Shoot Diameter (cm)

At different DAS shoot diameter of mungbean was varied significantly in the three treatments in respects to control (Fig. 42). The variation of shoot diameter was not significant at 26 DAS. Significantly the maximum inhibition (-46.73 at 36 DAS; -47.73 at 46 DAS and -41.42 at 56 DAS) was found in the treatment T_3 (soil mulched with dry leaf) and the lowest (-32.71 at 36 DAS; -10.67 at 46 DAS and -31.36 at 56 DAS) was observed in the treatment T_2 (root zone soil) (Appendix VII).

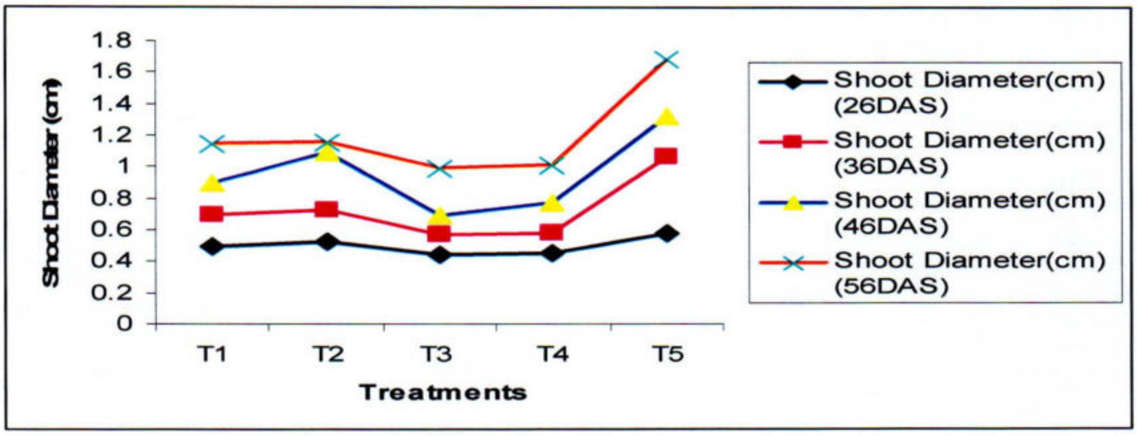

Fig.42. Allelopathic effects of *Litchi chinensis* on Shoot diameter of mungbean

4.4.1.1.7 Root length (cm)

From table 7, it was revealed that all the treatments significantly suppress the root length of that crop.The treatment T_3 (soil mulched with dry leaf) has highest inhibitory effect (-27.91) on root length of mungbean over control. The lowest inhibitory effect (-25.13) was found in the treatment T_2 (root zone soil) followed by T_1 (top soil) and T_4 (soil mulched with aqueous leaf extracts).

4.4.1.1.8 Shoot Fresh Weight (g)

Shoot fresh weight of mungbean was significantly suppressed under all the treatments in respect to control (Table 7). Significantly the highest inhibition (-52.54) was observed in the treatment T_3 (soil mulched with dry leaf). The lowest suppression (-46.5) was in T_2 (root zone soil) which was stitistically similar to that of treatment T_1 (top soil) and T_4 (soil watered with aqueous leaf extract).

4.4.1.1.9 Shoot dry weight (g)

Shoot dry weight of mungbean was significantly inhibited in all treatments (Table 7). Mungbean shoot dry weight inhibition (-32.00) was high in the treatment T_3 (soil mulched with dry leaf) followed by T_4 (soil with aqueous leaf extract), T_1 (top soil) and T_2 (root zone soil).

Table 7. Allelpoathic effects of *Litchi chinensis* on 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	34.14b (-26.42)	4.10b (-50.48)	2.63b (-34.25)	4.27b (-44.90)	2.29b (-58.59)	4.92b (-48.37)
T_2	34.74b (-25.13)	4.43b (-46.50)	2.72b (-32.00)	4.40b (-43.23)	2.32b (-58.05)	5.04c (-47.11)
T_3	33.45c (-27.91)	3.93c (-52.54)	2.18b (-45.50)	3.86c (-50.19)	2.10b (-62.03)	4.28b (-55.09)
T_4	34.27b (-26.14)	4.00b (-51.69)	2.48b (-38.00)	4.05b (-47.74)	2.21b (-60.03)	4.69b (-50.79)
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 significance	*	*	*	*	*	*
CV%	10.28	16.31	8.92	7.38	15.40	6.56

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**

4.4.1.1.10 Root Fresh Weight (g)

All the treatments significantly suppress the root fresh weight of mungbean over control (Table 7). Significantly the highest inhibition (-50.19) of root fresh weight was observed in the treatment T_3 (soil mulched with dry leaf). Significantly the lowest inhibition (-43.23) was found in the treatment T_2 (root zone soil) which was stitistically similar to that of treatments T_1 (top soil) and T_4 (soil with aqueous leaf extracts

4.4.1.1.11 Root dry weight (g)

Root dry weight was significantly inhibited in all treatments (Table 7). The highest suppression (-62.03) of root dry weight was showed in the treatment T_3 (soil mulched with dry leaf) over control which was stitistically similar to that of treatments T_4 (soil with aqueous leaf extract), T_1 (top soil) and T_2 (root zone soil).

4.4.1.1.12 Total Dry Matter (g)

All the treatments significantly inhibit the shoot dry weight of mungbean. Mungbean total dry matter inhibition (-55.09) was high in the treatment T_3 (soil mulched with dry leaf) followed by T_4 (soil with aquous leaf extract) and T_1 (top soil). The lowest inhibition (-47.11) was reported in the treatment T_2 (root zone soil) over control.

