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Allelopathic potential of mangrove species *Excoecaria agallocha L.*on growth responses of some agricultural crops

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Excoecaria agallocha L. also known as milky mangrove and 'Blind-Your-Eyes'-belonging to Euphorbiaceae family commonly grown in the mangrove forest of Pitchavaram, Tamil Nadu,south India was tested for its allelopathic potential against seed germination and early seedling growth of green gram (Vigna radiata (L.)R. Wilczek.),Black gram (Vigna mungo (L.)Hepper),groundnut (Arachis hypogaea L.), pearlmillet (Pennisetum typhoides St.& Hub.) and fingermillet (Eleusine coracana Gaertn.).Green house experimental studies were conducted in plastic pot with normal field soil for the evaluation of germination and growth attributes of crop plants by applying various concentrations (2,5,10,15,20 and 25%) of leaf extracts of E.agallocha. The results showed that the germination percentage was gradually decreased, seedling lengths also affected in all the five crops from lower concentration to higher concentrations of leaf extracts. The fresh and dry weights, Chlorophyll, aminoacid and protein contents of crop sesedlings were decreasing with increasing concentration of leaf extracts.The inhibitory effect was concentration dependent.The results clearly indicated that the leaf extracts of E. agallocha exhibited strong inhibitory effects on the germination and growth parameters of millets than pulses.

KeyWords: Allelopathy,*Excoecaria agallocha*,greengram,blackgram,groundnut, pearlmillet,fingermillet.

INTRODUCTION

Allelopathy is an important mechanism of plant interference by the addition of plant-produced phytotoxins to the plant environment. Many of the phytotoxic substances suspected of causing germination and growth inhibition have been identified from plant tissues and soil.These substances are termed allelo chemics or allelochemicals (Whittaker and Fenney, 1971).

Plants produce a large variety of secondary metabolites like phenols, tannins, terpenoids, alkaloids, polyacetylenes, fatty acids and steroids, which have an allelopathic effect on the growth and development of the same plant or neighbouring plants. Considerable knowledge has been obtained concerning the chemicals involved in allelopathy (Narwal, 1994).Patrick *et al.*,(1963) reported that depending on the decomposing conditions, substances of plant parts are highly toxic and nontoxic or stimulatory to other plant growth.

Plant parts like roots, rhizomes, stems; leaves, flowers/inflorescence, pollens, fruits and seeds are known to contain allelochemicals (Rice,1984). Evidence for allelopathy has accumulated in the literature over many years and many kinds of alleochemicals have been identified, isolated and characterized from various plants,(Putnum,1988;Gross,1994;Seligler,1996;Oyun,2006; Bouchagier *etal*, 2008; Borella and Lindamir,2009 and Swapnal and siddique,2010).

Allelopathy includes both promoting and inhibitory activities and is a concentration dependent phenomenon (Daniel,1999).Rajangam (1986),reported that the aqueous extracts of mangrove species *Avicennia marina* influenced on germination and growth of paddy.Rajangam and Arumugam recorded the inhibitory effects of *Excoecaria agallocha* plant extracts on rice seedlings. Li Jing *et al.,(*2010) reported that *Sonneratia apetala* potentially control *Spartina alterniflora* a weed by using allelopathy as a tool. However, the little information is available concerning the allelopathic studies in mangrove species with crop plants. Hence the present investigation has been aimed to evaluate the allelopathic potential of *Excoecaria agallocha* L. a mangrove species of Pitchavaram on growth and development of green gram (*Vigna radiata*

(L.)R.Wilczek.),Black gram (*Vigna mungo* (L.)Hepper),groundnut (*Arachis hypogaea L.*), pearlmillet (*Pennisetum typhoides* St.& Hub.) and fingermillet (*Eleusine coracana Gaertn*.). *Excoecaria agallocha* L. belonging to Euphorbiaceae family also known as milky mangrove, blind-your-eye mangrove and river poison tree, is poisonous. Contact with skin can cause irritation and rapid blistering; contact with eyes will result in temporary blindness.

