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Allelopathic effects of *Flemingia semialata* Roxb. on seedling growth of maize (*Zea mays* L.) and rice (*Oryza sativa* L.)

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ABSTRACT

We studied the allelopathic effects of *Flemingia semialata* Roxb. leaf aqueous extracts in laboratory bioassays and in pot experiments on the growth of maize (*Zea mays* L.) and rice (*Oryza sativa* L.). The leaf aqueous extracts stimulated growth and yield of maize but was inhibitory to rice. The 100 % concentration of extract was most inhibitory to the growth and biomass of rice. On the contrary, the extracts stimulated the growth and biomass of maize at all test concentration. Gas chromatography-mass spectrometry (GC-MS) analysis of *F. semialata* leaf litter revealed the presence of alkaloids, phenols, terpenoids, unsaturated fatty acids and many others compounds. The compounds detected in methanol extracts were : 2-Isopropyl-5-methylcyclohexyl 3-(1-(4-chlorophenyl)-3-oxobutyl)-C (38.36, %), in petroleum ether extracts major compound was : 2R-acetoxymethyl-1,3,3-trimethyl-4T-(3-methyl-2-buten-1-yl)-1T-cyclohexanol (24.04 %) and in chloroform extract major compound was : Z-2-Octadecen-1-ol (36.74 %). Allelopathic effects of extracts from the leaf of *F. semialata* may be due to the presence of above compounds identified by GC-MS analysis.

Key words: Allelochemicals, aqueous, chloroform extracts, *Flemingia semialata*, GC-MS, Lab. bioassay, leaf litter, maize, methanol extract, *Oryza sativa*, petroleum ether extracts, pot culture, rice, *Zea mays*.

INTRODUCTION

Allelopathy is the negative/positive effects of chemicals release by one plant species on the growth and reproduction of another plant (1). These allelochemicals are present in all parts of the plant (leaf, flower, bark, root etc.) in varying concentrations, however, leaves are richest in allelochemicals (14,27) and are inhibitory to other plants (32). They are released by root exudation, leaching, volatilization and plant biomass decomposition. These allelochemicals affects the seed germination and seedlings growth (15) and reduced the yields in many plants species (1). Bioassays using leaf extracts are done to determine the allelopathic effects of plants (13,31). The inhibitory role of allelochemicals slows down the important physiological and metabolic processes in affected plants. Contrarily, some allelochemicals at low concentration promotes the plants growth and resistance to several biotic stresses (9). However, relatively few studies have been done to investigate the effects of allelochemicals on growth promotion. The GC-MS analysis identifies various classes of allelochemicals (steroids, terpenes, terpenoids, fatty acids and their esters, alcoholic and phenolic compounds, esters, flavanoids, hydrocarbons, coumarins and ketones). These chemicals when released from the plants are inhibitory to

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germination and seedling growth of plants (12,24). These phytochemicals have antifungal, antibacterial, anti-tumor, antimicrobial and allelopathic properties (6,41). *Flemingia semialata* Roxb. (family Fabaceae) is a legume shrub with symbiotic nitrogen fixing ability, conserves soil and water and thus used as hedge in Jhum and Alley cropping (34). It is deep rooted, hence, withstand long drought and submergence and also used in lac production (10). The plant is still under-utilized; hence, this may be introduced as intercrop in areas of shifting cultivation (Photograph 1).

Photograph 1. *Flemingia semialata* and its inflorescene.

Many tree species have negative allelopathic effects on the crops growth, when grown together (33). Likewise, leguminous tree species (*Leucaena leucocephala* and *Acacia* species) are allelopathic to crops when grown together (4,30). Due to limited information on the use of *F. semialata* in homegardens and other land use systems, this study was done to determine its allelopathic effects on maize and rice, major crops in the region.

MATERIALS AND METHODS

The studies were conducted from June- November, 2017 in Mizoram University, Tanhril, Aizawl (23° 44`N, 92° 39`E, 775 m above sea level). Freshly fallen leaves of *F. semialata* were collected during February and March, 2017 at seeds maturity from its plantation site and air dried for one week at room temperature. *F. semialata* flowers in the months of August to September and seeds matured in the next year during February and March. The air dried leaves were cut into smaller pieces and grinded into fine powder using grinding machine. Leaf extracts were prepared by adding 100 g powdered leaf in 1.0 L distilled water and soaked for 24 h at room temperature (25±2 °C). The resultant extract was filtered using Whatman filter paper No. 1 and 25,50,75 and 100 % concentrations were made with distilled water from the stock solution. The distilled water was used as control for Lab. bioassay. While tap water was used as control in pot experiment. The extracts were stored at 4 °C in refrigerator until further use. The experiments include five

treatments (0 %, 25 %, 50 %, 75 %, 100 %) including distilled/tap water as control. The treatments were replicated thrice in completely randomized design (CRD).