Plate 13. Vegetative growth of mungbean influnced by *Litchi chinensis*

Plate 14. Vegetative growth of soybean influnced by *Litchi chinensis*

4.4.1.2 Allelopathic effects of *Litchi chinensis* on soybean (*Glycine max*)

4.4.1.2.1 Germination percentage

Germination percentage of the crop was significantly inhibited in all the treatments in respect to control (Fig. 43). Statistically the highest inhibition (-11.28) was found in the treatment T_3 (soil mulched with dry leaf) followed by T_4 (soil with aqueous leaf extracts), T_1 (top soil) and T_2 (root zone soil) (Appendix VIII).

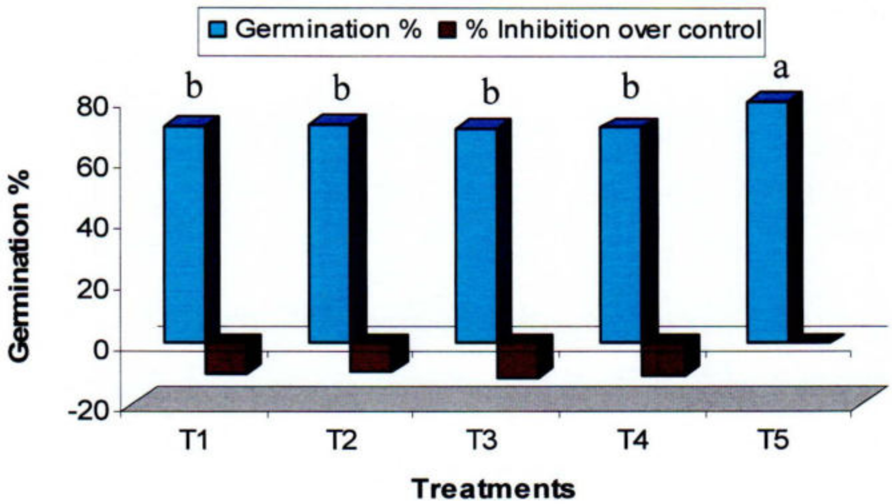

Fig.43. Allelopathic effects of *Litchi chinensis* on germination of Soybean

Note: Mean followed by a common letter is not significantly different at the 5% level by DMRT

4.4.1.2.2 No. of Leaf

No. of leaf of soybean was varied significantly at different DAS in all the treatments in respects to control (Fig. 44). Significantly the maximum inhibition (-34.21 at 26 DAS; -41.50 at 36 DAS; -47.64 at 46 DAS and -43.63 at 56 DAS) was found in the treatment T_3 (soil mulched with dry leaf) and the minimum (-31.80 at 26 DAS; -35.51 at 36 DAS; -65.47 at 46 DAS and -15.04 at 56 DAS) was observed in the treatment T_2 (root zone soil) (Appendix VIII).

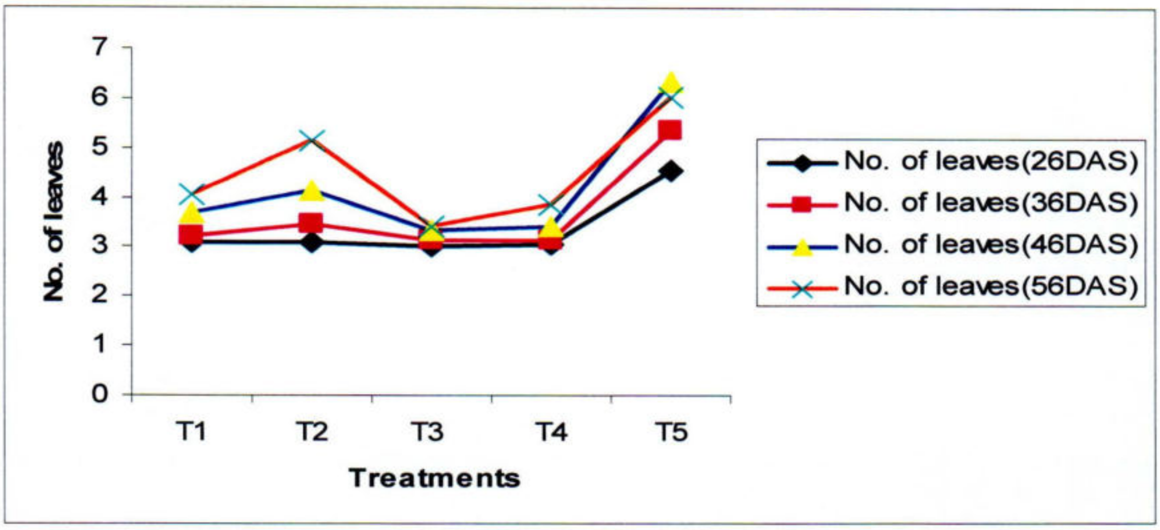

Fig.44. Allelopathic effects of *Litchi chinensis* on no. of leaf of Soybean

4.4.1.2.3 Shoot Length (cm)

All the treatments significantly influenced the shoot length of soybean at different DAS in comparism to control (Fig. 45). Significantly the highest inhibition (-13.04 at 26 DAS; -17.41 at 36 DAS; -35.08 at 46 DAS and -34.40 at 56 DAS) was found in the treatment T_3 (soil mulched with dry leaf) and the lowest (-12.57 at 26 DAS; -16.18 at 36 DAS; -28.07 at 46 DAS and -1.84 at 56 DAS) was observed in the treatment T_2 (root zone soil).

