

Allelopathic Effects of Leaf Leachate of *Mangifera indica* L. on Initial Growth Parameters of Few Homegarden Food Crops

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Abstract: Aqueous leaf extract of different concentrations of *Mangifera indica* L. was used to investigate their effects on germination, shoot and root length and dry matter yield of 5 food crops viz. *Capsicum annum* L. (Chilli), *Glycine max* (L.) Merr. (Soybean), *Zea mays* L. (Maize), *Oryza sativa* L. (Rice) and *Abelmoschus esculentus* (L.) Moench (Lady's finger). Mature fresh leaves of this tree were crushed and soaked for 24h; the filtrates were diluted to make different concentration and used to investigate their effect on the test crops. The experiment was carried out in sterilized Petri plates with sterilized absorbent cotton kept under natural light dark cycle and was replicated 3 times. The aqueous leaf leachate of *M. indica* was found to have both stimulatory and inhibitory effect on germination, shoot, root elongation and dry matter of receptor plants. Both bioassays and pot culture indicated that the inhibitory effect was much more pronounced at higher concentrations, while the lower concentration showed stimulatory effect in some cases. The most affected crop was lady's finger among the test crops. The inhibitory effect was much pronounced ($P < 0.001$) in shoot and root length as compared to the germination of the receptor crops.

Key words: Concentration • Germination • Inhibition • Leachate • *Mangifera indica* • Root length • Shoots length • Stimulation • Dry matter

INTRODUCTION

Mangifera indica L. belonging to the family Anacardiaceae is one of the best known and most popular evergreen trees, native to Indian subcontinent and found widely distributed in tropical and subtropical regions. The tree is large and tall (upto 40m) with a rounded canopy or foliage with leathery leaves and big fleshy edible drupes as fruits [1]. It is one of the most important multipurpose trees growing with wide range of cultivated species and forms a component of agroforestry practices like home garden and silvipastoral system, however, in recent years decline in crop yield under this tree is reportedly attributed mostly to its allelopathic effects. Analyses of the aqueous extracts of mango leaves by HPLC have indicated the presence of caffeic acid, coumaric acid, vanelic acid, benzoic acid and other phenolic acid [2], besides other parts of *M. indica* has demonstrated the presence of phenolic constituents, triterpenes, flavonoids,

phytosterols and polyphenols [3, 4, 5, 6, 7]. Mango leaves are reported to contain 43-46.7 % euxanthin acid ($C_{19}H_{16}O_{10}$) and also some euxanthone ($C_{13}H_8O_4$), hippuric acid and benzoic acids and 4% mangin [8, 9]. The dried mango leaf powder was reported to significantly inhibit sprouting of purple nutsedge tubers [10] and its aqueous extract inhibiting germination and growth of some crops [11].

Several studies have indicated that the allelochemicals (eg. Phenolics, terpenoids, alkaloids and their derivatives) are toxics which may inhibit shoot/ root growth, nutrient uptake, or may attack a naturally occurring symbiotic relationship thereby destroying the usable source of plants of a nutrient. The consequent effects may be inhibited or retarded germination rate, reduced roots or radical and shoot or coleoptiles extension, lack of root hairs, swelling or necrosis of root tips, curling of root axis, increased number of seminal roots, discolouration, reduced dry weight accumulation

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and lower reproductive capacity [12]. The reduction in germination [13] and growth are attributable to restrain cell division, reduction in mineral uptake, hinder or augments respiration, hamper the production of protein and leghemoglobin in certain crops [14] and thereby effecting the vegetation composition [15,16]. They are released from higher plants through [17] volatilization, [17,18] leaf or stem leachates, [19] root exudates and [20] decomposition of plant residues [21,22]. Allelochemicals, which inhibit the growth of same or different species at higher concentrations, may not influence the germination and growth at lower concentration of extracts and vice versa. For example, varied concentrations of *Eucalyptus urophylla* leaf have different effects; less concentration having least/no effect while higher concentration has remarkable inhibitory effects [23, 24]. It has been reported that *Eucalyptus* species and *Acacia* sps have phytotoxic effects on tree crops and legumes [25, 26]. Although the toxic metabolites are distributed in all plant tissues, the bark and leaves are the most potent source [20, 27, 28]. It was also demonstrated that leaf litter is the major source of phenolic compounds as a by product during putrefaction and green leaf leachate contained tannin [29]. The chemicals with allelopathy activity are present in many plants and various organs including leaves and fruits [25, 30] and have potential inhibitory effect on crops [31]. Other researchers have evaluated the allelopathic effects grasses/trees on the germination, shoot length, root length, bioassay on different crop species. For instance, pure tuber extract of *Cyperus rotundus* impede the cucumber, onion, radish and tomato's radical elongation [32], at time, the effect was confined to only certain parts of the plant, as it was evident that, the elongation of forage grasses radicle was more responsive than seed germination upon treatment with *Leucaena* [33]. The root length/growth and the lateral root development were more susceptible to the increase in the concentration of aqueous extract when compared to shoot [34- 38].