GC-MS Analysis

For this, fresh leaves of *F. semialata* were collected from the standing trees and air dried for one week. The dry leaves were chopped into smaller pieces and stored in air tied polythene bags till their extraction. The chopped leaves 250g/500ml (w/v) were put inside thimble in Soxhlet apparatus. The solvents (Methanol, Petroleum ether and Chloroform) were poured inside the thimble up to the level of siphon tube to avoid flowing out of solvents into the receiving flask. Compounds present in the leaf samples were extracted by distillation. The filtered supernatant was again condensed by rotary evaporation, then freeze dried and stored for GC-MS analysis.

Laboratory Bioassays

Test crops seeds were surface sterilized with sodium hypochlorite (1 %) to prevent fungus infection and then washed again in running tap water. Each petri dish (10 cms Dia) were sterilized in oven at 60 °C for 24 h and lined with Whatman filter paper No. 1 and moistened with 1 mL extract of different concentrations on alternate days as per treatments. Twenty seeds of maize or rice were sown equidistant on top of moistened filter paper and placed in laboratory at 25±2 °C. After 20 days, the shoot and root length, fresh and dry weight of test cops were measured and recorded (Photograph 2). For dry weight, the fresh roots and shoots were wrapped in aluminum foil and dried in oven at 60 °C for 24 h.

The % inhibition/stimulation effects on germination over control for both bioassays and pot experiment were calculated as under (37):

$$I = 100 - (E_2 \times 100/E_1),$$

Where I: Percentage inhibition/stimulation, E_1: Response of control and E_2: Response of treatment. Elongation ratio of roots and shoots were also calculated as under (28):

$$R = (T/Tr) \times 100$$

Where R : Relative elongation ratio, T : Ratio of treatment crop and Tr : Ratio of control crop.

Photograph 2. Bioassays experiment of *F. semialata* leaf extracts on rice and maize.

Pot culture

Ten sterilized seeds of rice and maize crops were sown 2-3 cm deep in poly-pots (26 cm x 20 cm with 24 cm depth and 8 kg of soil) kept in greenhouse at 29±2 °C. The poly-pot were irrigated with 150 ml extract or distilled water as per treatments on alternate days till 90 days. At two leaf stage, thinning was done and one seedling was kept per pot (Photograph 3). After 90 days, the seedlings were carefully uprooted from the poly-pots, washed with tap water to remove adhering soil. The shoot and root lengths and fresh weight were recorded. To determine dry weight, the plants were wrapped in aluminum foil and dried in oven at 60 °C for 24 h.

Photograph 3. Poly-pot experiment of *F. semialata* leaf extracts on rice and maize.

GC-MS analysis

Solvent extraction was done using three solvents viz., methanol, chloroform and petroleum ether. Fresh leaves from *F. semialata* were collected and air dried for one week. The dried leaves were chopped into small pieces and extracted using the solvents in Soxhlet apparatus to obtain the chemical compounds present in leaves. The aliquot samples were kept in plastic centrifuge tube vial and sent to VIT-SIF Lab, SAS, Chemistry Division for NMR and GC-MS Analysis in VIT University, Vellore.

The Clarus 680 GC was used in the analysis employed a fused silica column, packed with Elite-5MS (5 % biphenyl 95 % dimethylpolysiloxane, 30 m × 0.25 mm ID × 250 μm df) and the components were separated using Helium as carrier gas at a constant flow of 1 ml/min. The injector temperature was set at 260 °C during the chromatographic run. The 1 μL of extract sample was injected into the instrument and the oven temperature was as under : 60 °C (2 min); followed by 300 °C at the rate of 10 °C min^{-1}; and 300 °C, where it was held for 6 min. The mass detector conditions were: transfer line temperature 240 °C; ion source temperature 240 °C; and ionization mode electron impact at 70 eV, a scan time 0.2 sec and scan interval of 0.1 sec. The fragments from 40 to 600 Da. The spectrums of the components were compared with the Database of spectrum of known components stored in the GC-MS NIST (2008) library.