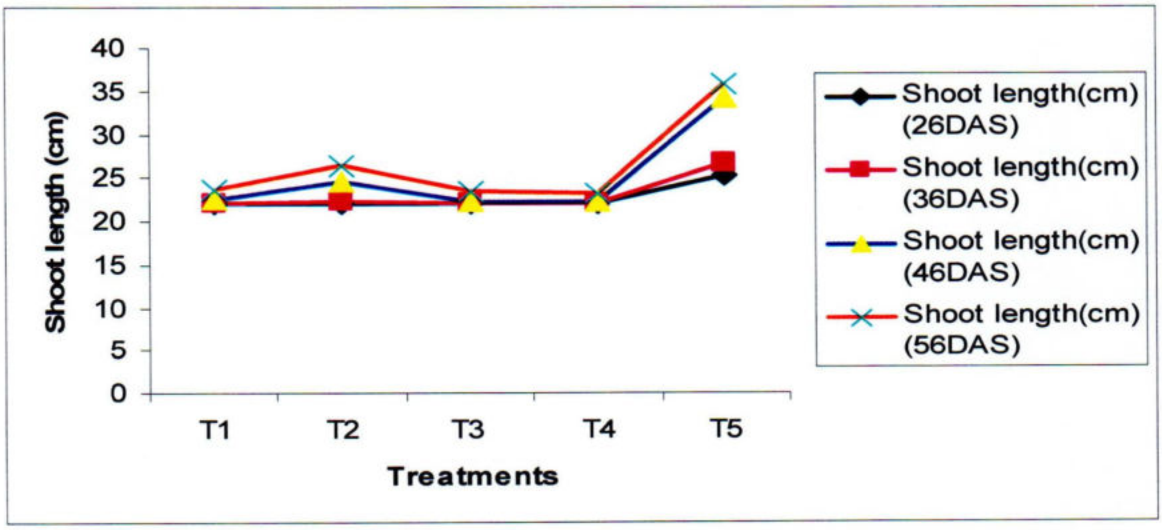

Fig.45. Allelopathic effects of *Litchi chinensis* on Shoot Length of Soybean

4.4.1.2.4 Leaf Length (cm)

Leaf length of soybean was varied significantly at different DAS in all the treatments in respects to control (Fig. 46). Significantly the maximum suppression (-27.48 at 26 DAS; -29.26 at 36 DAS; -36.75 at 46 DAS and -38.40 at 56 DAS) was noted in the treatment T_3 (soil mulched with dry leaf) and the lowest (-17.95 at 26 DAS; -25.56 at 36 DAS; -34.30 at 46 DAS and -32.97 at 56 DAS) was observed in the treatment T_2 (root zone soil).

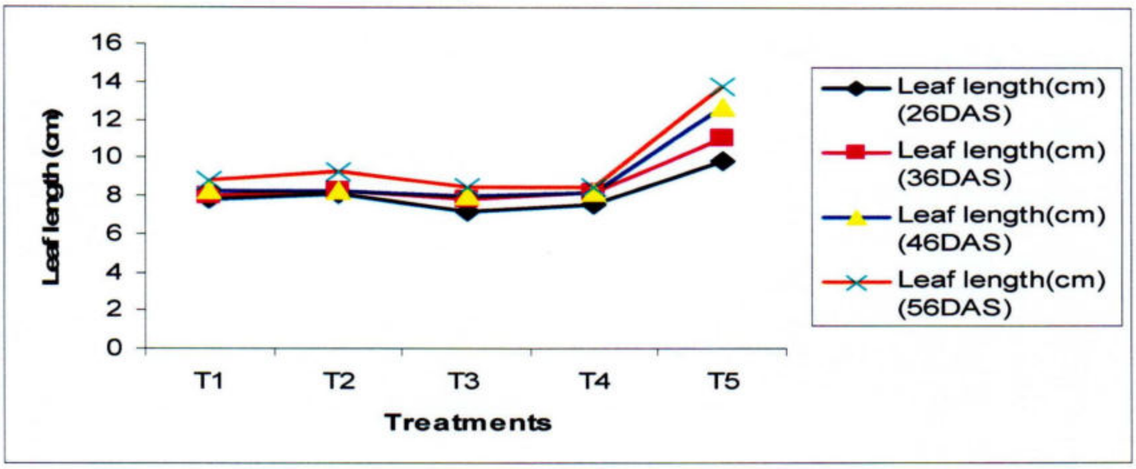

Fig.46. Allelopathic effects of *Litchi chinensis* on Leaf Length of Soybean

4.4.1.2.5 Leaflet Breath (cm)

Laeflet breath of soybean was varied significantly at different DAS in all the treatments over control (Fig. 47). Significantly the maximum inhibition (-51.76 at 26 DAS; -49.66 at 36 DAS; -49.36 at 46 DAS and -38.03 at 56 DAS) was found in the treatment T_3 (soil mulched with dry leaf) and the minimum (-31.22 at 26 DAS; -29.86 at 36 DAS; -34.68 at 46 DAS and -22.41 at 56 DAS) was recorded in the treatment T_2 (root zone soil) (Appendix VIII).