MATERIALS AND METHODS

Matured and fresh leaves of *Excoecaria agallocha L.* collected from Pitchavaram mangrove forest (11^0 27'N 79^0 47E),is located 12km north east of Chidambaram,Cuddalore District, Tamil Nadu.India. Collected leaves were washed thoroughly and allowed to dry under shade for 20-25 days then made into fine powder. 1kg of powder was soaked in 2lit.distilled water and kept for48 hours at room temperature with occasional shaking. The infusion was decanted and filtered through three layers of Whatman No.1 filter paper.From this (100%), different concentrations (2. 5, 10, 15, 20 and 25%) were prepared using distilled water for further studies.

Table-1.Allelopathic Potential of *E.agallocha* on germination percentage of green gram.black gram,groundnut,pearl millet and fingermillet (P < 0.05 Level).

Extract Con. (%)	*Green gram*	*Black gram*	*Goundnut*	*Pearl millet*	*Finger millet*
Control	100	100.	98	95	94
2%	92 (-8)	95 (-5)	96.0 (-2.04)	90 (-5.2)	89 (-5.3)
5%	86 (-14.0)	92 (- 8.0)	94.0 (-4.08)	82 (-13.7)	80 (-14.9)
10%	78 (-22.0)	85 (-15.0)	87.0 (-11.2)	71 (-25.3)	69 (-26.6)
15%	71 (-29.0)	79 (- 21.0)	78.0 (-20.4)	63 (-33.7)	58 (-38.2)
20%	65 (-35.0)	65 (-35.0)	71.0 (-27.5)	55 (-42.1)	51 (-45.7)
25%	52 (-48.0)	59 (-41.0)	64.0 (- 34.0)	44. (-53.7)	42 (-55.3)
Variance	272.9048	238.1429	175.6667	350.9524	386.6667
Source of Variation	Pulses Treatments	crops		Millets Treatments crops	
F	101.87	11.042		644.41	18.06

The data in parantheses indicates % of decrease(-) over control.

Table-2.Effect of aqueous leaf extract of *E.agallocha* on Seedling length (cm/plant) of green gram, black gram, groundnut, pearl millet and fingermillet (P < 0.05 Level).

Extact Con.(%)	Greengram		Blackgram		Groundnut		Pearlmillet		Fingermillet	
	Root	Shoot	Root	Shoot	Root	Shoot	Root	Shoot	Root	Shoot
C	5.5	8.6	6.4	8.3	6.6	8.0	6.2	7.6	5.3	7.2
2	5.3 (-3.6)	8.4 (-2.3)	6.2 (-3.12)	8.2 (-1.2)	6.5 (-1.5)	7.8 (-2.5)	5.8 (-6.45)	7.4 (-2.6)	4.9 (-7.5)	7.0 (-2.8)
5	5.0 (-9.1)	8.1 (-5.8)	6.0 (-6.2)	8.0 (-2.4)	6.2 (-6.0)	7.5 (-6.25)	5.3 (-14.5)	7.1 (-6.6)	4.5 (-15.1)	6.7 (-6.9)
10	4.7 (-14.5)	7.8 (-11.9)	5.7 (-10.9)	7.5 (-8.5)	5.9 (-10.6)	7.2 (-10.0)	4.9 (-20.9)	6.7 (-11.8)	4.0 (-24.5)	6.1 (-15.3)
15	4.2 (-23.6)	7.2 (-16.2)	5.3 (-17.2)	6.9 (-15.8)	5.5 (-16.6)	6.9 (-13.7)	4.5 (-27.5)	6.2 (-18.4)	3.6 (-32.1)	5.6 (-22.2)
20	3.8 (-30.9)	6.7 (-22.1)	4.9 (-23.4)	6.5 (-21.7)	5.1 (-22.2)	6.4 (-20.0)	4.1 (-33.9)	5.4 (-28.9)	3.3 (-37.7)	5.1 (-29.1)
25	3.3 (-40.0)	6.1 (-29.1)	4.4 (-31.2)	6.0 (-27.7)	4.7 (-28.7)	5.9 (-26.2)	3.6 (-41.9)	4.9 (-35.5)	2.9 (-45.2)	4.5 (-37.5)
Variance	0.65619	0.85619	0.52952	0.80285	0.51476	0.57333	0.85805	1.04574	0.76231	1.02574
Source of variation	Pulses- Root Treatments		Pulses- Shoot Treatments		Crops		Millets- Root Treatments		Millets-Shoot Treatments	
	Crops		Crops				Crops		Crops	
F	508.14	919.00	179.47		29.76		522.53	803.30	321.22	106.77