Statistical analysis

Data were subjected to one-way analysis of variance (ANOVA). Based on the outcome of ANOVA, LSD at 5% level of significance was calculated to separate the means. The statistical analysis was done using SAS version 9.2 software.

RESULTS AND DISCUSSION

Bioassays

The 75 % concentration of extract proved most stimulatory to root (+85.69) and shoot (+75.78) length of maize. The 25 and 50 % extracts also stimulated the root length and shoot length than control (Figure 1). This finding is in accord with other findings, where the shoot heights of cowpea was concentration dependent with *T. diversifolia* aqueous shoot extracts (23). The allelochemicals from sunflower and sorghum also stimulates the germination and seedling growth of rice (21) and the stimulatory effects of aqueous leaf extracts of *Pentaclethra macrophylla* on plant height of maize and okra (25).

In contrast, *F. semialata* aqueous extracts were inhibitory to root and shoot length of rice and the inhibitory effect increased with increase in the concentration of extracts. The 100 % extract concentration was most inhibitory to root (-27.67 %) and shoot length (-51.73 %) (Figure 2). This finding also confirm to other findings, where aqueous leaf extracts of *Citrus reticulata* inhibits the root and shoot length of soybean, maize, paddy, chilli and lady's finger (29) and leaf extracts of *Trevesia palmata* inhibits the root and shoot length of maize and french bean (17). Likewise, the litter leachate of *Excoecaria agallocha* inhibits the germination, root and shoot length, dry matter and vigour index of rice with increase in extracts concentration (7) and the root and aerial parts of *E. colona* extracts inhibits the seedlings growth of rice and soybean (5).

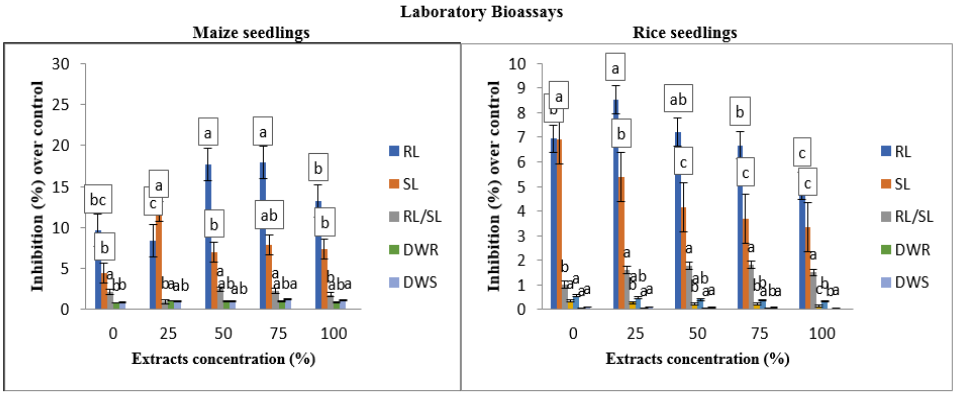

Figure 1. Effects of *F. semialata* leaf extract in Lab. bioassay on maize seedlings growth. (RL: Root length, SL: Shoot length, RL/SL: Root length/shoot length, ratio, DWR: Dry weight root, DWS: Dry weight shoot). Superscripts (a,b,c,ab,bc) indicates significant difference between extract concentrations.

Figure 2. Effects of *F. semialata* leaf extract in Lab. bioassay on rice seedlings growth. (RL: Root length, SL: Shoot length, RL/SL: Root length/shoot length ratio, DWR: Dry weight root, DWS: Dry weight shoot). Superscripts (a,b,c,ab) indicates significant difference between extract concentrations.