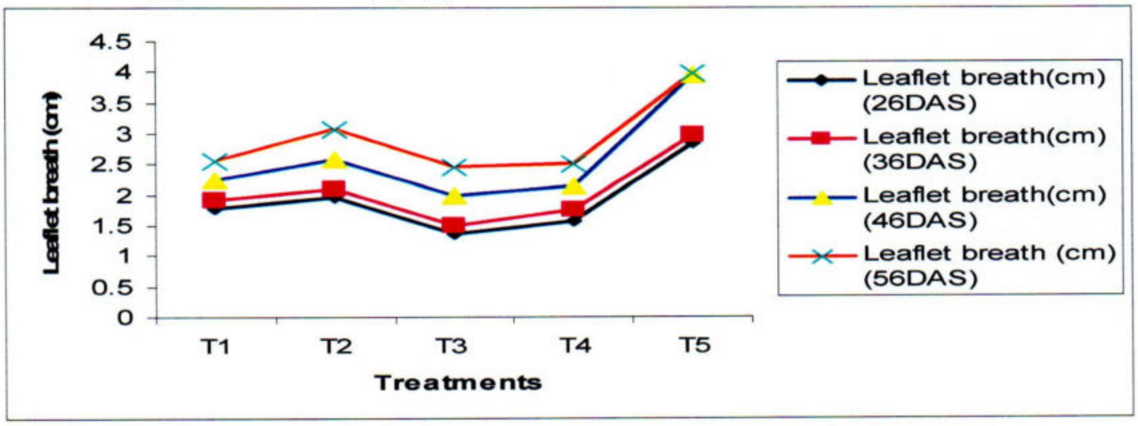

Fig.47. Allelopathic effects of *Litchi chinensis* on Leaflet breath of Soybean

4.4.1.2.6 Shoot Diameter (cm)

At different DAS under the three treatments shoot diameter of soybean was varied significantly in respects to control (Fig. 48). The variation of shoot diameter was not significant at 26 DAS. Significantly the highest inhibition (-47.16 at 36 DAS; -51.07 at 46 DAS and -41.66 at 56 DAS) was found in the treatment T_3 (soil mulched with dry leaf) and the lowest (-33.01 at 36 DAS; -16.80 at 46 DAS and -31.54 at 56 DAS) was observed in the treatment T_2 (root zone soil).

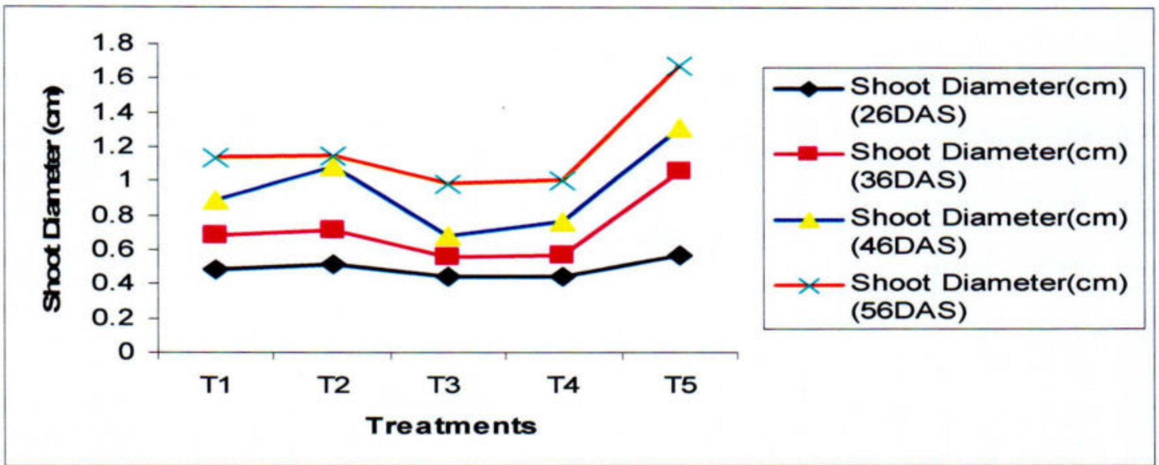

Fig.48. Allelopathic effects of *Litchi chinensis* on Shoot diameter of Soybean

4.4.1.2.7 Root length (cm)

It was revealed that all the treatments significantly suppress the root length of that crop (Table 8). Significantly the treatment T_3 (soil mulched with dry leaf) has highest inhibitory effect (-28.53) on root length of soybean over control (Table 8). The lowest inhibitory effect (-25.68) was found in the treatment T_2 (root zone soil) followed by T_1 (top soil) and T_4 (soil with aqueous leaf extracts).

4.4.1.2.8 Shoot Fresh Weight (g)

Shoot fresh weight of soybean was significantly suppressed under all the treatments over control (Table 8). The highest inhibition (-59.75) was observed in the treatments T_3 (soil mulched with dry leaf). The lowest suppression (-25.68) was in T_2 (root zone soil) followed by T_1 (top soil) and T_4 (soil with aqueous leaf extract).

Table 8. Allelpoathic effects of *Litchi chinensis* on 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	33.14b (-27.06)	3.10b (-57.42)	1.63b (-45.67)	3.27b (-51.56)	1.29b (-71.52)	2.92b (-61.22)
T_2	33.74b (-25.68)	3.43b (-52.88)	1.72b (-42.67)	3.40b (-49.63)	1.32b (-70.86)	3.04b (-59.63)
T_3	32.45c (-28.53)	2.93c (-59.75)	1.18b (-60.67)	2.86c (-58.52)	1.10b (-75.72)	2.28b (-69.72)
T_4	33.27b (-26.72)	3.00b (58.79)	1.48b (-50.67)	3.05b (-54.81)	1.21b (-73.51)	2.69b (-64.28)
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%	12.41	13.24	5.68	6.58	13.26	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**

4.4.1.2.9 Shoot dry weight (g)

All the treatments significantly inhibit the shoot dry weight of soybean (Table 8). Significantly soybean shoot dry weight inhibition (-60.67) was high in the treatment T_3 (soil mulched with dry leaf) which was statistically similar to that of the treatments T_4 (soil with aqueous leaf extract), T_1 (top soil) and T_2 (root zone soil).

