

Original Research Article

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Allelopathic Influence of Leaf Aqueous Extract and Leaf Litter of Indian Lilac (*Melia azedarach* L.) on Germination, Growth, Biomass and Grain Yield of Green Gram (*Vigna radiata* L.) and Black Chickpea (*Cicer arietinum* L.)

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ABSTRACT

The present study was carried out in Navsari Agricultural University Navsari, Gujarat, India, intended to analyze the phytochemicals in leaf litter of Indian lilac (*Melia azedarach* L.) and to examine its allelopathic influence in leaf aqueous extract and leaf litter form on two pulse crops. The phytochemicals in leaf litter of Indian lilac were analyzed through Gas chromatography mass-spectrometry (GC-MS). The allelopathic influence of leaf aqueous extracts (control, 25, 50, 75 and 100% concentration) and leaf litter (control, 5, 10, 15 and 20 g/pot) on germination and initial growth, and biomass of green gram (*Vigna radiata* L.) and black chickpea (*Cicer arietinum* L.) was carried out in laboratory and in pot culture. To comprehend the allelopathic effect of leaf litter on later stages of growth, biomass and grain yield of test crops, separate pot experiments were conducted. GC-MS analysis revealed different compounds like phenolic acids and their derivatives, alkaloids, methyl ketones (volatile allelochemical), unsaturated fatty acids, omega-3 fatty acid, benzofuran, propargyl acid, benzoxepine, fluorobenzoic acid, silicyclobutane, palmitic acid in leaf litter of *M. azedarach*. The leaf aqueous extract and leaf litter inhibited the germination, germination rate index, initial growth, and biomass of green gram and black chick pea in laboratory and pot culture bioassays. However, the results of pot experiment carried out till maturity of test crops showed no significant allelopathic effects of leaf litter on growth, biomass and grain yield. Thus the allelopathic effect of detected phytochemicals was fleeting in nature and it may have diminished with passage of time in pot soil due to volatilization.

Keywords

Allelopathy, GC-MS, Germination, Laboratory bioassay, *Melia azedarach*, Pot culture, Green gram, Black chick pea.

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Introduction

Beneficial or harmful effects of one plant on another plant due to release of phytochemicals, known as allelochemicals, from plant parts by leaching, root exudation, volatilization, residue decomposition, and other processes in both natural and agricultural systems is termed as allelopathy (Gupta *et al.*, 2007; Narwal *et al.*, 2011). The woody and non woody components of

agroforestry need to be tested for allelopathic effects, if any, to design ecologically viable land use systems. Such studies will not only make help the land use ecologically sound but economically acceptable. *Melia azedarach* L. is a commercial perennial, deciduous tree, native in Brazil, Bangladesh, India, Indonesia, Laos, Malaysia, Myanmar, Nepal, Pakistan, Papua New Guinea, Sri Lanka, Thailand,

Vietnam and exotic in Australia, China, Ethiopia, France, Greece, Iran, Iraq, Italy, Kenya, Korea, Mexico, Mozambique, Namibia, Philippines, Portugal, South Africa, Spain, Swaziland, Turkey, Uganda, United Kingdom, United States of America, Zanzibar (Orwa *et al.*, 2009). A multipurpose fast growing tree, commonly known by many names like, Indian lilac, Persian lilac, white cedar, chinaberry tree, bead-tree, Cape lilac, Syringa berry tree. It is planted by farmers in agroforestry systems either block or boundary plantations, preferred in alley cropping system of agro-forestry and ornamental purpose (Krishnan *et al.*, 2009; Nandal and Kumar, 2010; Hanif and Bari, 2013). It also helps to improve fertility of soil (Nandal and Kumar, 2010). The industrial and ecological importance of the species has encouraged the farmers to take large scale plantations with different intercrops, as shade tree in coffee and abaca (*Musa textilis*) plantations, sugarcane (Orwa *et al.*, 2009) and other vegetable, pulses and grain crops (Nandal and Kumar, 2010 and Patil *et al.*, 2012). To develop and commercialize *M. azedarach* based tree-crop combination, studies on allelopathic effects of leaf leachates or leaf litter on growth and yield of under storey crops are essential. The available literature suggests that such studies on this important species are limited to laboratory bioassays only. Therefore, the present investigation was undertaken to investigate the allelopathic effect of leaf aqueous extracts and leaf litter of *M. azedarach* on germination, growth, biomass and yield of green gram (*Vigna radiata* L.) and Black chickpea (*Cicer arietinum* L.) in laboratory bioassay and pot culture till crop maturity.

Materials and Methods

The present study was carried out in laboratory and green house complex of College of Forestry, ACHF, Navsari

Agricultural University, Navsari, Gujarat, India, during November 2014 to April 2015.

Phytochemical analysis of leaf litter of donor species

To detect and identify the chemical compounds in leaf litter samples of *M. azedarach* used in this study, Gas Chromatography-Mass Spectrometry (GC-MS) analysis was done following by Murugesan *et al.*, (2013).