The dry weight of root and shoot showed the stimulatory effects of *F. semialata* aqueous extracts on maize and was concentration dependent (Figure 1). However, these aqueous extracts inhibited the dry biomass in rice, where inhibitory effects increased with increase in extracts concentration. Higher concentrations of allelochemicals might inhibit the seed germination by suppressing the synthesis of gibberellins and indole acetic acid (20). Highest inhibitory effect on dry biomass was observed in 100 % extract concentration. This finding agrees with other findings, where the root and shoot biomass

of maize decreases with increase in the concentration of *Schima walichi* leaf extracts (18). The stimulatory effects on the biomass of maize is in agreement with other findings, where the neem leaf extracts significantly stimulates the root growth of wild oats (4) and the aqueous leaf extracts of *P. macrophylla* increases the seedling dry weight of maize and okra (25). The leaf and stem extracts of *Ludwigia adscendens* L. inhibited the dry weight of rice (22) (Figure 2), this may be due to greater sensitivity of smaller seeds of rice to allelochemicals (40). The reduction in biomass may be because the leaf extract stunted and reduces the seedlings growth (38).

Pot experiments

The higher concentration of extracts were stimulatory than control (Figure 3). Highest root (5.17 cm) and shoot (3.29 cm) length were found at 100 % extract concentration. The root and shoot length of maize was concentration dependent on leaf extracts. Maximum root (114.52 %) and shoot (14.63 %) elongation ratio was observed at 100 % concentration. However, the aqueous extract did not influence the root and shoot length of rice than control. Aqueous extract at 50% concentration significantly decreased the root length (41 %) of rice than control (Figure 4). Maximum root (84.65 %) and shoot (104.8 %) elongation ratio was observed in 100 % and 75 % concentrations, respectively. The stimulatory effects on the root and shoot length of maize conform to other finding, where aqueous extract of *Portulaca oleracea* L. stimulates the seed germination and seedling growth of *Sorghum vulgare* Pers (8).

The inhibitory effects of *F. semialata* aqueous extracts on root length of rice in this study was also at par with other findings, where aqueous leaf extracts of teak and subabul inhibits the radicle extension of maize (30). The decrease in the root length compared to shoot length, when treated with extracts may be due to early exposure of radicle to plants extracts as compared to plumule during seed germination (2). The root and shoot biomass of maize was concentration dependent on leaf extracts. The root and shoot biomass was maximum at 75 % and 100% and minimum in 25 % aqueous extract than control (Figure 4). The inhibitory effects on rice and stimulatory effects on maize in bioassay showed a positive correlation ($p < 0.05$) with pot experiments.

GC-MS Analysis of leaf extracts

Using the gas chromatography mass-spectrometry (GCMS), 38-types of compounds were detected from methanol, chloroform and petroleum ether extract in leaf litter samples used for bioassay and pot culture experiments (Table 1). These chemical compounds were from 7-Chemical classes: Terpenoids, Phenols, Alkaloids, Flavonoids, Saturated fatty Acids, Steroids, Esters and coumarin (Table 2). Terpenoids were found in all three solvents leaf extracts and their concentration was higher than other bioactive compounds. Two terpenoids (Phytol and squalene) were also found in both methanol and petroleum ether extracts. These compounds followed the order: alkaloids> phenols> fatty acids> esters> steroids> flavanoids (Table 1). The inhibitory compounds in *F. semialata* leaf extracts were: 2-Isopropyl-5-methylcyclohexyl 3-(1-(4-chlorophenyl)-3-oxobutyl)-C, hexadecanoic acid, oleic acid and pentadecanoid acid, which were also found in leaf extracts of *Cassia alata* (36).

