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Allelopathic effects of jute (*Corchorus capsularis* and *C. olitorius*) and sisal (*Agave sisalana*) leaf leachates on rice (*Oryza sativa*), wheat (*Triticum aestivum*) and greengram (*Vigna radiata*)

H CHOWDHURY[1], A R SAHA[2], S K SARKAR[3] and M K TRIPATHI[4]

Central Research Institute for Jute and Allied Fibres, Kolkata, West Bengal 700 120

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ABSTRACT

A study was conducted during 2007 to screen leaf leachates of jute (*Corchorus capsularis* L. and *C. olitorius* L.) and sisal (*Agave sisalana* Perrine) for allelochemicals effect on germination and seedling growth of some test plants. A rice (*Oryza sativa* L.), wheat (*Triticum aestivum* L. emeond. Fiori & Paol.) and (greengram [*Vigna radiata* (L.) R. wilczek] allelochemicals present in the leachates inhibited differentially the germination and growth of the plants. Effect of allelochemicals on germination of the plants was less pronounced as compared to that on seedling growth. Highest inhibition on germination (paddy seeds by about 28% over control) and seedling vigour (about 48 – 62% vigour loss over the control) in the plants was recorded in case of *Capsularis* jute leaf extracts. Among the test plants, seedling growth of wheat was affected most by the leachates. Similar effect on germination and seedling growth of plants was also recorded when leaf samples were incorporated into soil (1: 10, w/w).

Key words: Allelochemicals, *Corchorus capsularis, Corchorus olitorius*, Germination, Leaf leachates, Seedling vigour, Sisal

Plant allelochemicals when come in contact with water are released as leachates and greatly influence germination, growth, development and biomass production of other plants in co-existence. Such substances impose a stress on other plants growing in their vicinity and may thus assume a significant role in weed control (Cutler 1988, Putnam 1988). Allelopathic effects of various plants, such as neem, Chinaberry, Eucalyptus (Chowdhury *et al*. 2000, Saxena and Singh 1978) and weedy species, like Parthenium, Artemisia and crops, like buckwheat (Choudhuri and Dureja 2007), besides various forestry and agroforestry plants (Unial and Nautial 1997) have been reported. Among the various plant parts, foliage leachates are most potent source of phytoactive metabolites (May and Ash 1990).

Allelochemicals are the plant origin secondary metabolites or byproducts of primary metabolic processes. Allelochemicals are reported to affect on various enzymes governing physiological processes like growth, differentiation and lignin biosynthesis in plant body. Jute and sisal plants posses various bioactive metabolites (Hazra and Saha 2004). Suppression in weed growth in jute field (*C. capsularis*) after initiation of leaf fall is well documented.

In the present investigation, attempts were made to screen jute (*C. olitorius* and *C. capsularis*) and sisal (*A. sisalana*) leaf leachates for allelopathic effects on germination and seedling growth of some test plants.

MATERIALS AND METHODS

A laboratory experiment was conducted at the Central Seed Research Station for Jute and Allied Fibres, Bud Bud, Burdwan, West Bengal during March – December 2007. Fresh leaves of 'JRO 66' *olitorius* and 'Bidhan Pat 3' *capsularis* jute and sisal plants were collected from experimental farm of the research station. Leaves were cut into small pieces, dried under shade and ground in a mechanical grinder. Aqueous extracts of jute and sisal leaves were prepared by mixing a ground sample of 25 g of each component with 250 ml of double distilled water, shaken on a mechanical shaker for 2 hr and kept standing for 72 hr. The extracts thus obtained were filtered through 2 layers of filter paper (Whatman No.1) and stored in dark in conical flasks. Seeds of rice (*Oryza sativa* L.), wheat (*Triticum aestivum* L.

[1]Senior Scientist (Agricultural Chemistry) (E-mail: hemantac1@rediffmail.com), [2]Senior Scientist (Soil Science) (E-mail: amitsaha60@yahoo.co.in), Division of Crop Production, [3]Senior Scientist (Plant Pathology) (E-mail: surjapath@gmail.com), Division of Crop Protection, [4]Senior Scientist (Agronomy) (E-mail: sanaipbh@yahoo.co.in), Sunnhemp Research Station (CRIJAF), Pratapgarh, Uttar Pradesh.

emend. Fiori & Paol.) and (greengram [*Vigna radiata* (L.) R. wilczek] were collected from the local market. Cultivated soil (sandy loam) was collected from the experimental farm of the research station for testing the effect of plant leachates on germination and seedling growth of test plants in soil.