Plant material and preparation of aqueous extracts

The leaves (mixture of young and mature leaves showing signs of senescence) of *Melia azedarach* were collected from 6 year old plantations during October-November 2014. The leaves were initially dried at room temperature and later at 65°C in hot air oven until constant dry weight was reached (Perez- Corona *et al.*, 2013). The dried leaf litter was stored at room temperature and was used for both petriplate bioassay and pot experiments. Aqueous extracts were prepared by soaking 200 g of grounded dried leaf litter in 1L distilled water. The solution was stirred and kept at room temperature (20-25°C) for 24 hours. The filtrate was centrifuged and supernatant was decanted (Prasad *et al.*, 2011). The filtrate was defined as 100 per cent extract (Nikneshan *et al.*, 2011). From this 25, 50, 75, 100 per cent concentrations were prepared and distilled water was used as control (Lawan *et al.*, 2011). The treatments were replicated five times in completely randomized design (CRD).

Petri dish bioassay experiment

The pre-treated seeds (treated with Thirum @ 2g/kg) of green gram (*Vigna radiata* L.) and Black chickpea (*Cicer arietinum* L.) were used as test crops. In the laboratory

experiment, 5-treatments [T_1 (0), T_2 (25%), T_3 (50%), T_4 (75%) and T_5 (100%)] of aqueous extracts of *M. azedarach* were used and replicated five times. Each petridish of size 90 mm diameter is considered as replication. Total 50 seeds of each test crop were placed on filter paper in sterilized petridishes. Five ml aqueous extracts were applied on first day and afterwards, 2 ml on alternate days to keep the filter paper moist till the completion of experiment (Bhat *et al.*, 2011). Seeds were considered germinated upon radicle emergence (>1 cm length) from seeds. Germination was counted daily till 11 days after initiation of experiment. The seedling shoot and root length and biomass were recorded from 10-randomly selected seedlings of each test crop per petridish. Germination (%) and Germination Rate Index (GRI) were calculated following AOSA (1983). Root and shoot portion were separated and dried in hot air oven at 60° C for 48 h and sample were weighed. The germination (%), and GRI were calculated as per standard procedures.

Pot experiments

Pot experiments were done in green house to find the effects of leaf litter of *M. azedarach* on germination, GRI, initial growth and biomass of both the test crops. Total fifty seeds of each test crop were sown on soil filled in the plastic pots [18 cm diameter x 16 cm height (4070 cc)] containing approximately 2.5 kg normal soil (N, P and K content 84.82, 17.85 and 80.35 ppm, respectively). Course grounded leaf litter was applied at 5, 10, 15 and 20 g per pot (T_2 to T_5) and was mixed in the upper soil layer in the pots (Thakur 2014) and a control treatment (T_0) without leaf litter. For each leaf litter treatment, five replication were considered. The litter treatments were imposed according to annual average litter fall (Li *et al.*, 2013). We recorded the leaf litter fall of 3- months by placing the 1 m² traps under 6 years old plantation of *M. azedarach*. The average litter

fall was 446.43 g/m², which comes approximately 11.61 g/pot. Hence, the mulch treatments were calculated based on the range of litter fall as mentioned above. The replications and statistical design was same as used in petridish bioassay. Pots were irrigated (2 L/ pot) with water (pH 7.71, electrical conductivity 1.752 dS/m) a day prior to seed sowing and approx. 1 L on subsequent days to keep the soil moist. The seed germination and seedling growth (at 11th day from start of experiment) were recorded as done in petriplate bioassay, except that here seedling emergence from the soil was recorded. The germination (%) and GRI was worked out as per standard procedure followed in the petridish bioassays.

To evaluate the plant growth, biomass and yield of each test crop, a separate pot experiment was done in green house. Each litter treatment was replicated five times (3-plants per replication). In each pot, only 5-seeds were sown and one healthy seedling was retained 2-weeks after sowing. At maturity (90 days after sowing), fresh and dry biomass of plant and grain were recorded. Pods were separated from the plants as and when ripened and threshed to record gain yield.

The experimental data recorded for all the parameters in different experiments were the statistically analyzed following completely randomized design (CRD) and F-test was done and ANOVA was constructed following Sheron *et al.*, (1998). Treatment means were compared at P<0.05.

Results and Discussion

Leaf litter phytochemicals

In gas chromatography mass-spectrometry, 18 different types of compounds were detected in leaf litter samples of *M. azedarach* used for bioassay and pot culture experiments (Table

1, Fig. 1). The detected compounds are phenolic acids and their derivatives, omega-3 fatty acid, alkaloids, methyl ketones (volatile allelochemical), unsaturated fatty acids, aromatic ketone, alkaloids, methyl ketones (volatile allelochemical), unsaturated fatty acids, benzofuran, propargyl acid, benzoxepine, fluorobenzoic acid, silicyclobutane, palmitic acid.

Petri dish bioassays and pot culture experiments

Germination

The aqueous leaf extract concentrations and leaf litter significantly suppressed the germination (%) and germination rate index (GRI), relative to control (distilled water or no leaf litter), of green gram and black chick pea. The inhibitory effect gradually increased with increase in extract intensity or leaf litter quantity (Table 2, 3 and Fig. 2 A to D).