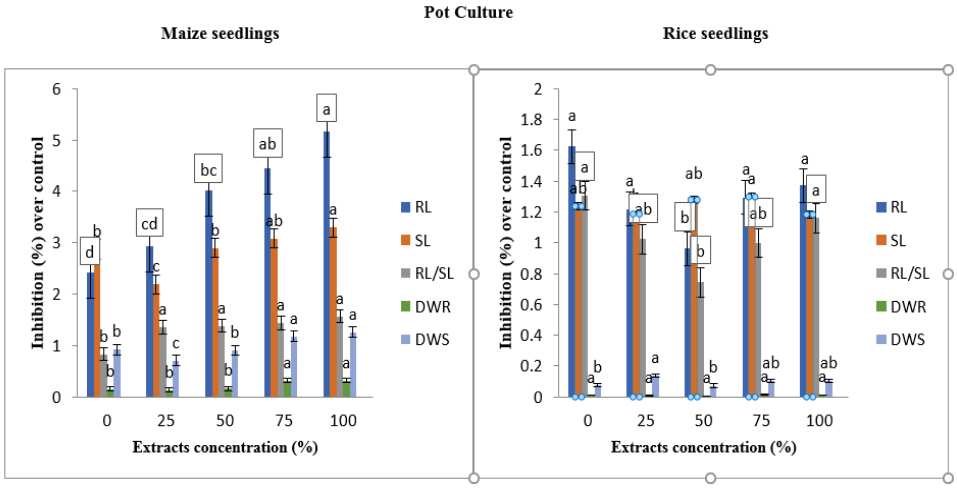

Figure 3. Effects of *F. semialata* leaf extract in pot culture on maize seedlings growth. (RL: Root length, SL: Shoot length, RL/SL: Root length/shoot length, ratio, DWR: Dry weight root, DWS: Dry weight shoot). Superscripts (a,b,c,d, ab,bc,cd) indicates significant difference between extract concentrations.

Figure 4. Effects of *F. semialata* leaf extract in pot culture on rice seedlings growth. (RL: Root length, SL: Shoot length, RL/SL: Root length/shoot length ratio, DWR: Dry weight root, DWS: Dry weight shoot). Superscripts (a,b,ab) indicates significant difference between extract concentrations.

(i). Methanol extract: The highest percentage was of 2-Isopropyl-5-methylcyclohexyl 3-(1-(4-chlorophenyl)-3-oxobutyl)-C (38.36 %).
(ii). Petroleum ether extract: The highest % was of 2R-acetoxymethyl-1,3,3-trimethyl -4T-(3-methyl-2-buten-1-yl)-1T-cyclohexanol (24.04 %).
(iii). Chloroform extract: The Z-2-Octadecen-1-ol was in highest concentration (36.74 %). Different fatty acids (hexadecanoic acid, formic acid, hexanodioic acid, octadecanoid acid) are also present in *C. equisetifolia*, which were allelopathic (42). The inhibitory effects in this study could be correlated with presence of fatty acids in the leaf extracts. The inhibitory flavanoids 7-Hydroxy-3-(1,1-dimethylprop-2-enyl), Coumarin in leaf extract confirms to other study in which leaf extract of *A. auriculiformis* inhibited the germination of some crops (3). The phenolic compounds present in the leaf extracts inhibits the root elongation, cell division, changes in ultra-cell structure and interfere with the growth and development of whole plant (16).

In the present study, inhibitory effects of *F. semialata* aqueous leaf extracts on the crops may be due to the presence of Phenol 2,4-Bis(1,1-Dimethylethyl). This confirms to other findings, where the leaf extracts of *Dicranopteris dichotoma* were inhibitory to *Bidens pilosa* and *Eupatorium catarium* due to the presence of same compound i.e. Phenol 2,4-Bis(1,1-Dimethylethyl) (11). Other inhibitory effects of Phenol 2,4-Bis(1,1-Dimethylethyl) were reported in rice, lettuce and barnyard grass, where, rice shows highest inhibition (26). The presence of Phenol 2,4-Bis(1,1-Dimethylethyl) was also reported in *Rehmannia glutinosa* and *C. equisetifolia* that affects the *Sesamum indicum*, *V. mangachapoi*, *T. lampas* and *C. inophyllum* (19,39,42). The presence of high amount of coumarin compounds [2-Isopropyl-5-methylcyclohexyl 3-(1-(4-chlorophenyl)-3-oxobutyl)-C] in methanol extracts may also inhibit the growth of test crops. This compound is antimicrobial and inhibits the enzyme activity and plants growth. The high

Table 1. Chemical compounds, retention time, peak height, molecular weight, chemical formula and area under curve detected in (GC-MS) analysis of *F. semialata* leaves from different solvent extracts.