However, studies on the comparative effects of different home garden trees on different food crops are few and far between in tropics. The selected home garden tree (*Magnifera indica* L.) and food crops are some of the most common plants available in Mizoram. The present study was aimed at investigating the effects of different concentration of aqueous leachate of *M. indica* on five food crops to assess the compatibility among them so that appropriate combination can be suggested to enhance the home garden productivity.

MATERIALS AND METHODS

Plant Extracts: Leaves of field grown mature plants were selected from the Aizawl District (92°38' to 92°42' E longitude and 23°42' to 23°46' N latitude 950 m above sea level). The aqueous extracts of mango (*Magnifera indica* L.) were prepared by adding 100 gram crushed fresh mature leaves in 500 ml of distilled water, soaked for 24 h. at room temperature, hereafter, the mixtures were filtered through ordinary filter paper. Different concentrations were prepared by adding distilled water to make 20, 40 and 80% store in dark conical flasks and used to irrigate the seeds.

Bioassays: 10 seed of each food crops were placed in sterilized Petri-plates containing absorbent cotton which was spread evenly on the surface and saturated with the respective concentration. The treatments were replicated 3 times and 3 replicates of control treatment with distilled water were also prepared. The seed were observed every day and number of germinated seeds were recorded, extract/distilled water was added just to moisten the seed when required. The Petri plates were kept under natural light dark cycle [22] with temperature ranging from 25-30°C. The following nomenclatures were used as T_0 = Control (distilled water); T_1 = 20% leachate solution; T_2 = 40% leachate solution; T_3 = 80% leachate solution and T_4 = 100% leachate solution.

The emergence of the radical from the seed was regarded as germinated and germination was recorded every day till the 5th day. The root length and shoot length of the seedlings were recorded on the 10th day. The experimental results were subjected to analysis of variance. Percentage of inhibition/stimulation effect on germination over control (T_0) was calculated using the formula given by Surendra and Pota [39]: $I = 100 - (E_2 \times 100/E_1)$, where, I is % of inhibition/stimulation, E_1 the response of control and E_2 the response of treatment. Relative Elongation Ratio (RER) of shoots and roots of crops was also calculated with the formula suggested by Rho and Kil [40]: $R = (T/Tr) \times 100$; where, R is the Relative Elongation Ratio, T is the ratio of treatment crop and Tr , the test ratio of control.

Pot Culture: Ten seeds of each food crops were sown in poly pots (5 kg soil per pot) and irrigated with 500 ml of leachate prepared from 1 g (T_1), 2 g (T_2), 4g (T_3) and 5 g (T_4) powered leaf of *M. indica* per plot, replicated twice.

Germination per cent, root and shoot length of the seedlings were recorded on the 30th day and the dry matter was estimated after carefully cleaning the excavated ten seedlings of each test crop.

Statistical Analysis: To determine statistical difference between the treatments, variance analysis and least significant difference (LSD) tests were performed using SPSS 11.1.1 software programme. Percentage growth inhibition was calculated using the following equation: Percentage inhibition (%) = [(Control value - treatment value)/Control value] x 100.

RESULTS AND DISCUSSION

Effects of Aqueous Leaf Extracts on Germination:

The study revealed that the inhibitory effects of leaf leachate on the seed germination is a concentration dependent phenomenon i.e. increase in concentration exerted more inhibition [22] and different species varied in their response to different leachates [41]. The highest inhibitory effect (85.18%) was recorded in chilli at T₃ treatment while the lowest (6.89%) was in maize (T₂) and soybean (T₁). Neither inhibitory nor stimulatory effect (0%) was observed in soybean (T₂, T₃), maize (T₁, T₃) and paddy (T₁, T₂ and T₄). Stimulatory effect was observed only in paddy (T₃), though non-significant (Table 1, Figure 2).