The effect of the extracts on germination and seedling growth of 3 test plants, namely paddy, wheat and mungbean was tested by placing 20 seeds of the test plants in Petri-dishes (3 replications) containing 3 layers of Whatman No.1 filter paper saturated with the extracts (5 ml). A separate control series was also set up using only distilled water. Moisture in the petri-dishes was maintained by adding about 2 ml of extract/distilled water (control) as and when required.

For testing the effects of plant leachates on seed germination and seedling growth of test plants in the soil, 500 g of plant samples were mixed in 5 kg of soil in earthen pots. The soil was moistened to field capacity by adding water and kept for 72 hr. Then the soil was once again mixed thoroughly so that the plant leachates were uniformly distributed. Seeds of the test plants were placed in the soil and covered. To keep the soil moist, water was added as and when required. Three replications for each plant sample were maintained. Seeds placed in only soil containing no plant samples served as control.

Total number of seeds germinated after 7 days were counted both in Petri-dishes and soil and compared with the control. Root and shoot length (average of 10 plants) and dry weight (of 10 plants) were taken and compared with the control. Soil in earthen pots was washed and drained under tap water. After removing the soil, seedlings were collected for measurement of root and shoot length and dry mass. Vigour index was calculated by multiplying seedling length (cm) with per cent seed germination.

RESULTS AND DISCUSSION

The allelochemicals present in aqueous extract of *capsularis* jute leaves inhibited germination of paddy seeds by about 28% over control, whereas very little or no significant effect on germination of the test seeds by other 2 plant leachates was observed (Table 1).

Root and shoot elongation of the test plants seedlings was more adversely affected than seed germination due to the allelochemicals. Root elongation of paddy was reduced by about 52 and 33% by *capsularius* and *olitorius* jute leachates, respectively. Root elongation of wheat was more adversely affected than paddy and mungbean seedlings due to the allelochemicals. The *capsularis* leachate reduced root elongation of wheat by 54% and about 17%–40 reduction by sisal and *olitorius* leachates was recorded. Reduction of root elongation in greengram by 46% was recorded when treated with *capsularis* leachate.

All the 3 plant leachates significantly inhibited the shoot

Table 1 Effect of plant leachates on germination and seedling growth of test plants

Treatment	Petri-dishes			Soil		
	Paddy	Wheat	Mungbean	Paddy	Wheat	Mungbean
			Mean germination (%)			
Olitorius	81.66	86.66	95.00	75.00	68.33	83.33
Capsularis	70.00	83.33	96.66	73.33	58.33	80.00
Sisal	83.33	88.33	100.00	76.66	80.00	91.66
Control	98.33	98.33	100.00	88.33	86.66	96.66
CD (*P*=0.05)	5.52	14.13	8.65	20.73	6.86	7.44
			Mean root length (cm)			
Olitorius	4.12	5.07	4.77	4.78	3.35	3.01
Capsularis	2.95	3.84	3.24	2.41	2.67	2.82
Sisal	5.92	7.01	5.39	4.52	3.50	5.12
Control	6.20	8.51	6.05	5.51	7.01	5.28
CD (*P*=0.05)	1.34	0.99	1.22	0.62	0.59	1.41
			Mean shoot length (cm)			
Olitorius	3.60	7.92	7.06	4.44	4.18	5.70
Capsularis	3.34	4.73	5.22	3.22	3.33	4.65
Sisal	4.11	7.55	8.81	5.42	6.11	5.66
Control	5.54	11.50	9.90	6.62	6.98	8.50
CD (*P*=0.05)	0.49	1.58	1.37	0.69	1.13	1.42
			Mean dry weight/10 plants (g)			
Olitorius	0.141	0.235	0.202	0.122	0.223	0.188
Capsularis	0.133	0.205	0.171	0.119	0.175	0.171
Sisal	0.146	0.245	0.226	0.168	0.263	0.191
Control	0.152	0.249	0.241	0.183	0.277	0.210
CD (*P*=0.05)	0.008	0.043	0.034	0.006	0.055	0.022