S. No.	RT	Compound name	Peak Height	Area (%)	Mol. Weight	Chemical formula
		Solvent : Methanol				
1	17.489	Phytol	20,693,860	9.636	296	$C_{20}H_{40}O$
2	17.899	3,7,11,15-Tetramethyl-2-Hexadecene-1-ol	11,674,422	4.249	296	$C_{20}H_{40}O$
3	25.012	Oleic acid	6,920,550	1.603	282	$C_{18}H_{34}O_2$
4	25.512	Pentadecanoid acid	9,345,512	2.639	242	$C_{15}H_{30}O_2$
5	26.078	T-Butyl Cyclopentaneperoxycarboxylate	14,323,848	9.366	186	$C_{10}H_{18}O_3$
6	26.528	1,6;3,4-Dianhydro-2-Deoxy-Beta-D-Lyxo-	15,198,562	5.528	128	$C_6H_8O_3$
7	26.943	2,6-Pyrazinediamine	17,994,224	13.827	110	$C_4H_6N_4$
8	27.303	14-Heptadecenal	11,707,493	2.27	252	$C_{17}H_{32}O$
9	27.433	Pentanoic acid, 2-(Aminooxy)-	10,975,939	3.428	133	$C_5H_{11}O_3N$
10	27.853	7-Hydroxy-3-(1,1-Dimethylprop-2 Enyl)Coumarin	15,666,573	5.456	230	$C_{14}H_{14}O_3$
11	28.093	N-(5-Chloro-2-Hydroxyphenyl)Dodecanamide	8,931,113	1.854	325	$C_{18}H_{28}O_2NCl$
12	29.514	2-Isopropyl-5-Mehtylcyclohexyl 3-(1-(4-Chlorophenyl)-3-Oxobutyl)-C	53,121,816	38.36	524	$C_{30}H_{33}O_6Cl$
13	30.329	Stigmastan-6,22-Dien, 3,5-Dedihydro-	9,356,690	1.784	394	$C_{29}H_{46}$
		Solvent : Petroleum Ether				
14	16.964	3,7,11,15-Tetramethyl-2-Hexadecene-1ol	56,250,304	3.693	296	$C_{20}H_{40}O$
15	24.077	Squalene	898,596,54	16.862	410	$C_{30}H_{50}$
16	24.442	Octadecanoic acid, 9,10-Epoxy-,Isopropyl ester	90,926,888	2.653	340	$C_{21}H_{40}O_3$
17	24.587	Cyclohexanol,4-Ethyl-4-Methyl-3-(1-Methylethyl),(1.Alpha.,3.Beta.,4.Alpha.)-	97,398,128	2.497	184	$C_{12}H_{24}O$
18	25.833	Sulfurous acid, Octadecyl 2-Propyl ester	122,770,224	1.588	376	$C_{21}H_{44}O_3S$
19	26.393	Vitamine E	369,778,832	23.551	430	$C_{29}H_{50}O_2$
20	28.284	4,4,6A,6B,8A,11,11,14B-Octamethyl 1,4,4A,5,6,6A,6B,7,8,8A,9,10,11,12,12A,14,14A,	171,778,832	5.685	424	$C_{30}H_{48}O$
21	28.689	2R-Acetoxymethyl-1,3,3-Trimethyl-4T-(3-Methyl-2-Buten-1-yl)-1T-Cyclohexanol	507,688,032	24.04	282	$C_{17}H_{30}O_3$
22	28.889	9,19-Cyclolanost-24-en-3-ol, Acetate, (3.Beta.)-	189,876,656	9.523	468	$C_{32}H_{52}O_2$
23	29.134	9,19-Cycloergost-24-(28)-en-3-ol,4,14-Dimethyl-,Acetate,(3.Beta.,4.Alpha.,5.Alpha.)-	56,440,372	3.397	468	$C_{32}H_{52}O_2$
24	29304	2,4,4-Trimethyl-3-Hydroxymethyl-5A-(3-Methyl-But-2-enyl)-Cyclohexene	49,038,372	2.373	222	$C_{15}H_{26}O$
25	30.364	7-Dehydrocholesteryl Isocaproate	52,383,040	4.138	482	$C_{33}H_{54}O_2$
		Solvent : Chloroform				
26	14.698	Phenol,2,4-Bis(1,1-Dimethylethyl)-	16,535,517	2.244	206	$C_{14}H_{22}O$
27	15.323	4-Trifluoromethylbenzoic acid,Octadecyl ester	20,241,120	2.811	442	$C_{26}H_{41}O_2F_3$
28	16.739	Z-2-Octadecen-1-ol	261,607,456	36.739	268	$C_{18}H_{36}O$
29	17.064	3,7,11,15-Tetramethyl-2-Hexadecen-1-ol	102,491,672	10.923	296	$C_{20}H_{40}O$
30	17.299	Phytol	114,568,856	21.472	296	$C_{20}H_{40}O$
31	18.45	N-Tetracosanol-1	51,128,940	5.046	354	$C_{24}H_{50}O$
32	19.99	1-Eicosanol	52,637,084	4.376	298	$C_{20}H_{42}O$
33	21.426	1-Hexacosanol	53,467,209	2.92	382	$C_{26}H_{54}O$
34	22.821	1-Docosene	38,238,264	1.552	308	$C_{22}H_{44}$
35	24.267	Squalene	51,063,476	1.503	410	$C_{30}H_{50}$
36	26.528	Cholesta-8,24-Dien-3-ol,4-Methyl-,(3.Beta.,4.Alpha.)-	36,144,160	2.07	398	$C_{28}H_{46}O$
37	26.673	2,4-Dimethyl-7-oxo-4,7-Dihydro-Triazolo(3,2-C)Triazine	45,77,240	5.687	165	$C_6H_7ON_5$
38	30.464	2H-Ideno[1,2-B]Furan-2-one,3,3A,4,5,6,7,8,8B-Octahydro-8,8-Dimethyl	39,988,204	2.658	206	$C_{13}H_{18}O_2$