The per cent inhibition, compared to control, increased with increase in extract concentration and leaf litter amount (Fig. 3 and 4). The percentage of inhibition, in both the test crops, was higher against aqueous extracts as compared to leaf litter application in petri dish bioassay and pots culture, respectively.

Initial growth and biomass

Application of leaf aqueous extract and leaf litter significantly ($P<0.05$) inhibited the growth and biomass of shoot, root and entire seedling (Table 2 and 3) of both the test crops. The per cent inhibition, over control, in laboratory and pot culture, increased with increase in aqueous concentration and leaf litter quantity (Fig. 3 and 4) showing maximum inhibitory effects at 100% extract concentration and 20 g litter application. The per cent inhibition was more pronounced on root growth as compared shoot in laboratory

as well as in pot culture experiments except in case of black chick pea in pot culture bioassay.

Later growth, biomass and grain yield

The result of pot experiments carried out till maturity of test crops indicated that there was no significant effects ($P<0.05$) of different leaf litter applications (5, 10, 15 and 20 g/pot) on growth, biomass and grain yield both the test crops (Table 4, Fig. 5).

In GC-MS analysis we could identify 18 different types of phytochemicals. The GC-MS studies of *M. azedarach* leaf extracts carried out by Sharma and Paul (2013) also reported the similar chemicals. The phytochemicals like benzoic acids, benzofuran and benzopyran, cyclohexanone, octanoate, dicarboxylic acid, icosapentaenoic acid, 5-methyl (5-8 dihydro 1-4 Naphthoquinone), cyclohexanone, 3-hydroxy-3-phenyl-, 1-Pentanone, 1-(4-methoxyphenyl)-Oxim Or 1-(4-Methoxyphenyl)-1-pentanone oxime etc., detected in leaf litter of *M. azedarach* in our study, are reported with inhibitory effect on germination and growth of test crops either in extract form or as leaf litter of many plant species (Razavia and Ebrahimi, 2010; Koder, 2011; Ramalakshmi and Muthuchelian, 2013; Walsh *et al.*, 2014; Danilo *et al.*, 2016).

Inhibitory effects of *M. azedarach* on seed germination reported in the present study are in line with the laboratory bioassay studies of Phuwiwat *et al.*, (2012), Akacha *et al.*, (2013). Dinesh Kumar *et al.*, (2017) reported similar inhibitory effects on black gram against aqueous extract and leaf litter of *Melia composita*. The inhibitory effects on germination parameters and initial growth and biomass against aqueous leaf extract and leaf litter of *M. azedarach* is the result of water soluble allelochemicals present in leaf litter (Rezaeinodehi *et al.*, 2006).

Table.1 Chemical compounds, their retention times and area under curve detected in (GC-MS) analysis of *M. azedarach* leaf litter

Sr. No.	Compound name	Retention time	Area under Curve
1	1-benzofuran-2,3-dione	5.49	192729
2	4 methylbenzoic acid, Propargyl acid	9.71	90293
3	2,3-Benzofurandione,2-oxime	10.34	143614
4	2,3,4,5-tetrahydro-1-benzoxepine	10.57	815388
5	3-Fluorobenzoic acid, 4-nitrophenyl ester	11.04	117505
6	1-cyclohexyloxy-1-methyl-1-silicyclobutane	11.30	-
7	4H-Pyrazino[2,3-b]indole, 6,7,8,9-tetrahydro-	11.41	237741
8	Cyclohexanone, 3-hydroxy-3-phenyl-	12.14	138784
9	1,4-Dithiepan-2-one, 3-phenyl	12.93	74168
10	1,4,7,10,13,16-Hexaoxacyclooctadecane-2,5,9-trione,3-(phenylmethyl)-	14.24	-
11	1-Decen-3-yne	14.33	-
12	2-Methyl-3,5-dodecadiyne	15.14	3884632
13	Methyl 5,7 hexadeadiynoate (Palmitic acid methyl ester; Hexadecanoic acid, methyl ester; Palmitic acid)	16.23	191202
14	Methyl 8-(5-octyl-1,2,4-trioxolan-3-yl) octanoate	16.79	115882
15	Methyl (4E,7E,10E)-Hexadeca-4,7,10-Trienoate	21.83	1157941
16	1,3-Dioxolane-4-methanol, 2-pentadecyl-, acetate, cis-	24.02	162408
17	Spiro [adamantine-2,2-(1,3) dithiolane]-1,5-dicarboxylic acid, 6 oxo		
18	1-Pentanone, 1-(4-methoxyphenyl)-Oxim Or 1-(4-Methoxyphenyl)-1-pentanone oxime Or p-Methoxy valerophenone oxime	27.20	1370885

Table.2 Allelopathic effect of aqueous leaf extract of *M. azedarach* on germination traits, initial growth and biomass of green gram and black chickpea in bioassay culture