The data in parantheses indicates % of decrease(-) over control.

Table-3.Effect of aqueous leaf extract of *E.agallocha* on Fresh Weight (FW) and Dry Weight(DW) (g/plant)of green gram.black gram,groundnut, pearl millet and fingermillet (P < 0.05 Level).

Extact Con.(%)	Greengram		Blackgram		Groundnut		Pearlmillet		Fingermillet	
	FW	DW	FW	DW	FW	DW	FW	DW	FW	DW
C	0.95	0.32	1.06	0.39	3.2	1.7	0.81	0.28	0.77	0.24
2	0.93 (-2.1)	0.31 (-3.1)	1.04 (-1.8)	0.38 (-2.5)	3.1 (-3.1)	1.6 (-5.8)	0.78 (-3.7)	0.26 (-7.1)	0.75 (-2.5)	0.23 (-11.5)
5	0.86 (-9.5)	0.28 (-12.5)	0.95 (-6.8)	0.35 (-10.2)	3.0 (-6.2)	1.5 (-11.6)	0.72 (-11.1)	0.22 (-21.4)	0.68 (-11.6)	0.20 (-23.0)
10	0.75 (-21.0)	0.25 (-21.8)	0.83 (-18.6)	0.32 (-17.9)	2.7 (-15.6)	1.45 (-14.7)	0.65 (-19.7)	0.20 (-28.6)	0.59 (-23.3)	0.18 (-30.7)
15	0.63 (-33.7)	0.21 (-34.3)	0.72 (-29.4)	0.28 (-28.2)	2.5 (-19.3)	1.2 (-29.4)	0.55 (-22.1)	0.17 (-39.3)	0.48 (-37.6)	0.15 (-42.3)
20	0.51 (-46.3)	0.19 (-40.6)	0.61 (-40.2)	0.24 (-38.4)	2.2 (-31.2)	1.0 (-41.1)	0.39 (-51.8)	0.16 (-42.8)	0.37 (-51.9)	0.13 (-50.0)
25	0.48 (-49.5)	0.16 (-50.0)	0.55 (-46.1)	0.21 (-46.1)	1.9 (-40.6)	0.95 (-44.1)	0.33 (-59.2)	0.14 (-50.0)	0.30 (-61.0)	0.12 (-53.8)
Variance	0.37767	0.00376	0.04165	0.0048	0.23619	0.08702	0.03546	0.002729	0.034257	0.002248
Source of variance	Pulses -FW Treatments Crops		Pulses- DW Treatments Crops				Millets- FW Treatments Crops		Millets- DW Treatments Crops	
F	9.17	292.83	3.379	149.35			442.666	38.22	159.76	74.76

The data in parantheses indicates % of decrease(-) over control.

Table-4.Effect of aqueous leaf extract of *E.agallocha* on total Chlorophyll,Aminoacid and Protein contents(mg/g.fr.wt.) of green gram.black gram and groundnut, (P < 0.05 Level).