amount of sesquiterpenoid 2R-acetoxymethyl -1, 3, 3-trimethyl-4T -(3-methyl-2-buten-1-yl) -1T-cyclohexanol in Petroleum ether extract might have caused inhibitory effects in present study. Alkaloids also have inhibitory effects on some agricultural crops. Alkaloids 2,6-Pyrazinediamine found in the leaf extracts inhibits the synthesis of ethylene in *Arabidopsis thaliana*, thereby, suppressing the growth and root hair development (35).

Table 2. Chemical classes of Compounds detected in leaves of *F. semialata* leaves using different solvent extracts.

Chemical Class	Numbers	Chemical Compounds
Terpenoids	9	(phytol, 3,7,11,15-tetramethyl-2-hexadecene-1-ol, stigmastan-6,22-dien,3,5-dedihydro-, squalene, 2R-acetoxymethyl-1,3,3-trimethyl-4T-(3-methyl-2-buten-1-yl)-1T-cyclohexanol, 9,19-cyclolanost-24-en-3-ol,Acetate,(3.Beta.)-, 9,19-cycloergost-24-(28)-en-3-ol,4,14-dimehtyl-acetate(3.Beta., 4.Alpha., 5.Alpha.), Z-2-Octadecen-1-ol and 2H-Idenol[1,2-B]Furan-2-one,3,3A,4,5,6,7,8,8B-Octahydro-8,8-dimethyl)
Phenols	6	(14-heptadecenal, 2,4,4-trimethyl-3-hydroxymethyl-5A-(3-methyl-but-2-enyl)-Cyclohexene, N-tetracosanol-1, 1-Eicosanol,1-Hexacosanol and Phenol2,4-Bis(1,1-Dimethylethyl)-)
Alkaloids	3	(2,6-Pyrazinediamine, Vitamin E and 2,4-Dimethyl-7-oxo-4,7-dihydro-triazolo(3,2-C)Triazine)
Flavonoids	1	(7-Hydroxy-3-(1,1-dimethylprop-2-enyl)
Saturated Fatty Acids	4	(Oleic acid, pentadecanoic acid, T-butylcyclopentaneperoxy-carboxylate and pentanoic acid)
Steriods	2	(7-dehydrocholestryl Isocaproate and Cholesta-8,24-dien-3-ol,4-methyl-,(3.Beta.,4.Alpha.)
Esters	3	(Octadecanoic acid, 9,10-Epoxy-,Isopropyl ester, Sulfurous acid,Octadecyl 2-propyl ester and 4-trifluoromethylbenzoic acid, Octadecyl ester)
Coumarin	1	(2-Isopropyl-5-methylcyclohexyl 3-(1-(4-chlorophenyl)-3-oxobutyl)-C)

It is clear from the results, that the presence of different allelochemicals in the leaf extracts inhibited the growth and development of crops. The presence of Phenol 2,4-Bis(1,1-Dimethylethyl) although in less amount but has inhibitory effects on crops.

CONCLUSIONS

The allelochemicals in *F. semialata* leaf extracts were both stimulatory and inhibitory to seedlings growth of maize and rice. The inhibitory/stimulatory responses to allelochemicals varied with test crops. The stimulatory effects of *F. semialata* on maize suggested that *F. semialata* can be intercropped with maize in agroforestry systems. However, further investigation on the effects of individual chemical compounds on the growth and development of crops needs to be studied to find the most potent compound, which may lead to the development of bio-pesticide and to assess its effect on other agricultural crops in various land use systems.

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