Extract concentration (%)	Germination (%)	GRI	Growth		Biomass (DM mg/plant)		
			Shoot length (cm)	Root length (cm)	Shoot	Root	Total
Green gram							
0% control	99.60 (88.36)	96.24	7.10	3.80	13.75	9.82	23.57
25%	98.80 (84.42)	94.23	6.00	2.30	11.88	8.43	20.31
50%	97.60 (81.1)	78.22	5.50	1.90	9.91	7.24	17.15
75%	90.80 (73.14)	63.50	4.60	1.70	8.54	6.05	14.59
100%	84.80 (68.02)	56.79	3.60	1.50	7.42	5.07	12.49
CD at 5%	5.28	5.58	0.25	0.12	0.77	0.37	0.82
SEM \pm	1.78	1.89	0.09	0.04	0.26	0.13	0.27
Black chickpea							
0% control	100.00 (90.00)	54.60	3.50	4.00	22.01	22.57	44.78
25%	96.80 (83.41)	47.41	3.00	3.00	19.31	20.39	39.70
50%	85.20 (66.64)	24.60	2.30	2.50	17.28	18.00	35.29
75%	51.60 (46.12)	14.89	1.80	2.10	14.75	15.49	30.24
100%	48.80 (44.75)	14.00	1.40	1.90	11.81	12.66	24.47
CD at 5%	6.37	1.18	0.14	0.12	0.91	1.10	2.05
SEM \pm	2.14	0.40	0.05	0.04	0.31	0.37	0.69

DM=Dry Matter; GRI= Germination rate index; Treatments means compared at p<0.05

Table.3 Allelopathic effect of leaf litter of *M. azedarach* on germination traits, initial growth and biomass of green gram and black chickpea in pot culture

Litter (g/pot)	Germination (%)	GRI	Growth		Biomass (DM mg/plant)		
			Shoot length (cm)	Root length (cm)	Shoot	Root	Total
Green gram							
0 control	93.20 (75.01)	24.29	15.50	12.50	50.64	27.14	77.78
5 g	86.40 (68.38)	19.63	14.60	11.20	42.83	22.96	65.79
10 g	79.60 (63.12)	18.74	13.70	9.80	37.09	19.88	56.97
15 g	65.60 (54.07)	16.37	13.00	8.70	34.31	18.39	52.70
20 g	59.20 (50.29)	15.71	12.50	7.70	32.39	17.36	49.74
CD at 5%	2.43	0.96	0.34	0.58	2.50	1.37	4.72
SEM \pm	0.82	0.32	0.12	0.19	0.84	0.46	1.59
Black chickpea							
0 control	92.00 (74.56)	23.83	17.10	18.70	61.40	31.73	93.12
5 g	87.60 (69.36)	20.84	16.40	18.00	54.67	28.25	82.92
10 g	80.80 (64.01)	20.82	15.60	17.20	50.18	25.93	76.11
15 g	74.40 (59.65)	16.73	14.60	16.20	47.32	24.45	71.78
20 g	65.20 (53.84)	17.78	13.80	15.40	45.41	23.46	68.87
CD at 5%	2.99	1.18	0.36	0.36	0.85	0.52	1.36
SEM \pm	1.01	0.40	0.12	0.12	0.29	0.17	0.46

DM=Dry Matter; GRI= Germination rate index; Treatments means compared at p<0.05

Table.4 Allelopathic effects of leaf litter of *M. azedarach* on growth, biomass (DM g/ plant) and fruit yield (at 90 days old) of green gram and black chickpea in pots

Leaf litter (g/pot)	Plant Height (cm)	Root length (cm)	No. of pods/plant	Grain yield (g/ plant)	Biomass (DM g/ plant)
Green gram					
0 control	46.81	23.16	5.72	2.41	10.34
5 g	47.47	23.17	6.27	2.68	10.55
10 g	50.42	24.17	7.00	2.93	11.65
15 g	48.29	23.17	7.37	3.02	8.48
20 g	46.93	21.83	6.20	2.63	9.90
CD at 5%	N.S.	N.S.	N.S.	N.S.	N.S.
SEM \pm	1.77	1.47	0.92	0.35	2.12
Black chickpea					
0 control	34.46	7.08	*	*	4.30
5 g	33.60	7.58	*	*	3.98
10 g	35.55	7.26	*	*	4.48
15 g	34.72	6.78	*	*	4.09
20 g	36.03	6.46	*	*	3.76
CD at 5%	N.S.	N.S.	*	*	N.S.
SEM \pm	1.93	0.49	*	*	0.51

DM=Dry Matter; FW=Fresh Weight; * Did not flower; Treatments means compared at p<0.05

Fig.1 GC-MS chromatogram showing retention time and peaks of different chemical compounds in *Melia composita* leaf litter