In general, the germination of test crops chilli and lady's finger were the most inhibited by the leaf leachates of *M. indica*. Maize and paddy were the least affected crops. The highest reduction in this case was observed at T₄ treatment. However, higher concentration level of leachates showed maximum reduction in germination in these test crops. Similar observation was also found by Mousawi *et al.* [42], Kalitha, *et al.* [43], Sazada *et al.* [25].

It was well documented that, release of allelochemicals occurs at the time of germination or at the early developmental stage, as the plants are more susceptible

in terms of competition with their neighbouring plants for light, nutrients and water [44]. An indirect relation between lower germination rate and allelopathic inhibition may be the consequence of inhibition of water uptake [45] and alteration in the synthesis or activity of gibberellic acid (GA₃) [46]. This may be due to the presence of phenolic compounds inhibit the activity of GA₃ [47] or inhibit the synthesis of GA₃ which regulate de novo amylase production during seed germination [48].

The following trends of inhibited germination were obtained for *Mangifera indica*: chilli > lady finger > soybean > maize > paddy. (Table 1). It is also reported that allelopathy could bring about either inhibition or promotion which in turn is a concentration dependent [22]. In addition to the mortality, the reduced seedling vigour is attributed to the accumulation of toxic or poisonous chemicals of the donor in the soil which is harmful for the recipient plants both in the laboratory and field [22, 49, 50]. It was well established that, plants parts contain allelochemicals which they released in the soil and these are known to inhibit or sometime promote germination, growth, development, distribution and propagation of plants species [16] and our experiments on germination of seed do agree with it as, germination were promoted by *M. Indica* in paddy (T₃). Nevertheless, leaf leachate extracts had inhibited growth of the seedlings. The extent of affect depends on their rate of production, leaching amount and their combination time, which they released in the soil [51]. Also, the amount of chemical released in the soil or in solution [52]. The leachate solution not only affected percent germination [53] but also rate of germination (illustrated in Figure 1) and caused complete failure of germination [41]. Reserve mobilization, a process which usually takes place rapidly during early stages of seed germination seems to be delayed or decreased under allelopathy stress conditions [54]. Our results indicated variation in germination which agrees with Patil [55] who reported the same observation with *Glyricidia maculata* leaf extract in the field.

Table 1: Germination percentage of some common home garden crops treated with different concentrations of aqueous leaf extract of *Mangifera indica*. Values in the parenthesis indicates the inhibitory (-) or stimulatory (+) effects in comparison to control (T₀)

Tree species	Treatments	Soybean	Maize	Paddy	Chilli	Lady's finger
Control	T ₀	96.67	100.00	96.67	90.00	90.00
	T ₁	90.00(-6.89)	100.00(0)	96.67(0)	33.33(-62.96)	43.33(51.87)
	T ₂	96.67(0)	93.33(-6.89)	96.67(0)	30.00(-66.66)	36.67(-59.52)
	T ₃	96.67(0)	100.00(0)	100.00(+3.44)	13.33(-85.18)	56.67(-37.03)
	T ₄	86.67(-10.34)	90.00(-10.34)	96.67(0)	26.67(-70.36)	40.00(55.5)
LSD @5%	16.76	5.71	11.06	19.63	21.91	