	Green gram			Blackgram			Groundnut		
Extract Con. (%)	Total Chl.	Amino acid	Protein	Total Chl.	Amino acid	Protein	Total Chl.	Amino acid	Protein
C	1.05	3.11	9.12	1.25	3.23	9.45	1.45	4.56	12.45
2	1.00 (-16.6)	3.05 (-1.9)	9.05 (-0.7)	1.12 (-10.4)	3.18 (-1.5)	9.38 (-0.7)	1.38 (-4.8)	4.49 (-1.5)	12.33 (-0.9)
5	0.950 (-20.8)	2.95 (-5.1)	8.85 (-2.9)	1.00 (-20.0)	3.12 (-3.4)	9.22 (-2.4)	1.19 (-17.9)	4.32 (-4.8)	12.15 (-2.4)
10	0.915 (-23.7)	2.82 (-9.3)	8.62 (-5.5)	0.960 (-23.2)	2.95 (-8.6)	9.00 (-4.7)	1.12 (-22.7)	4.20 (-7.8)	11.93 (-4.2)
15	0.829 (-30.9)	2.63 (-15.4)	8.15 (-10.6)	0.869 (-30.5)	2.79 (-13.6)	8.72 (-7.7)	1.02 (-29.6)	3.95 (-13.3)	11.75 (-5.6)
20	0.785 (-34.2)	2.49 (-19.9)	7.81 (-14.2)	0.822 (-34.2)	2.65 (-17.9)	8.51 (-9.9)	0.985 (-32.0)	3.82 (-16.2)	11.13 (-10.6)
25	0.712 (-40.7)	2.32 (-25.0)	6.95 (-23.8)	0.785 (-37.2)	2.51 (-22.3)	7.84 (-17.0)	0.960 (-33.7)	3.63 (-20.4)	10.14 (-18.5)
Variance	0.01472	0.08822	0.61599	0.02803	0.07708	0.32479	0.03753	0.12224	0.66264
Source of variance	Total Chl. Treatments Crops			Amino acid Treatments Crops			Protein Treatments Crops		
F	36.277		62.217	2352.10			1003.02		

Table-5.Effect of aqueous leaf extract of *E.agallocha* on total Chlorophyll,Aminoacid and Protein contents (mg/g.fr.wt.)of pearl millet and fingermillet (P < 0.05 Level)

Extract Con. (%)	Pearlmillet			Fingermillet		
	Total Chl.	Amino acid	Protein	Total Chl.	Amino acid	Protein
C	0.92	3.05	8.23	0.87	3.02	8.12
2	0.854 (-7.2)	3.00 (-1.6)	8.12 (-1.3)	0.821 (-5.6)	2.93 (-2.9)	7.82 (-3.7)
5	0.832 (- 9.5)	2.85 (-6.5)	7.65 (-7.0)	0.765 (-.765)	2.72 (-9.9)	7.55 (-7.0)
10	0.819 (-11.0)	2.62 (-14.1)	7.43 (-9.7)	0.652 (-25.1)	2.53 (-16.2)	7.31 (-10.1)
15	0.737 (-19.8)	2.41 (-20.9)	7.12 (-13.5)	0.585 (-32.7)	2.34 (-22.5)	6.84 (-15.6)
20	0.602 (-34.5)	2.23 (-26.9)	6.83 (-17.0)	0.512 (-41.1)	2.12 (-29.8)	6.45 (-20.6)
25	0.538 (-41.5)	2.02 (-33.8)	6.15 (-25.3)	0.438 (-49.6)	1.95 (-35.4)	5.85 (-28.0)
Variance	0.019639	0.15579	0.162562	0.026308	0.469187	0.54324
Source of Variation	Total Chl.		Amino acid		Protein	
	Treatments	Crops	Treatments	Crops	Treatments	Crops
F	35.439	24.601	606.7636	44.304	161.9442	29.377

The data in parantheses indicates % of decrease(-) over control.