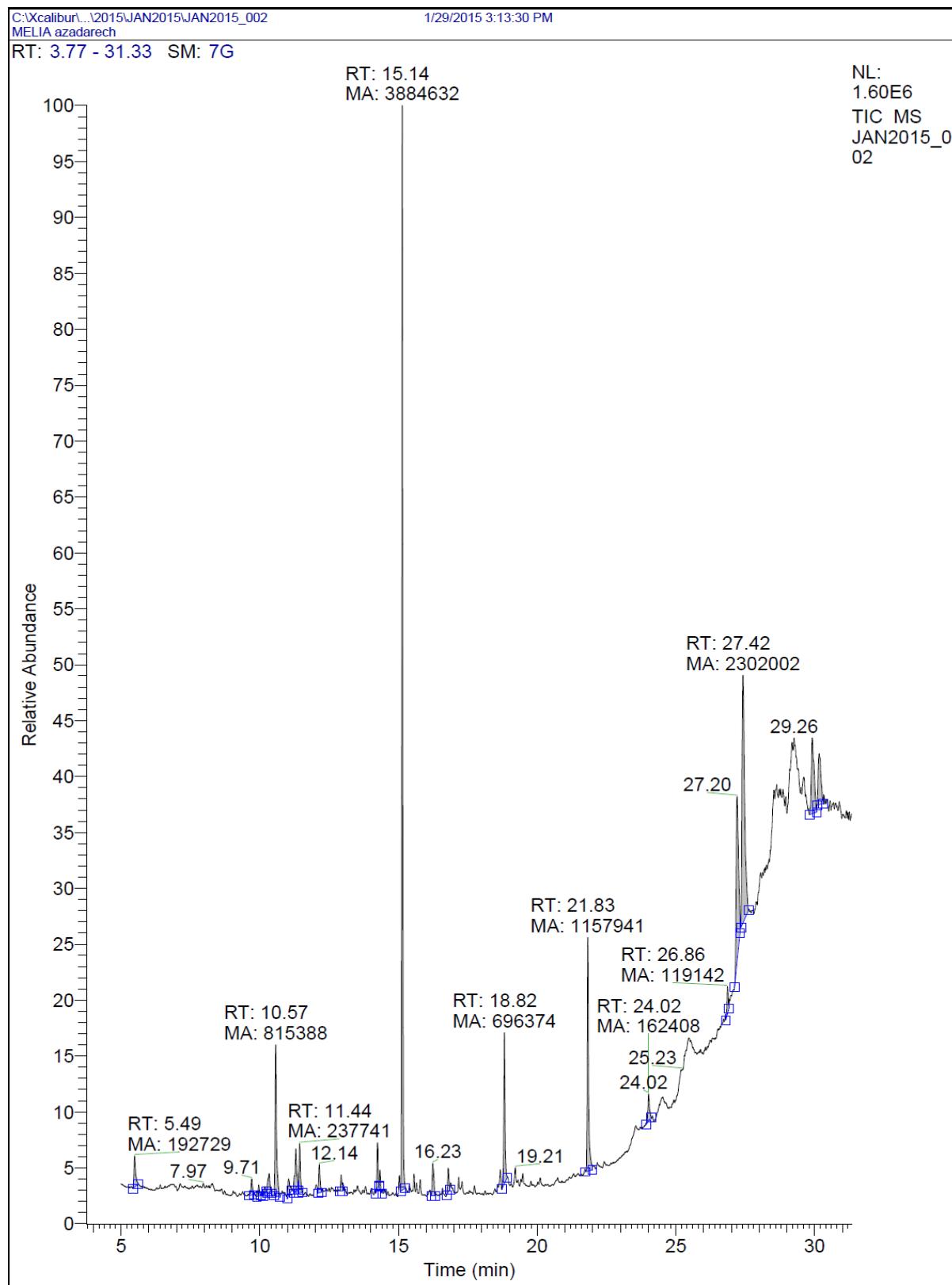


Fig.2 Showing the allelopathic influence of aqueous leaf extracts [0 (distilled water), 25, 50, 75 and 100%] and leaf litter [0 (no leaf litter), 5, 10, 15 and 20 g/pot] of *M. azedarach* on germination and initial growth of green gram and black chickpea in laboratory (a and b) and pot culture bioassays (c and d)