4.4.1.2.10 Root Fresh Weight (g)

All the treatments significantly suppress the root fresh weight of soybean in comparison to control (Table 8). The highest inhibition (-58.52) of root fresh weight was observed in the treatment T_3 (soil mulched with dry leaf). The lowest inhibition (-49.63) was found in the treatment T_2 (root zone soil) followed by T_1 (top soil) and T_4 (soil with aqueous leaf extracts.

4.4.1.2.11 Root dry weight (g)

From table 8, it was revealed that root dry weight was significantly inhibited in all the treatments. The highest suppression (-75.72) of root dry weight was showed in the treatment T_3 (soil mulched with dry leaf) over control followed by T_4 (soil watered with aqueous leaf extract), T_1 (top soil) and T_2 (root zone soil).

4.4.1.2.12 Total Dry Matter (g)

All the treatments significantly inhibit the shoot dry weight of soybean (Table 8). Soybean total dry matter inhibition (-69.72) was high in the treatment T_3 (soil mulched with dry leaf) followed by T_4 (soil with aqueous leaf extract) and T_1 (top soil). The lowest inhibition (-59.63) was reported in the treatment T_2 (root zone soil) in respects to control.

4.4.2 Discussion

The present study indicated the suppressive effects of *Litchi chinensis* on both test crops. It can be inferred from the present study that germination and all growth characters of crops were more suppressed by dry leaf of litchi. This bioassay indicates that the dry leaves collected from the ground have the potential to release high amount of water-soluble toxic compounds (Guenther, 1950. Leaf extracts of litchi has less allelopathic effects on the test crops. It is similar in accordance to the experiment of Arshad-Javaid *et al.* (2006) who found that aqueous extracts of *Mangifera indica* suppress all the growth characters of crops. Inhibitory effects varied among plant parts such as the leaves, stem and root. All treatments in the experiment inhibit the germination and growth of mungbean and soybean over control. The morphological characters of *Eucalyptus* are similar to that of litchi tree. Both contain thick and more or less broad leaf. As the leaf of these trees release some chemical and decompose slowly, they inhibit the germination and growth of crops. The result is similar to Allolli *et al.* (2000) who found that *Eucalyptus tereticornis* leaf, bark and root extracts has allelopathic potential on germination and growth of garlic. The lowest germination, and root and shoot length of garlic (73.20%, and 6.07 and 8.44 cm, respectively) was observed in treatments with leaf extract, while the highest germination was observed in the control.

5. General Discussion

The forgoing results clearly show the suppressive effect of *Albizia lebbeck, Leucaena leucocephala, Melia azedarach* and *Litchi chinensis* on germination, leaf number, shoot length, root length, and other growth characteristics of the test crops. *Litchi chinensis* was found to have severe effect followed by *Albizia lebbeck, Melia azedarach* and *Leucaena leucaena.* The result is corelated with Samaiya *et al.* (2001) who conducted a field experiment to evaluate the growth of the agrosilvicultural model multipurpose tree species (MPTs) viz., subabul (*Leucaena leucocephala*), bakain (*Melia azedarach*) and siris (*Albizia lebbeck*) intercropped with soyabean under rainfed conditions for Sagar region. Results showed that the maximum tree height (524 cm) was recorded in subabul, while highest collar diameter (37.30 cm) and number of branches were recorded in bakain. Black siris showed slow growth in height, diameter at breast height, collar diameter and number of branches. The results also revealed that soyabean produced a maximum yield of 6.46 g per plant in control plot. Maximum yield reduction of 49% was observed with subabul association followed by bakain with 48% and 24% with siris association. Germination and growth of both mungben and soyben were suppressed by the all treatments over control except *Leucaena leucocephala* which stimulated the growth parameters of both crops. This result is aggered with Hiwale *et al.* (2007) who conducted an experiment to study allelopathic effect of leaf leachate tree species viz., Neem (*Azadirachta indica*) and Subabool (*Leucaena leucocephala*) on Soyabean (*Glycin max*), Maize (*Zea mays*), Okra (*Abelmoschus esculentus*), Sunhemp (*Crotolaria juntia*). Seed germination was suppressed by leaf leachates of neem tree species compared to control (seed treatment with distilled water). Observation on growth parameters indicated shoot and root length was significantly influenced by the leaf leachates of all the tree species. Neem was found to suppress most of the growth parameters, whereas, Subabool promoted them. Subabool were found to have beneficial effect on Soya bean, Green gram, Pigeon pea and Sesamum.

CHAPTER V

SUMMARY, CONCLUSION AND RECOMMENDATION

CHAPTER V

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary

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, Leucaena leucocephala, Melia azedarach* and *Litchi chinensis* on two agricultural crops viz: mungbean and soybean. There were four experiments and each expriment had 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 Randomized Complete Block Dessign (RCBD) with four replications.

The result 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. From experiment no.1, singnificantly the maximum suppression of mungben germination percentage (-9.45), no. of leaf (-28.80), shoot length (-28.63), leaf length (-35.95), leaflet breath (-33.74), shoot diameter (-40.23), root length (-26.14), root fresh weight (-46.84), root dry weight (-59.31), shoot fresh weight (-51.74), shoot dry weight (-37.50), total dry matter (-50.16) were obtained in the treatment T_4 (soil watered with aqueous leaf extracts) and the minimum suppression of germination percentage (-3.70), no. of leaf (-8.09), shoot length (-4.79), leaf length (-9.78), leaflet breath (-15.49), shoot diameter (-3.74), root length (-9.00), root fresh weight (-24.65), root dry weight (-32.73), shoot fresh weight(-12.34), shoot dry weight (-4.45), total dry matter (-14.27) were found in the treatment T_1 (top soil). For soybean, singnificantly the maximum suppression of germination percentage (-9.57), no. of leaf (-33.83), shoot length (-31.14), leaf length (-38.55), leaflet breath (-42.27), shoot diameter (-40.47), root length (-26.72), root fresh weight (-53.78), root dry weight (-72.40), shoot fresh weight (-58.79), shoot dry weight (-50.00), total dry matter (-63.48) were obtained in the treatment T_4 (soil watered with aqueous leaf extracts) and the minimum suppression of germination (-3.75), no. of leaf (-9.42), shoot length (-4.98), leaf length (-12.68), leaflet breath (-20.50), shoot diameter (-3.77), root length (-7.00), root fresh weight (-28.30), root dry weight (-39.96), shoot fresh weight(-15.00), shoot dry weight (-18.33), total dry matter (-31.34) were found in the treatment T_1 (top soil).