Certified seeds of green gram (*Vigna radiata* (L.)R.Wilczek.)*Cv*.VBN-1,Black gram (*Vigna mungo* (L.)Hepper.)*Cv*.T-9,groundnut (*Arachis hypogaea L.*)*Cv*.VRI-2,pearlmillet(*Pennisetum typhoides* St.&Hub.)*Cv*.K-3 and fingermillet (*Eleusine coracana Gaertn*.) *Cv*.CO-11.were used in germination studies in the experiment. The selected seeds were surface sterilized with 0.2g HgCl. solution for 2 min. and then washed thoroughly with distilled water. For the germination study, 25 seeds were sown in plastic pots (12cm dia.) with 700g normal field soil under the green house. The treatments were replicated five times.On the first day, different concentrations of equal amount of aqueous extracts of *E. agallocha* was irrigated in each

treatment (2,5,10,15,20 and 25%) in the Plastic pots. Distilled water served as control. Afterwards the seeds were allowed to germinate in the green house till 12 days after the seed was sown. The leaf extracts /distilled water was irrigated per pot on 3, 6, 9 and 11th day after the seeds were sown. The emergence of radicle was taken as criterion for the germination of seeds. The growth parameters and bio chemical constituents like Chlorophyll (Arnon,1949), aminoacids (Moore and Stein,1948) and proteins (Lowry *et al.*, 1951) were analyzed on 12 day old seedlings of all the test crops. The obtained mean data were analyzed statistically (ANOVA) to find out the significance ($P< 0.05$ Level) of the treatments on the crops.

RESULTS AND DISCUSSION

The results of the germination percentage, seedling growth and fresh and dry weight of green gram,blackgram,groundnut, pearlmillet and fingermillet seeds treated with aqueous leaf extracts of *E.agallocha* are given in Tables-1,2&3. In comparison with the control, aqueous leaf extracts of *E.agallocha* showed inhibitory effects on seed germination percentage, root and shoot length, fresh and dry weight of all the five test crops. The degree of inhibition increased with increasing extract concentration. The highest extract concentration (25%) showed significant inhibitory effects on all growth parameters measured ($P<0.05$). Among the five test crops studied, the greatest reduction in germination percentage and seedling length, biomass production was noticed in fingermillet. The least inhibition percentage of seed germination and other growth parameters were observed in groundnut than other four crops. The order of inhibition percentage was fingermillet>Pearlmillet>greengram>blackgram>groundnut. Similar findings were previously noticed by Rajangam and Arumugam (1999). They found that the aqueous leaf extract of *E.agallocha* inhibited seed germination and plumule and radicle elongation of rice. Similar allelopathic inhibition of *Eucalyptus*, have been observed in pearlmillet (Pathy *et al.,* 2000). Parvin *et al.*(2011) concluded that the aqueous leaf extracts and roots of *Albizia lebbeck* had highest allelopathic effects on germination, growth and development of mungbean and soybean . The study of Rejila and Vijayakumar,(2011) revealed that aqueous leaf extract of *Jatropha curcas* inhibit the growth of *Capsicum annum.* The present results are in coincide with the studies on *Acacia nilotica* on cereals and legume crops(Duhan, and Lakshminarayanan,1995).

Allelopathic activity depended on the concentration of the extracts, target species, and the plant tissues from which the chemicals were extracted. Increasing inhibitory rates with increasing concentration was in accordance with previous reports (Ismail and Chong 2002; Singh *et al.* 2003; Batish *et al.* 2006). Phytotoxic effects may be caused by more than one chemical component present in the leaves and the crop species react differently to these compounds and the inhibition might have been presence of allelochemicals in the plant extracts (Chaturvedi and Jha,1992).Swaminathan *et al.,* (1989) reported that the potential compounds which are able to induce inhibitory effect on seed germination are identified as phenolic acids. Allelepathic agents may act in many ways directly and indirectly to modify plant growth. They may inhibit cell division and cell elongation, inhibit hormonal relations, modify mineral uptake, retard photosynthesis, inhibit protein synthesis, change permeability of membranes, inhibit specific enzymes and affect respiration and stomatal opening (Rice, 1974 and Lodhi, 1976). Membrane plays as key role in the ability of a plant cell to withstand stress of plants.Allelochemicals can damage cell membrane through direct interact with its constituent or an impairment of some metabolic function necessary to the maintenance of membrane function (Yebing Che *et al*., 2009).The total chlorophyll, aminoacid and protein contents were significantly reduced in all the five test crops treated with leaf extract of *E.agallocha* (tables-4&5). Among the pulses, groundnut showed lesser inhibition on the biochemical constituents than black gram and green gram.