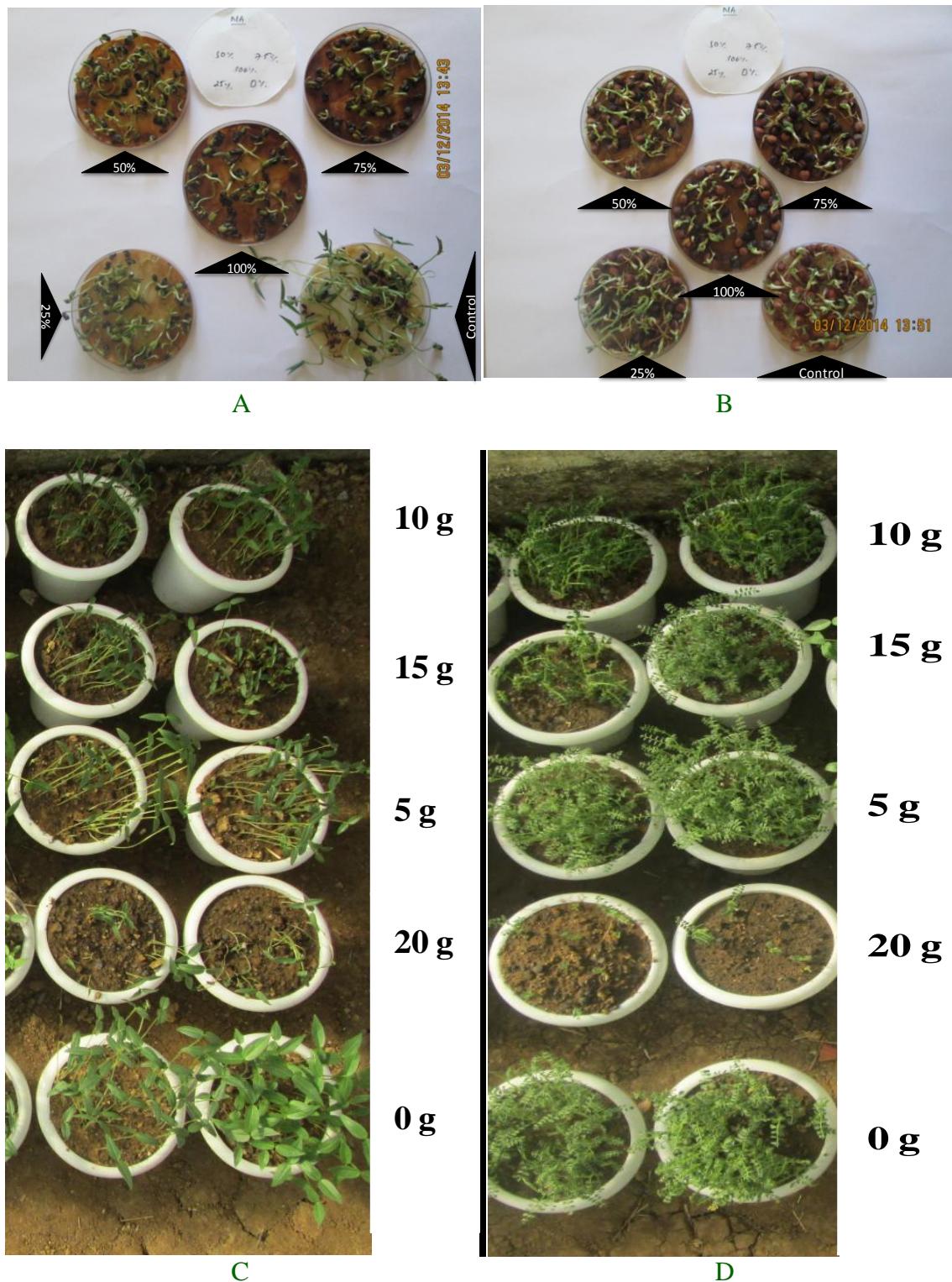


Fig.3 Per cent Inhibitory effects (over control) of aqueous leaf extract concentration (%) of *M. azedarach* on germination, GRI, growth and biomass of green gram and black chickpea

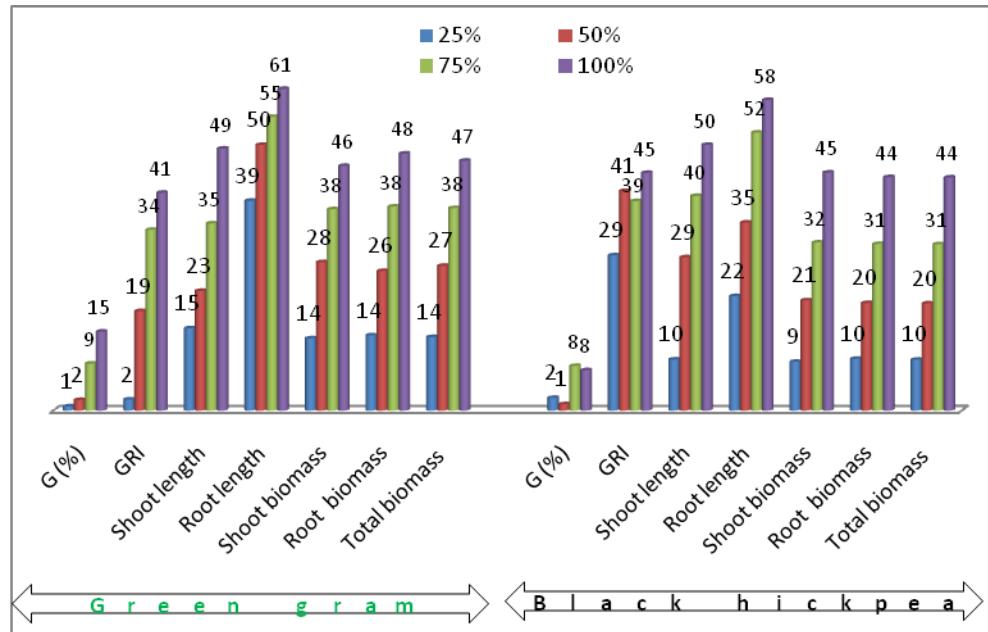


Fig.4 Per cent Inhibitory effects (over control) of aqueous leaf extract concentration of *M. azedarach* on germination, GRI, growth and biomass of green gram and black chickpea