From experiment no.2, significantly the highest suppression of mungben germination percentage (-5.47), no. of leaf (-17.81), shoot length (-16.08), leaf length (-18.02), leaflet breath (-18.96), shoot diameter (-7.69), root length (-21.25), root fresh weight (-25.42), root dry weight (-40.33), shoot fresh weight (-32.61), shoot dry weight (-22.50), total dry matter (-32.84) were obtained in the treatment T_4 (soil watered with aqueous leaf extracts). Little stimulatory effects were gained in the treatment T_2 (root zone soil). For soybean, the lowest suppression of germination percentage (-5.53), no. of leaf (-21.71), shoot length (-16.55), leaf length (-18.02), leaflet breath (-25.61), shoot diameter (-7.74), root length (-6.87), root fresh weight (-29.19), root dry weight (-49.23), shoot fresh weight (-37.09), shoot dry weight (-30.00), total dry matter (-41.57) were obtained in the treatment T_4 (soil watered with aqueous leaf extracts).There were promotory effects were recorded in the treatment T_2 (root zone soil).

From experiment no.3, singnificantly the maximum suppression of mungben germination percentage (-7.44), no. of leaf (-31.07), shoot length (-27.13), leaf length (-29.93), leaflet breath, shoot diameter, root length (-24.31), root fresh weight (-40.39), root dry weight (-56.78), shoot fresh weight (-39.86), shoot dry weight (-44.00), total dry matter (-51.42) were obtained in the treatment T_2 (root zone soil) and the minimum suppression of germination percentage (-3.57), no. of leaf (-9.08), shoot length (-4.60), leaf length (-9.60), leaflet breath, shoot diameter, root length (-6.57), root fresh weight (-22.71), root dry weight (-32.56), shoot fresh weight(-24.52), shoot dry weight (-12.50), total dry matter (-24.13) were found in the treatment T_1 (top soil). For soybean, the maximum suppression of germination percentage (-7.55), no. of leaf (-31.14), shoot length (-27.92), leaf length (-32.25), leaflet breath, shoot diameter, root length (-24.85), root fresh weight (-46.37), root dry weight (-69.32), shoot fresh weight (-45.33), shoot dry weight (-58.67), total dry matter (-65.07) were obtained in the treatment T_2 (root zone soil) and the minimum suppression of germination percentage (-3.61), no. of leaf (-9.06), shoot length (-4.78), leaf length (-10.48), leaflet breath, shoot diameter, root length (-6.72), root fresh weight (-26.07), root dry weight (-39.74), shoot fresh weight(-27.88), shoot dry weight (-16.67), total dry matter (-30.54) were found in the treatment T_1 (top soil).

From experiment no.4, the highest suppression of mungben germination percentage (-11.14), no. of leaf (-41.28), shoot length (-34.09), leaf length (-35.80), leaflet breath (-39.39), shoot diameter (-47.73), root length (-27.91), root fresh weight (-50.19), root dry weight (-62.03), shoot fresh weight (-52.54), shoot dry weight (-32.00), total dry matter (-55.09) were obtained in the treatment T_3 (soil mulched with dry leaf) and the lowest suppression of germination percentage, no. of leaf (-12.91), shoot length (-12.09), leaf length (-16.30), leaflet breath (-17.9), shoot diameter (-10.67), root length (-25.13), root fresh weight (-43.23), root dry weight, shoot fresh weight(-46.50), shoot dry weight, total dry matter (-47.11) were found in the treatment T_2 (root zone soil). For soybean, the maximum suppression of germination percentage (-11.28), no. of leaf (-47.64), shoot length (-35.08), leaf length (-38.40), leaflet breath (-51.76), shoot diameter (-51.07), root length (-28.53), root fresh weight (-58.52), root dry weight (-75.72), shoot fresh weight (-59.75), shoot dry weight (-60.67), total dry matter (-69.72) were obtained in the treatment T_3 (soil mulched with dry leaf) and the minimum suppression of germination, no. of leaf (-15.04), shoot length (-1.84), leaf length (-17.95), leaflet breath (-22.41), shoot diameter (-16.80), root length (-25.68), root fresh weight (-49.63), root dry weight, shoot fresh weight(-25.68), shoot dry weight, total dry matter (-59.63) were found in the treatment T_2 (root zone soil).