Table 2 Effect of plant leachates on seedling vigour of the test plants

Treatment	Vigour index					
	Petri-dishes			Soil		
	Paddy	Wheat	Mungbean	Paddy	Wheat	Mungbean
Olitorius	630.41	1 125.71	1 123.85	691.50	514.52	725.80
Capsularis	440.30	714.13	817.74	412.84	349.98	597.60
Sisal	835.79	1 286.08	1 420.00	762.00	768.80	988.09
Control	1 154.39	1 967.58	1 595.00	1 071.44	1 212.37	1 331.97

elongation of the test species. The *capsularis* jute leachate exhibited highest inhibition of shoot elongation of all the test plants. About 40% reduction in shoot elongation of paddy by *Capsularis* jute leachate was recorded. *Olitorius* jute and sisal leachates moderately inhibited shoot elongation of paddy. Shoot elongation in wheat seedlings was more adversely affected by the leachates as compared to paddy and mungbean seedlings. The *capsularis* jute leachate reduced the shoot growth of wheat and mungbean by about 58 and 47%, respectively. Whereas 31–34% reduction in shoot elongation of wheat in case of *olitorius* jute and sisal leachates-treated seedling was recorded. Little effect on shoot elongation of munbean was observed when other 2 leachates were applied.

Effect of plant leachates on dry weight production of the test plants was less pronounced than effect on root and shoot elongation. The *capsularis* leachates exhibited 12, 17.67 and 24.04% reduction in dry weight of paddy, wheat and mungbean seedlings, respectively. The other 2 extracts exhibited little or no significant effect on dry matter production of the test species.

When 500 g of plant samples was incorporated in 5 kg of soil and allowed to stay for 3 days, allelochemicals released into the soil and distributed thoroughly when the soil was mixed properly. When seeds were planted into the soil came in contact with the allelochemicals. Though very little effect on seed germination was observed due to the allelochemicals in soil, seedling growth of test plants was similarly affected as in the petri-dishes. The *capsularius* leachate in soil reduced paddy root elongation by 56%. The wheat root elongation was reduced by 50–62% by the plant leachates, highest effect was recorded by the *capsularius* leachate.

The leachate of *capsularis* jute produced similar effect on shoot elongation of the test plants. It reduced shoot elongation of paddy, wheat and mungbean by 51, 52 and 45% respectively. The leachate of *olitorius* jute reduced shoot elongation of the test plants by 32–40%.

The plant leachates reduced dry matter production by 8–35% in paddy and highest effect was observed in case of *capsularius* jute leachate. The *capsularius* leachate reduced dry weight production by 37 and 18% in wheat and mungbean, respectively.

It is evident that *capsularis* jute extract caused more vigour loss in test plants as compared to *olitorius* jute and sisal extracts (Table 2). About 48 – 62% vigour loss (over the control) in test plants was recorded with *capsularis* extracts, whereas 30 – 45% vigour loss with *olitorius* extract was observed in Petri-dish study. Sisal extract recorded less than 30% vigour loss in the test plants. Among the test plants, more vigour loss was recorded in wheat, followed by paddy and mungbean.

Similar effects on vigour of test plants were recorded when the leaf samples were incorporated into the soil (1: 10, w/w). About 55 – 71% vigour loss in test plants due to *capsularis* leaf leachates was recorded. About 25–45% vigour loss in test plants was observed due to *olitorius* and sisal leaf leachates.

This study indicates that plant leachates regulate differentially the germination and growth of other plants. Germination of paddy seeds was inhibited by about 28% over control by the allelochemicals present in aqueous extract of *capsularis* jute leaves, whereas very little or no significant effect on germination of the test seeds by other plant leachates was observed. Similarly, seedling growth of test plants was affected differently by the leachates and highest inhibition was exhibited by the *capsularis* jute leaf leachates. Among the test plants, seedling growth of wheat was affected most by the leachates.

Leachates from different plant species may contain different phytoactive compounds which may interact differently to other plant species. Plant leachates exhibiting allelopathic effects are reported to posses various organic acids, phenols, phenyl aglycones, glucosides, terpenoids etc.

It is evident that the *capsularis* jute leaves have potential allelochemicals inhibiting growth of other plants. At harvest of jute crop good amount of crop residue in the form of leaf (1.81 tonnes dry matter/ha) and shoot parts (0.47 tonnes dry matter/ha) goes in waste (CRIJAF). These residues if incorporated into the soil may help in reducing weed biomass in the field. However, further investigation may result in identifying molecule(s) responsible for the allelopathic efficacy which may lead in developing ecofriendly bioherbicide (s).

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