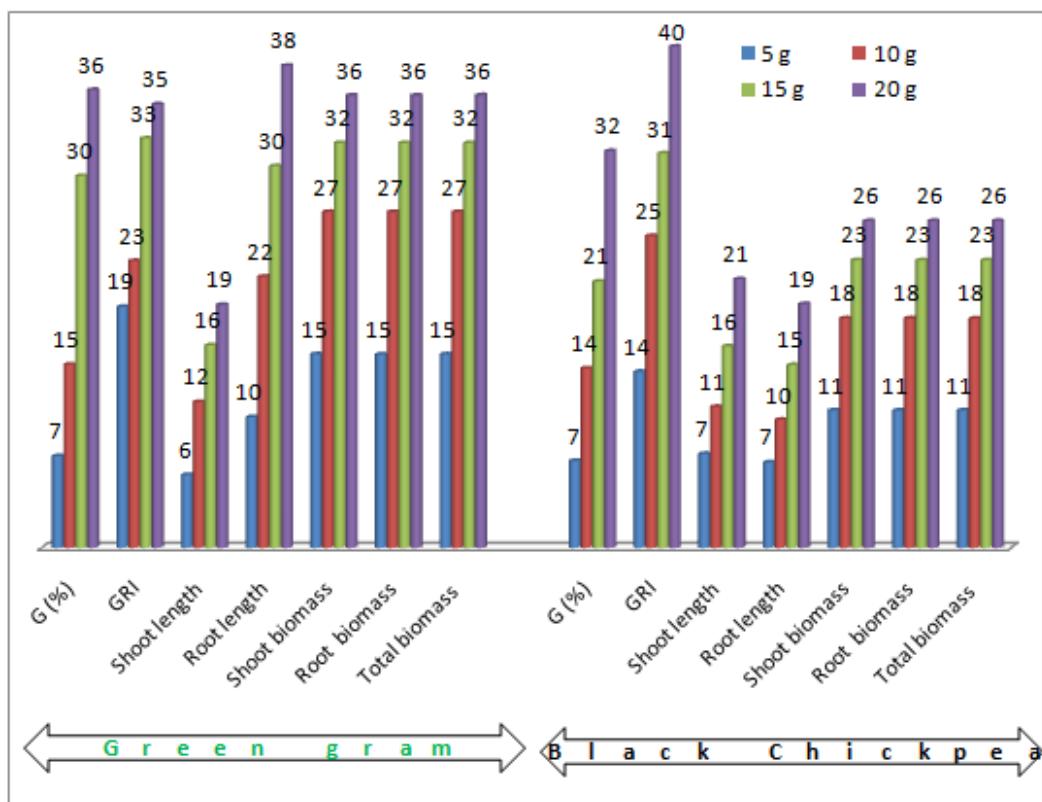


Fig.5 Showing the uniform crop growth of green gram (a) and black chickpea (b) at maturity against *M. azedarach* leaf litter application



A



B

The present study evinced that the magnitude of inhibition on germination traits, initial growth and biomass increased with incremental extract intensity. Similar concentration depended inhibitory effects are reported by Phuwiwat *et al.*, (2012) and Akacha *et al.*, (2013), while examining the effect of aqueous leaf extracts of *M. azedarach* on *Echinochloa crusgalli* and radish, respectively. Similar results have also been reported by Singh *et al.*, (2014) and Aslani *et al.*, (2014) on various pulse crops against leachates of other tree species.

The results of the present study show that per cent inhibitory effect of aqueous leaf extract and leaf litter was more pronounced on initial root growth as compared to shoot growth. Similar organ specific effects of *M. azedarach* leaf aqueous extracts have been reported by Phuwiwat *et al.*, (2012) on *E. crusgalli* and Akacha *et al.*, (2013) on radish against leaf

leachates of *M. azedarach*, in laboratory bioassays. Shapla *et al.*, (2011) have reported inhibitory effect of *M. azedarach* mulch on germination, initial growth and biomass of mung bean in pot culture experiments. The roots first come in contact with allelochemicals (Rezaeinodehi *et al.*, 2006) and are the first to absorb them from the environment in which they are growing (Kimber, 1973). This may also be attributed to the fact that, cell death and tissue browning frequently occur in the root apical zone, an area with active cell division, when roots are exposed to allelopathic agents (Ding *et al.*, 2007). Similar to present findings, several studies have shown that young seedlings, especially the roots, are more sensitive to allelopathic agents than adult plants or other plant organs (Zhang *et al.*, 2010). The leaf leachates hamper the physiological processes of the seedlings growing in such environment. Akacha *et al.*, (2013) reported that *M.*

azedarach allelochemicals produce an imbalance in the oxidative status of cells and they observed changes in activity of catalase (CAT), ascorbate peroxidase (APX), guaiacol peroxidase (GPX) as well as in the levels of H₂O₂ and assimilatory pigments. There were changes in membrane lipid peroxidation and electrolytes leakage in radish seedlings. Water uptake and α -amylase activity is inhibited by aqueous extracts and water soluble allelochemicals cause inhibition during germination process compared to control (Phuwiwat *et al.*, 2012). Most seeds require adequate moisture level for activation of metabolism within seed (Chong *et al.*, 2002). However, seed which exhibit inhibited water uptake may be limited in specific enzymes required for metabolism of reserved food and hence exhibited poor seed germination. Germination inhibition is the result of induction of oxidative stress also (Javed, 2011). All these findings may be ascribed to the inhibitory effect of *M. azedarach* aqueous extracts on seed germination of green gram and black chick pea in our study.