5.2 Conclusion and Recommendation

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. For *Albizia lebbeck* the allelopathic effects of the treatments were as the following the 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).Again the order for *Leucaena leucocephala*: T_4 (soil watered with aqueous leaf extract) > T_1 (top soil) > T_3 (soil mulched with dry leaf) >T_5 (control/fresh garden soil)>T_2 (root zone soil). Incase of *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). For *Litchi chinensis* the order was: T_3 (soil mulched with dry leaf)>T_4 (soil watered with aqueous leaf extracts)>T_1 (top soil)>T_2 (root zone soil)>T_5 (control/fresh garden soil). Among the four tree species *Leucaena leucocephala* has little stimulatory effects on mungbean and soybean. In mixed plantation, *Leucaena leucochephala* is a better choice while compared to other three tree species like *Albizia lebbeck*, *Melia azedarach* and *Litchi chinensis*. Although, *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. Among the four tree species the maximum inhibition was observed in the tree of *Litchi chinenis*. So, the allelopathic effects of the trees were as the following order: *Litchi chinensis >Albizia lebbeck >Melia azedarach > Leucaena leucocephala*. Biological weed control is an area where the allelopathic potential of a species can be succesfully exploited for beneficial purposes. It is possible to manage allelopathy of *Litchi chinensis*, *Albizia lebbeck*, *Melia azedarach* and *Leucaena leucocephala* a s one mechanism of weed control in agriculture and agroforestry. So, management of allelopathy is applicable in efforts focused in reducing herbicide and pesticide uses to enable sustainable agricultural practices that have less deleterious effects on the environment. Finally, a depth field study may recommend on all the trees and crops of agroforestry systems to find the best compatible associations of species.

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APPENDICES

Appendix II. Analysis of Variance of germination and growth of Soybean as influenced by *Albizia lebbeck* (Continued)

Source of Variation	Degrees of Freedom	%Germination	Mean Square Values							
			No. of leaves at				Shoot length (cm) at			
			26DAS	36DAS	46DAS	56DAS	26DAS	36DAS	46DAS	56DAS
Replication	3	1.860	3.170	6.627	6.487	3.176	4.200	14.480	20.110	0.501
Treatments	4	71.709*	2.624*	2.710*	2.157 *	2.754*	15.458*	16.586*	53.136*	33.514*
Error	12	0.221	1.192	1.051	1.130	2.137	2.942	9.740	2.072	0.613

--------------- (Continued)

Source of Variation	Degrees of Freedom	Mean Square Values								
		Leaf length (cm) at				Leaflet breath (cm) at				
		26DAS	36DAS	46DAS	56DAS	26DAS	36DAS	46DAS	56DAS	Total Dry Matter(g)
Replication	3	0.571	1.153	1.000	0.003	0.011	0.141	0.013	0.106	5.120
treatments	4	4.213*	1.751 *	7.325*	13.973*	0.610^{NS}	1.500^{NS}	2.025*	1.600*	21.865*
Error	12	0.426	0.405	0.143	0.112	0.053	0.014	0.011	0.019	2.051

--------------- (Continued)

Source of Variation	Degrees of Freedom	Mean Square Values								
		Shoot diameter (cm) at				Root length (cm)	Shoot Fresh Weight (g)	Shoot Dry Weight (g)	Root Fresh Weight (g)	Root Dry Weight (g)
		26DAS	36DAS	46DAS	56DAS					
Replication	3	0.001	0.012	0.011	0.011	4.526	5.932	0.103	4.521	5.763
Treatments	4	0.001^{NS}	0.011*	0.013*	0.203*	92.230*	8.522*	5.503*	9.563*	6.745*
Error	12	0.001	0.001	0.103	0.101	2.503	1.156	0.212	2.224	0.637

Appendix V. Analysis of Variance of germination and growth of Mungbean as influenced by *Melia azedarach* (Continued)

Source of Variation	Degrees of Freedom	%Germination	Mean Square Values							
			No. of leaves at				Shoot length (cm) at			
			26DAS	36DAS	46DAS	56DAS	26DAS	36DAS	46DAS	56DAS
Replication	3	1.271	3.510	6.659	5.697	7.166	4.250	16.850	21.150	2.552
Treatments	4	68.859*	2.261*	1.512*	1.196 *	2.594*	15.758*	15.897*	61.336*	25.635*
Error	12	0.331	1.253	1.210	2.363	2.497	2.987	8.952	2.183	0.705

--------------- (Continued)

Source of Variation	Degrees of Freedom	Mean Square Values								
		Leaf length (cm) at				Leaflet breath (cm) at				Total Dry Matter(g)
		26DAS	36DAS	46DAS	56DAS	26DAS	36DAS	46DAS	56DAS	
Replication	3	1.692	0.653	1.125	0.584	0.414	1.035	0.151	0.259	5.235
treatments	4	3.331*	1.964*	7.469*	13.683*	0.821^{NS}	0.500^{NS}	2.049^{NS}	1.718^{NS}	25.799*
Error	12	0.524	1.219	0.169	0.155	1.072	0.019	0.017	0.110	2.172

--------------- (Continued)

Source of Variation	Degrees of Freedom	Mean Square Values								
		Shoot diameter (cm) at				Root length (cm)	Shoot Fresh Weight (g)	Shoot Dry Weight (g)	Root Fresh Weight (g)	Root Dry Weight (g)
		26DAS	36DAS	46DAS	56DAS					
Replication	3	0.004	0.113	0.115	0.111	4.946	6.913	0.220	3.930	5.467
Treatments	4	0.012 ^{NS}	0.111^{NS}	0.062 ^{NS}	0.016 ^{NS}	82.431*	11.857*	5.733*	10.563*	5.947*
Error	12	0.015	0.005	0.423	0.123	2.469	1.187	0.152	2.267	0.667

Appendix VI. Analysis of Variance of germination and growth of Soybean as influenced by *Melia azedarach* (Continued)

Source of Variation	Degrees of Freedom	%Germination	Mean Square Values							
			No. of leaves at				Shoot length (cm) at			
			26DAS	36DAS	46DAS	56DAS	26DAS	36DAS	46DAS	56DAS
Replication	3	1.860	3.070	6.538	6.677	3.297	4.215	13.770	20.010	0.540
Treatments	4	71.819*	2.025*	2.711*	2.186 *	2.756*	15.367*	16.577*	53.036*	33.500*
Error	12	0.220	1.202	1.041	1.131	2.139	2.941	9.641	2.072	0.600