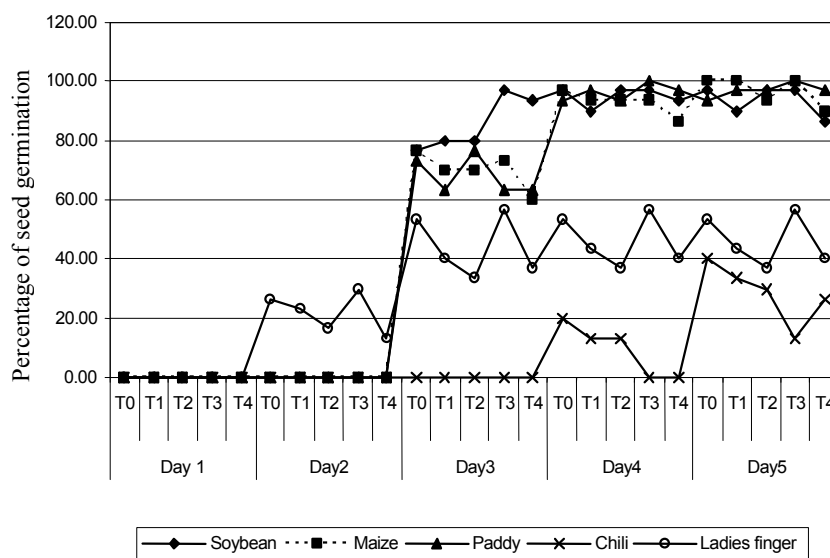


Fig. 1: Effects of different concentrations ($T_0=0\%$, $T_1=20\%$, $T_2=40\%$, $T_3=80\%$, $T_4=100\%$) of aqueous leaf extract of *Mangifera indica* on seed germination of some common homegarden crops

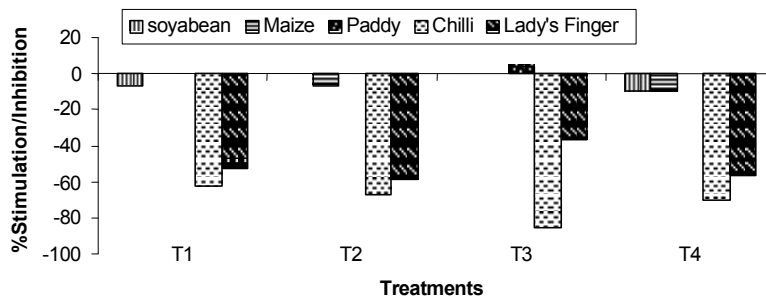


Fig. 2: Inhibitory (-) or stimulatory (+) effects on germination percentage of some common home garden crops treated with different concentrations ($T_0=0\%$, $T_1=20\%$, $T_2=40\%$, $T_3=80\%$, $T_4=100\%$) of aqueous leaf extract of *Mangifera indica*

Table 2: Effects of aqueous leaf extracts ($T_0=0\%$ (Control), $T_1=20\%$, $T_3=80\%$, $T_4=100\%$) of *Mangifera indica* on shoot length of test crops. Values in the parenthesis indicates the inhibitory (-) or stimulatory (+) effects in comparison to control (T_0)

Tree species	Treatment	Soybean	Maize	Paddy	Chilli	Lady's finger
Control	T_0	24.99	10.68	5.60	4.12	12.66
	T_1	21.28(-14.85)	12.52(+17.23)	5.40(-3.58)	4.81(+16.86)	11.87(-6.27)
	T_2	21.88(-12.46)	15.11(+41.45)	5.75(+2.63)	5.39(+30.91)	11.49(-9.25)
	T_3	20.49(-18.0)	10.92(+2.23)	4.98(-11.04)	4.36(+5.72)	7.25(-42.72)
	T_4	23.18(-7.24)	9.79(-8.36)	4.73(-15.60)	4.60(11.56)	7.32(-42.22)
LSD @5%	4.27	2.80	0.62	1.27	2.30	

Effects of Aqueous Leaf Extracts on Shoot Elongation:

The allelopathic affects of different leaf leachate concentration on shoot length have been summarised in the Table 2. Shoot length was found to be suppressed significantly ($P<0.01$) in lady's finger with all treatments exhibiting concentration dependent. Nevertheless, the root length of all the five bioassay species were greatly

inhibited with the increasing of concentration of leachates except in chilli and maize on which stimulatory effects were observed at T_1 , T_2 , T_3 . The highest Relative Elongation Ratio (RER) was found in maize (141.48%) treated with *M. indica* at T_2 treatment. The highest and lowest inhibitory effect on shoot length was recorded in lady's finger (42.73%) at T_3 and