Allelochemicals decrease stomatal conductance by inducing ABA production, which indirectly impacts on the rates of photosynthesis and transpiration (Akacha *et al.*, 2013), decrease respiration and uncoupling oxidative phosphorylation (Abrahim *et al.*, 2003). Multiple physiological effects have commonly been observed from treatments with many phenolics. These effects include reduction in plant growth, absorption of water and mineral nutrients, ion uptake, leaf water potential, shoot turgor pressure, physiological drought and osmotic potential (Barkosky and Einhellig, 2003; Rezaeinodehi *et al.*, 2006) and are attributed to inhibitory effects on germination and growth. Addition or incorporation of plant residues into the growth environment of another plant can result in germination and growth inhibition (Al-Khatib *et al.*, 1997). Some authors

reported that adding of leachates and plant debris to the growing medium may deplete nitrogen (Harper, 1977) and cause inhibitory effects. These evidences may be attributed to reduced growth and biomass traits of both the test crops against leaf litter of *M. azedarach* in our study.

Despite validation of alleged allelochemicals in *M. azedarach* through GC-MS analysis. There was no significant allelopathic effects of different leaf litter applications (5, 10, 15 and 20 g/pot) on growth, biomass and grain yield both the test crops (Table 4, Fig. 5). However, Shapla *et al.*, (2011) reported that *M. azedarach* mulch application @ 20 gm/pot inhibited the growth and biomass of mung bean and soybean. Similar adverse effect of leaf mulch of several tree species have been reported on various pulses used as test crops (Sale and Oyun, 2013; Thakur, 2014).

These studies have reported inhibitory effect only up to a month or so. However, the present study reports the results of growth, biomass and grain yield of test crops till maturity. Similar initial allelopathic effects on germination and growth and no such significant effects against leaf litter of *Melia composita* on black gram have been reported by Dinesh Kumar *et al.*, (2017). This may be attributed to faster mulch decomposition, leaching out of allelochemicals due to frequent irrigation done to maintain the moisture in the pots, ephemeral nature of allelochemicals present in leaf litter of donor species especially phenolics. Hossain *et al.*, (2011) have reported faster decomposition rate of leaf litter of *M. azedarach* compared to other tree species. Phytotoxicity due to crop residue disappears quickly upon decomposition (Burnsid *et al.*, 1985). In addition, the phytotoxic effect due to leaf mulch addition is less under field condition as the phytotoxic compound degrade faster in the field than in the laboratory (Tian, 1992).

Further, it is observed that highest concentrations of allelochemicals are near the soil surfaces and are more rapidly lost in the soil through volatilization (Chen *et al.*, 1991). Allelopathic or phytotoxic compounds are known to be mainly phenolic acids (Glass 1976) and these phenolic compounds degrade with decomposition of plants residues, resulting in the alleviation of phytotoxicity of the decomposing plant residues (Ampofo, 2009). It is advocated that addition of readily decomposable organic matter of wide C:N ratio to soil, enhances the microbial activity leading to nitrogen immobilization, thereby depressing the plant growth (Harper, 1977), however, watering and addition of nitrogen, overcome such growth decreases (Narwal *et al.*, 2011). Management practices like frequent watering resulted in faster decomposition of leaf mulch of *M. azedarach*, hence did not exhibited any significant inhibitory effect on growth, yield and dry matter production of pulse crops in present study. The mulch used in the present study was crushed and reduced in size before application, which might have resulted in quick decomposition, thus alleviating the allelochemicals. Similar conclusions have also been drawn in earlier studies (Ampofo 2009). These evidences may be attributed to non-significant effect of mulch treatments of *M. azedarach* on growth, biomass and grain yield of tested pulse crops in the present study.

The GC-MS analysis revealed that leaf litter of *M. azedarach* contain phenolic acids and their derivatives which have inhibitory effect on germination and growth of test crops. Laboratory bioassay and pot culture studies revealed that detected allelochemicals have putative inhibitive potential on seed germination, initial growth and biomass of green gram and black chick pea. However, pot culture studies, carried out to examine the effect of leaf litter underpinned that, different litter treatments did not show any significant

allelopathic effects on growth, biomass and grain yield of test crops. Thus, the phytotoxic compounds in leaves litter of *M. azedarach* are of ephemeral in nature and their effect got alleviated over of the time.

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