Between the millets, the maximum inhibitory effect was observed in fingermillet than pearlmillet. The results showed that the percentage of inhibition on the total chlorophyll, proteins and amino acid contents of test crops increase with increasing the leaf extract concentrations of *E.agallocha*. Similar to this result, there was a reduction on total chlorophyll contents in rice seedlings trated with aqueous leaf extract of *E.agallocha* (Rajangam and Arumugam,1999) and another mangrove *Avicennia marina* on rice seedlings(Rajangam,1986).The present resutls also coincides with Padthy *et al.,* (2000), where the decrease of chlorophyll pigments, protein, carbohydrate and nucleic acid contents of shoot and roots of fingermillet by leaf leachates and extract treatments of Eucalyptus. Yang *et al.,* (2006) reported that the reduction of Chlorophyll pigments in rice seedlings was caused by leachates of *Ageratina adenophora* and in groundnut by the extracts treatment of bamboo (Eyine *et al*., 1989). The application of aqueous leaf extracts of *E.agallocha* influenced negatively on the metabolism of seed germination and seedling growth of pulses and millets. The known targets of the allelochemicals affect the cell division, production of plant hormones and their stability and permeability of membrane, mineral uptake, pigment synthesis, photosynthesis, respiration, amino acid synthesis, nitrogen fixation, specific enzyme activities and conduction tissue (Wink *et al*, 1998, Rizvi *et al.,* 1992).

Allelopathic inhibition is complex and can involve the interaction of different classes of chemicals like phenolic compounds, flavonoids, terpenoids, alkaloids, steroids, carbohydrates, and amino acids, with mixtures of different compounds sometimes having a greater allelopathic effect than individual compounds alone (James and Bala,2003).The phenolic acids identified from the leaves of *E.agallocha* are β-hydroxybenzoic,syringic,vanillic,protocatechuic,caffeic and chlorogenic acids (Rajangam and Arumugam,1999).Phenolic acids have already been reported to be inhibitors on germination and plant growth. The inhibitory effect of phenolic acids on plant growth were noticed by many researchers. β-hydroxybenzoic acid and vanillic acid (Grummer and Beyer, 1960; Whitehead, 1964; Chandramohan *et al*., 1973), vanillic acid (Leela,1981), Syringic acid (Guenzi and Mccalla,1966), protocatechuic, vanillic and β-hydroxybenzoic acids (Winter, 1961;Chou and Muller, 1972), chlorogenic acid and caffeic acid (del Moral and Muller, 1970; Al-Mousawi and Al-Naib, 1975; Lodhi, 1975; Kanchan and Jayachandra,1980). These studies are in conformity with the present findings. Phytotoxicity of allelochemicals present in the leaf extracts of *E. agallocha* might be caused by their synergistic activity on the retardation of growth and biochemical constituents of test seedlings rather than single chemical.The potential of allelopathic inhibition exhibited by *E. agallocha* was more on millets than pulses and the degree of inhibition was dependent on concentration of extracts. Further,the identification of specific inhibiting allelochemical screening studies and wider range of bioassay for pre and post-emergent experiments are required with other crop and weeds to develope a potential natural herbicides from *E.agallocha* in future.

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REFERENCES

1. Al. Mousawi AH and FAG Al-Naib, Allelopathic effects of *Eucalyptus microtheea* F. Muell. *J. Univ. Kuwait* (Sci.), 2: 59-66. (1975).