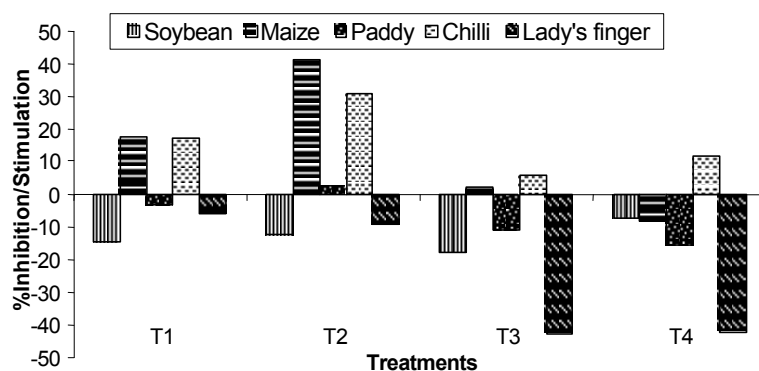


Fig. 3: Inhibitory (-) or stimulatory (+) effects on Shoot length percentage of some common home garden crops treated with different concentrations ($T_0=0\%$, $T_1=20\%$, $T_2=40\%$, $T_3=80\%$, $T_4=100\%$) of aqueous leaf extract of *Mangifera indica*

Table 3: Effects of aqueous leaf extracts ($T_0=0\%$ (Control), $T_1=20\%$, $T_2=40\%$, $T_3=80\%$, $T_4=100\%$) of *Mangifera indica* on root length of test crops. Values in the parenthesis indicates the inhibitory (-) or stimulatory (+) effects in comparison to control (T_0)

Tree species	Treatment	Soybean	Maize	Paddy	Chilli	Lady's finger
Control	T_0	16.13	17.74	10.11	5.09	6.85
	T_1	17.63(+9.31)	17.59(-0.83)	8.01(-20.80)	6.52(+28.12)	5.36(-57.50)
	T_2	14.51(-10.03)	19.45(+9.62)	8.57(-15.20)	7.31(+43.68)	5.61(-55.67)
	T_3	14.64(-9.25)	16.97(-4.36)	7.95(-21.36)	6.03(+81.46)	6.17(-51.29)
	T_4	13.26(-17.78)	12.80(-27.82)	7.32(-27.63)	4.74(-6.79)	5.74(-54.67)
LSD @5%	1.84	3.51	1.10	1.62	1.26	

paddy (3.57%) at T_1 treatment respectively (Figure 3). The inhibitory effect was much more pronounced at T_3 and T_4 treatments. Among the test crops, lady's finger exhibited more sensitive responses followed by soybean and paddy to the aqueous leaf extracts. In contrast chilli exhibited less sensitive responses followed by maize. The inhibition of shoot length by *Mangifera indica* may be due to the presence of higher amount of phenols like caffeic acid, coumaric acid, vanelic acid, benzoic acid and other phenolic acid [2]. These phenolic compounds might have interfered with the phosphorylation pathway or inhibiting the activation of Mg^{2+} and ATPase activity or might be due to decreased synthesis of total carbohydrates, proteins and nucleic acids (DNA and RNA) or interference in cell division, mineral uptake and biosynthetic processes [56]. Impaired metabolic activities caused by allelochemicals decreased root and shoot length. Allelochemicals decreased elongation, expansion and division of cells which are growth prerequisite [47]. Also, allelochemicals inhibit absorption of ions [57] and therefore, resulted in arrested growth [58]. The leachate solution of *capsicum* inhibited the germination of *Vigna radiate* (L) and upon treatment with 50 or 75% leachate concentration it affected the root and shoot growth, they noticed that root and shoot growth was inversely

correlated to the concentration of the leachate solution, as increase in concentration retarded the growth of both the root and shoot and eventually affecting the overall length of the seedling [59], our results agrees with these findings.

Effects of Aqueous Leaf Extracts on Root Length:

The root length of all the five bioassay species were greatly inhibited with the increasing of concentration of leachates (Table 3) and was more pronounced in paddy. The inhibitory effect was much more pronounced at T_3 and T_4 . However, stimulatory effect was seen in the root length of soybean (T_1), maize (T_2) and chilli (T_1 , T_2 , T_3) but root growth was inhibited as the concentration increased. It was evident that, all the receptors crops were affected by increased concentration levels. The maximum Relative Elongation ratio (RER) of root was recorded in chilli when treated with *Mangifera indica* at T_2 (Figure 4). Numerous studies revealed that, various secondary metabolites are discharged in the soil by various mean viz. exudation from plant tissues or putrefaction of plant parts under certain environmental condition [22] and these chemicals are the potential germination, seedling growth inhibitors and they includes phenolics, terpenoids and alkaloids and their derivatives and some other enzymes activity [60].