--------------- **(Continued)**

Source of Variation	Degrees of Freedom	Mean Square Values								
		Leaf length (cm) at				Leaflet breath (cm) at				Total Dry Matter(g)
		26DAS	36DAS	46DAS	56DAS	26DAS	36DAS	46DAS	56DAS	
Replication	3	0.572	1.054	1.000	0.013	0.001	0.133	0.003	0.216	5.120
treatments	4	4.213 *	1.742 *	7.325*	13.973*	0.620 NS	1.500 NS	2.016 NS	1.501 NS	21.769*
Error	12	0.416	0.519	0.240	0.111	0.053	0.015	0.001	0.018	2.052

--------------- **(Continued)**

Source of Variation	Degrees of Freedom	Mean Square Values								
		Shoot diameter (cm) at				Root length (cm)	Shoot Fresh Weight (g)	Shoot Dry Weight (g)	Root Fresh Weight (g)	Root Dry Weight (g)
		26DAS	36DAS	46DAS	56DAS					
Replication	3	0.012	0.002	0.012	0.022	4.535	5.930	0.102	4.613	5.527
Treatments	4	0.001 NS	0.011 NS	0.023 NS	0.203 NS	92.230*	8.502*	5.402*	9.554*	6.345*
Error	12	0.011	0.001	0.103	0.101	2.503	1.105	0.220	2.133	0.639

Appendix VII. Analysis of Variance of germination and growth of Mungbean as influenced by *Litchi chinensis* (Continued)

Source of Variation	Degrees of Freedom	%Germination	Mean Square Values							
			No. of leaves at				Shoot length (cm) at			
			26DAS	36DAS	46DAS	56DAS	26DAS	36DAS	46DAS	56DAS
Replication	3	1.071	3.400	6.667	5.667	6.166	4.200	15.850	20.250	1.552
Treatments	4	67.859*	2.067*	1.312*	1.192 *	2.574*	15.768*	15.897*	61.346*	25.635*
Error	12	0.321	1.203	1.010	2.333	2.197	2.997	8.850	2.083	0.705

--------------- (Continued)

Source of Variation	Degrees of Freedom	Mean Square Values								
		Leaf length (cm) at				Leaflet breath (cm) at				
		26DAS	36DAS	46DAS	56DAS	26DAS	36DAS	46DAS	56DAS	Total Dry Matter(g)
Replication	3	1.591	0.753	0.125	0.524	0.014	1.045	0.051	0.219	5.230
treatments	4	3.231*	1.862 *	7.449*	13.483*	0.720*	0.500*	2.046*	1.712*	24.759*
Error	12	0.426	1.517	0.169	0.150	1.070	0.029	0.016	0.109	2.073

--------------- (Continued)

Source of Variation	Degrees of Freedom	Mean Square Values								
		Shoot diameter (cm) at				Root length (cm)	Shoot Fresh Weight (g)	Shoot Dry Weight (g)	Root Fresh Weight (g)	Root Dry Weight (g)
		26DAS	36DAS	46DAS	56DAS					
Replication	3	0.003	0.013	0.015	0.011	3.946	6.903	0.210	3.933	5.567
Treatments	4	0.011^{NS}	0.101*	0.063*	0.013*	81.431*	10.957*	5.713*	9.593*	4.947*
Error	12	0.010	0.001	0.403	0.103	2.429	1.167	0.142	2.257	0.607

Appendix VIII. Analysis of Variance of germination and growth of Soybean as influenced by *Litchi chinensis* (Continued)

Source of Variation	Degrees of Freedom	%Germination	Mean Square Values							
			No. of leaves at				Shoot length (cm) at			
			26DAS	36DAS	46DAS	56DAS	26DAS	36DAS	46DAS	56DAS
Replication	3	1.870	3.270	6.637	6.687	3.196	4.205	14.780	20.210	0.541
Treatments	4	71.809*	2.625*	2.720*	2.197 *	2.754*	15.468*	16.587*	53.336*	33.504*
Error	12	0.221	1.292	1.050	1.230	2.137	2.952	9.740	2.072	0.610

--------------- (Continued)

Source of Variation	Degrees of Freedom	Mean Square Values								
		Leaf length (cm) at				Leaflet breath (cm) at				
		26DAS	36DAS	46DAS	56DAS	26DAS	36DAS	46DAS	56DAS	Total Dry Matter(g)
Replication	3	0.582	1.154	1.100	0.013	0.011	0.143	0.013	0.116	5.130
treatments	4	4.223*	1.752 *	7.424*	13.983*	0.620^{NS}	1.510*	2.026*	1.600*	21.869*
Error	12	0.426	0.509	0.242	0.112	0.063	0.015	0.011	0.019	2.053

--------------- (Continued)

Source of Variation	Degrees of Freedom	Mean Square Values								
		Shoot diameter (cm) at				Root length (cm)	Shoot Fresh Weight (g)	Shoot Dry Weight (g)	Root Fresh Weight (g)	Root Dry Weight (g)
		26DAS	36DAS	46DAS	56DAS					
Replication	3	0.002	0.012	0.013	0.021	4.536	5.933	0.103	4.623	5.667
Treatments	4	0.001^{NS}	0.001*	0.013*	0.204*	92.231*	8.532*	5.513*	9.595*	6.547*
Error	12	0.001	0.001	0.103	0.102	2.504	1.157	0.222	2.234	0.647