2. Arnon DI, Copper enzymes in isolated chloroplast Polyphenol Oxidize in Beta vulgaris. J. Plant physiol., 24; 1-15. (1949).

3. Batish DR, Singh H, Rana N and Kohli RK, Assessment of allelopathic interference of Chenopodium album through its leachates, debris extracts, rhizosphere and amended soil. Arch Agron Soil Sci 52:705–715. (2006).

4. Borella J and Lindamir HP, Allelopathic influence of Phytolacca dioica L. on germination and erly growth of Lycopersicum esculentum and Bidens pilosa. Biotemas. 22(3):67-75. (2009).

5. Bouchagier P, Efthimiadou A, Katsileros A, Bilalis D and Ethimiadis P, Adverse effect of Bermudagrass on physiological and growth components of cotton. J. of Agronomy, 7 (1): 49-55. (2008).

6. Chandramohan D, Purushothaman D and Kothandaraman R, Soil phenolics and plant growth inhibition.Pl. and Soil. 39: 303-308. (1973).

7. Chaturvedi DP and Jha A N, Studies on allelopathic potential of an important agroforestry species. Forest Ecology and Management,53:91-98.(1992).

8. Chou CH and Muller CH, Allelopathic mechanisms. Arctostaphylos glandulosa var.zacaensis. Amer. Midl. Natur.,88:324-347. (1972).

9. Daniel W.G, Historical review and Current models of forest succession and interference CRC – Press LLC, 237-251. (1999).

10. del Moral R and Muller CH, A mechanisms of toxin transport from Eucalyptus globules Labill. Torrey Bot. Club., 96: 467-475. (1969).

11. Duhan, J.S. Lakshminarayanan, K.A, Allelopathic effects of Acacia nilotica on cereal and legume crop grown in fields. Allelopathy J. 2: 93-98. (1995).

12. Eyini M, Jayakumar M and Pannerselvam S, Allelopathic effects of bamboo leaf extracts on the seedlings of groundnut.Tripical Ecol.30:138-141. (1989).

13. Grummer G and Beyer H, In; The Biology of Weeds (J.L. Harperi, ed.),53–157. Blackwell, Oxford. (1960).

14. Guenzi W and Mc Calla T, Phenolic acids in oats,wheat,sorghum and corn residues and their phytotoxicity.Agron. J., 58: 303-304. (1966).

15. Ismail BS and Chong TV, Effects of aqueous extracts and decomposition of Mikania micrantha H.B.K. debris on selected agronomic crops. Weed Biol. Manag., 2:31–38. (2002).

16. James J F and Bala R, Allelopathy: How Plants Suppress Other Plants,IFAS,University of Florida, U.S.A. (2003).

17. Kanchan SD and Jayachandra, Allelopathic effects of Parthenium hysterophorus L.part IV. Identification of inhibitory chemicals on plants and Soil., 55(1): 67-75. (1980).

18. Leela D, Allelopathy in Argemon mexicana L.8th Asian Pacific Weed Sci. Soc. Conf., 401-404. (1981).

19. Li Jing, Peng Shaolin, Chen Leiyi, Wang Ruilong, Ni Guangyan, Use of Sonneratia apetala allelopathy to control Spartina alterniflora weed Allelopathy J., 25(1):256-259. (2010).

20. Lodhi MAK, Role of Allelopathy as expressed by dominating trees in a low land forest in controlling the productivity and pattern of herbaceous growth. Am. J. Bot., 63:1-8. (1976).

21. Lowry OH, Rosenberg NJ, Farr AL and Randall RJ, Protein measurement with folin phenol reagent. J. Biol. Chem., 193;265-275. (1951).

22. Moore S and Stein WH, Photometric method for use in the Chromatography of aminoacids. J. Biol. Chem., 176; 367-388. (1948).