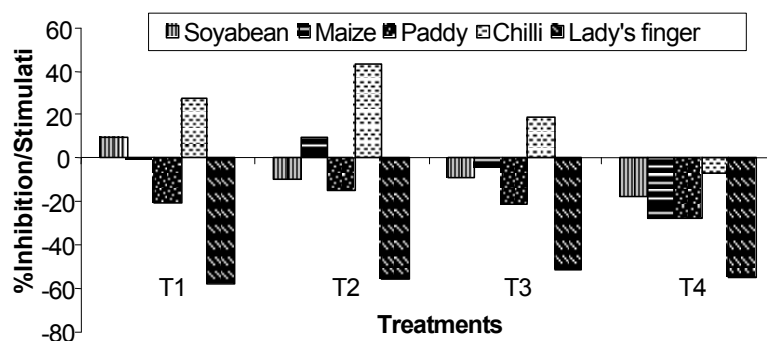


Fig. 4: Inhibitory (-) or stimulatory (+) effects on root length percentage of some common home garden crops treated with different concentrations ($T_0=0\%$, $T_1=20\%$, $T_2=40\%$, $T_3=80\%$, $T_4=100\%$) of aqueous leaf extract of *Mangifera indica*

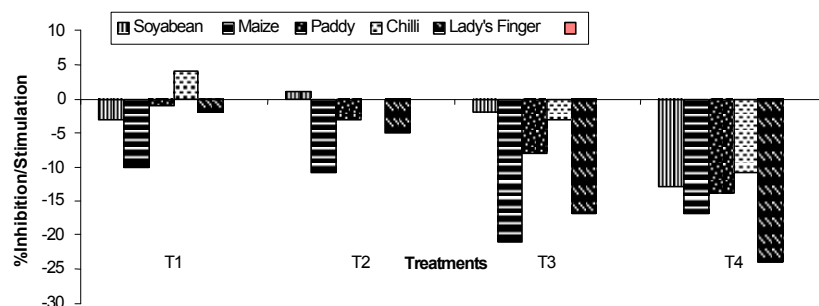


Fig. 5: Inhibitory (-) or stimulatory (+) effects on germination percentage of some common home garden crops treated with different concentrations ($T_0=0g$, $T_1=1g$, $T_2=2g$, $T_3=4g$, $T_4=5g$) of dried powdered leaf of *Mangifera indica*.

Table 4: Germination percentage of some common home garden crops treated with different concentrations of aqueous leaf extract of five different tree species (Pot culture).

Tree species	Treatments	Soybean	Maize	Paddy	Chilli	Lady's finger
Control	T_0	97.1	96.2	91.1	87.5	92.1
<i>Mangifera indica</i>	T_1	94.3 (-2.9)	87.3 (-9.3)	90.4 (-0.8)	91.2 (+4.23)	90.7 (-1.5)
	T_2	97.4 (+0.3)	85.3 (-11.3)	88.7 (-2.6)	87.4 (-0.1)	87.6 (-4.9)
	T_3	95.4 (-1.8)	75.9 (-21.1)	84.2 (-7.6)	85.4 (-2.4)	76.2 (-17.3)
	T_4	84.4 (-13.1)	80.2 (-16.6)	78.2 (-14.2)	78.4 (-10.4)	70.1 (-23.6)

Effect of Finely Grounded Leaf Powder on Seed Germination and Initial Growth Parameters of Test Crops under Pot Culture: The results demonstrated in Table 4 showed the effect of finely grounded leaf powder of *M. indica* at different concentration on seed germination on the test crops. The degree of inhibition was concentration dependent. Among the four leachate concentrations tried, maximum seed germination was obtained at T_1 treatment in all the test crops, though there was stimulatory effect of increasing seed germination on Chilli at same treatment. However, in case of soybean the maximum germination was recorded at T_2 treatment. Our results revealed a gradual increase in germination with decreasing concentration of leachate in the entire test

crops, a similar phenomenon reported elsewhere [22]. The highest inhibitory effect (25.62%) was recorded in lady's finger and lowest effect on chilli at T_4 treatment. Compared to the control, the following trend of inhibition was obtained: Lady's finger > Maize > Paddy > Chilli > Soybean (Figure 5).

The shoot length of different receptor crops are presented in Table 5. The higher concentration here also caused severe inhibition in comparison to control (T_0) except in paddy where stimulatory effect on shoot elongation was observed irrespective of concentrations. The highest inhibition (37.36%) was recorded in lady's finger at T_3 treatment while the lowest (8.98%) in soybean at the same treatment. Maize showed some stimulatory

Table 5: Shoot length of some common home garden crops treated with different concentrations of aqueous leaf extract of five different tree species (Pot culture).

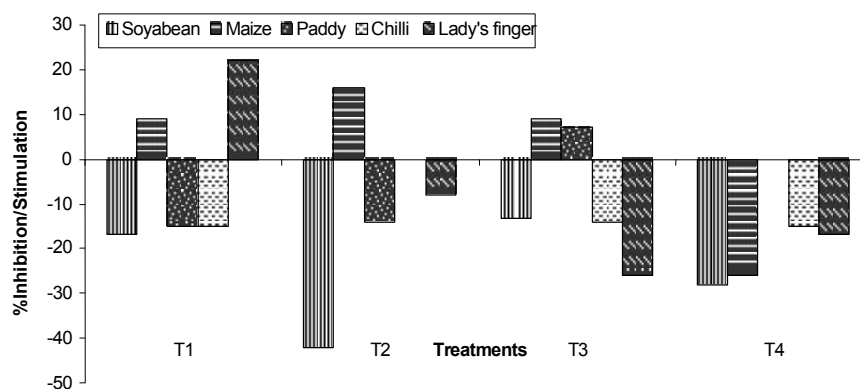
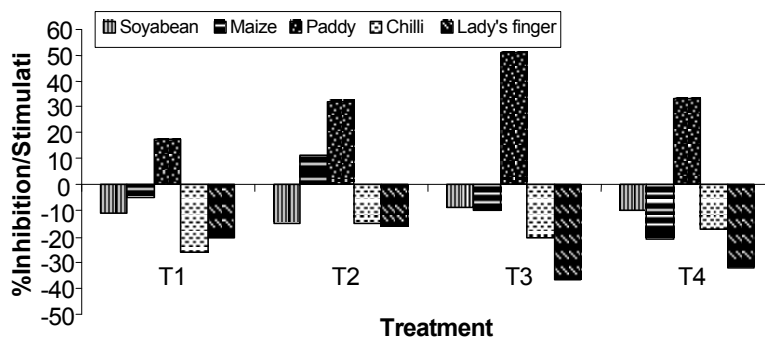
Tree species	Treatments	Soybean	Maize	Paddy	Chilli	Lady's finger
Control	T ₀	32.3	20.2	9.6	17.2	18.2
<i>Mangifera indica</i>	T ₁	28.8(-10.84)	19.2(-4.95)	11.2(+16.67)	12.7(-26.16)	14.5(-20.33)
	T ₂	27.3(-15.48)	22.4(+10.89)	12.7(+32.29)	14.7(-14.53)	15.3(-15.93)
	T ₃	29.4(-8.98)	18.2(-9.90)	14.5(+51.04)	13.7(-20.35)	11.4(-37.36)
	T ₄	29.1(-9.91)	15.9(-21.29)	12.8(+33.33)	14.2(-17.44)	12.4(-31.87)

Table 6: Root length of some common home garden crops treated with different concentrations of aqueous leaf extract of five different tree species (Pot culture).

Tree species	Treatments	Soybean	Maize	Paddy	Chilli	Lady's finger
Control	T ₀	24.5	24.6	18.2	18.4	10.2
<i>Mangifera indica</i>	T ₁	20.3(-17.14)	26.9(+9.35)	15.4(-15.38)	15.7(-14.67)	12.4(+21.57)
	T ₂	14.1(-42.45)	28.5(+15.85)	15.6(-14.29)	18.4(0.00)	9.40(-7.84)
	T ₃	21.4(-12.65)	26.7(+8.54)	19.4(+6.59)	15.8(-14.13)	7.5(-26.47)
	T ₄	17.6(-28.16)	18.1(-26.42)	18.2(0.00)	15.7(-14.67)	8.5(-16.67)

Table 7: Dry matter of some common home garden crops treated with different concentrations of aqueous leaf extract of five different tree species (Pot culture).