23. Narwal SS, Allelopathy in crop production. Scientific Publisher, Jodhpur, India, (1994).

24. Oyun MB, Allelopathic potentialities of Gliricidea sepium and Acacia auriculiformis on the germination and seedling vigour of maize (Zea mays L.) American. J. Agri. and Biol. Sci., 1(3): 44-47. (2006).

25. Padhy B, Patinaik PK and Tripathy AK, Allelopathic potential of Eucalyptus leaf litter leachates on germination and seedling growth of finger millet. Allelopathy J., 7: 69-78. (2000).

26. Parvin R, Shapla TL and Amin MHA, Allelopathic effects of Albizia lebbeck on agricultural crops. Int. J. Sustain. Crop Prod. 6(1):50-57. (2011).

27. Patric ZA, Toussoun TA and Snyder WC, Phytotoxic substances in arable soils associated with decomposition of plant residues. Phytopath., 53:152-161. (1963)

28. Putnam AR, Allelochemicals from plants as herbicides. Weed technol. 2: 510-518. (1988).

29. Rajangam, M., Allelopathic influence of Avicennia marina on germination and growth of paddy, Indian Botanical Cong. 3 : 117-120. (1986).

30. Rajangam M and Arumugam K, Allelopathic effects of Excoecaria agallocha L. on germination and growth of rice . J. Ecotox. Environ. Monit., 9: 63-66. (1999).

31. Rejila S and N Vijayakumar, Allelopathic Effect of Jatropha curcas on selected intercropping plants (green chilli and sesame), Journal of Phytology, 3(5):01-03. (2011).

32. Rice E Lallelopathy, Academic Press, New York, USA. . (1974).

33. Rice EL, Allelopathy, 2nd Edition. Oriando,Florida; Academic press. (1984).

34. Rizvi SJ H, Haque H, Singh VK and Rizvi V, A discipline called allelopathy. In allelopathy basic and applied aspects (ed. S.J.H. Rizvi and V. Rizvi) 1- 8 Chapman & Hall, London. (1992).

35. Seligler DS Chemistry and Mechanisms of allelopathic interaction. Agro. J., 88: 876-885. (1996).

36. Singh HP, Batish DR, Pandher JK and Kohli RK,.Assessment of allelopathic properties of Parthenium hysterophorus residues. Agric Ecosyst Environ. 95:537–541. (2003).

37. Swaminathan C,Vinayrai RS and Suresh KK, Allelopathic activities of Acacia nilotica. J.of Tropical Forest Sci.,2:56-60. (1989).

38. Swapnal S and Siddique MB, Allelopathic effect by aqueous extracts of different parts of Croton banplandianum Bail. on some crop and weed plants. J. Agri. Ext. and Rural Dev.,2(1):22-28. (2010).

39. Whitehead DC, Identification of β-hydroxy benzoic,vanillic,β-coumaric and ferulic acids in soil. Nature.,202:417-418.(1964).

40. Whittaker RH and Feeny PP, Allelochemics: Chemical Interactions between Species. *Science*, 26:757-770. (1971).

41. Wink M Schmeller T and Latz–Brunning B, Modes of action of allelochemicals-alkaloids: Interaction with neuroreceptors. DNA and other molecular trait. J. Chemical Ecol., 24,1881-1937. (1998)

42. Winter AG, New physiological and biological aspects in the interrelationships between higher plants Soc. Ex. Biol., 5:229-234. (1961).

43. Yang G,Wan FH, Liu WX and Zhang XW, Physiological effects or allelochemical from leachates of Ageratina adenophora Sperg.on rice seedlings. Alleloopathy J.,18:237-246. (2006).

44. Yebing Che J,Wang,Xiaohu Wu, Na Yang and Jilan Sun, Effects of aqueous leaf extracts of Parthenium hysterophorus L. on growth, photosynthesis, nitrogen and phosphorus absorption and antioxidant enzymes of wheat (Triticum aestivum). Proc.:I Assian Allelelopathic Society, 134-140. (2009).