Tree species	Treatments	Soybean	Maize	Paddy	Chilli	Lady's finger
Control	T ₀	1.94	0.74	0.43	0.42	1.20
<i>Mangifera indica</i>	T ₁	1.4(-27.84)	0.58(-21.62)	0.38(-11.63)	0.41(-2.38)	2.0(+66.67)
	T ₂	1.3(-32.99)	0.75(+1.35)	0.41(-4.65)	0.42(0.00)	1.7(+41.67)
	T ₃	1.4(-27.84)	0.58(-21.62)	0.38(-11.63)	0.37(-11.90)	1.6(+33.33)
	T ₄	1.5(-22.68)	0.55(-25.68)	0.4(-6.98)	0.39(-7.14)	2.1(+75.00)

Fig. 6: Inhibitory (-) or stimulatory (+) effects on root length percentage of some common home garden crops treated with different concentrations (T₀=0g, T₁=1g, T₂=2g, T₃=4g, T₄= 5g of dried powdered leaf of *Mangifera indica*Fig. 7: Inhibitory (-) or stimulatory (+) effects on shoot length percentage of some common home garden crops treated with different concentrations (T₀=0g, T₁=1g, T₂=2g, T₃=4g, T₄= 5g of dried powdered leaf of *Mangifera indica*

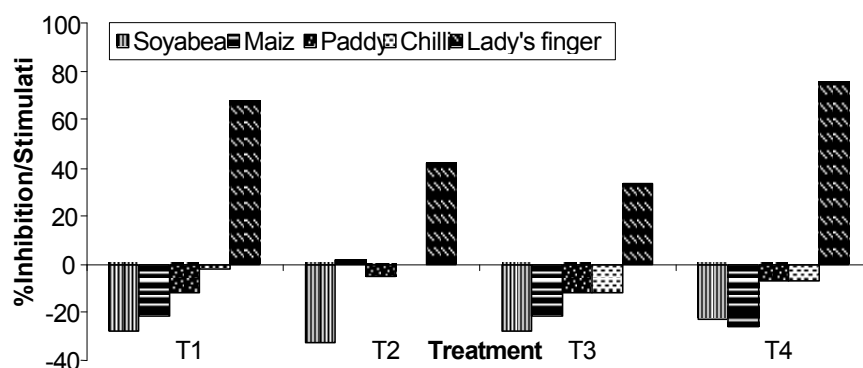


Fig. 8: Inhibitory (-) or stimulatory (+) effects on dry matter percentage of some common home garden crops treated with different concentrations ($T_0=0g$, $T_1=1g$, $T_2=2g$, $T_3=4g$, $T_4=5g$ of dried powdered leaf of *Mangifera indica*

effect on shoot length at T_2 treatment. Lady's finger was the most affected crop, followed by chilli, soybean and maize (Figure 6).

There was a remarkable inhibition effect on root lengths of all the test crops at higher concentration, except in maize where stimulatory effect was observed at T_1 , T_2 and T_3 (Table 6). But the maximum root elongation ratio (121.57%) was observed in lady's finger at T_1 treatment. The least affected crop among the test crops was maize followed by paddy, lady's finger, chilli and soybean (Figure 7).

The dry matters of all the test crops were greatly inhibited with the increasing of concentration of leachate application except in lady's finger on which stimulatory effect was observed irrespective of treatments (Table 7). The inhibitory effect was much pronounced at T_3 and T_4 concentration. Among the test crops, the highest inhibitory effect was recorded from soybean (27.84%) at T_1 and T_3 treatments (Figure 8).

Several studies have reported that many secondary metabolites are released into the environment either as exudation from living plant tissues or by decomposition of plant materials under certain conditions [23, 36, 49, 53, 59]. These chemicals like phenolics, terpenoids and alkaloids and their derivatives are potential inhibitors of germination and seedling growth [14, 22, 29, 51]. Although it was difficult to relate the bioassay result with the pot culture, there has been clear indication on the role played by higher concentration of leachates either in promotion or inhibition of germination, root and shoot growth of the test crops.

Although our findings are preliminary, nevertheless, the water soluble leachate from the matured fresh leaves of *M. indica* has the allelopathic potential to reduce the germination as well to suppress the growth and development of the test crops. In general,

the root lengths were more sensitive to allelochemicals from the leaf leachates than the shoot length under pot culture consequently affecting the biomass and survival of the young seedlings, presumably because they were the one which first absorbed the chemicals under pot culture. It is recommended to carry to long term field studies to know that the seasonal variation in the constituents of leaf litter and green leaf on the N cycles, germination, seedling growth to as to get better insight of how they affect on plants in nature as well as in the laboratory.

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