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Bioefficacy of formulations of different allelofractions of sesame (*Sesamum indicum*) against purple nutsedge (*Cyprus rotundus*)

LALIT KUMAR [1], JAY G VARSHNEY[2] and A BHATTACHARYA[3]

Indian Institute of Pulses Research, Kanpur, Uttar Pradesh 208 024

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ABSTRACT

An experiment was conducted during 2005–07 at Kanpur, Uttar Pradesh to find out the effect of different polarity of allelofractions, viz F, E, D, C, B and A of sesame (*Sesamum indicum* L.) root exudates on the vegetative growth and root and tuber development of purple nutsedge (*Cyprus rotundus* L.), emulsifiable concentrate and emulsive water formulations developed from the extracted allelofractions not only revealed a grave impact on the vegetative growth of treated plants but also caused severe reduction in root biomass and their tuber-forming tendencies. Emulsifiable concentrate formulations developed from completely non-polar fractions, viz F and E caused nearly 90% reduction, compared to control in both of the parameters, i e the total biomass as well as the shoot biomass at 90 µg/g concentrations. At the same concentration, compared to control both the emulsifiable concentrates were also observed quite effective in reducing up to 80–90% and 95–97% in the root biomass and their tuber-forming tendencies, respectively. Emulsifiable concentrate (fraction D) and Emulsive water (fraction B and C) formulations exhibited nearly 60–70% reduction in total biomass and about 70–75% reduction in root biomass and tuber-forming tendencies of treated purple nutsedge plants at 180 µg/g concentrations. However, the emulsive water formulation developed from the completely polar fraction (A) caused around 50–60% reduction in the entire observed root and shoot parameters that too at very high concentrations, i e 270 µg/g.

Key words: Allelopathy, Allelocompounds, Crop protection, *Cyprus rotundus*, Root exudates, *Sesamum indicum*

Purple nutsedge (*Cyprus rotundus* L) is considered to be the most obnoxious weed in tropical and subtropical regions of the world. In India, it infests almost all crops throughout the year and cause heavy financial loss to the nation. Compared to other weeds, the management of this weed is difficult owing to be its tuber regeneration capacity which lies predominately underground approximately 1–1½, m, thereby once removed it regenerates very soon in fields via propagation of new tubers. The allelopathic suppression of this weed in sesame fields was known by the farmers since ancient and subsequently its effect was also evaluated by various workers (Chandrasekhar *et al.* 1998, Nesser and Varshney 2001) in several field experiments. With this back ground, in-depth studies were conducted at Indian Institute of Pulses Research to ascertain the allelopathic potential of sesame against this weed. In our initial experiments, exudates isolated from sesame not only revealed a grave impact on the germination of tubers and suppression of vegetative growth of plants but also showed predominant impact on the roots and development of tuber forming tendency of the weed (Kumar and Varshney 2004, 2008). Since root exudates of any plant species is the mixture of several allelopathic molecules of different polarity which serve different kind of physiological roles. Hence, it was felt imperative to isolate and separate all kinds of allelopathic molecules present in root exudates of sesame and study their individual effect on *Cyprus rotundus* with the main goal to utilize the generated information for the development of more potent natural herbicide. Therefore, in the present study an attempt was made to isolate the allelopathic compounds of different polarity of sesame up to the purity of more than 95% as a single pure compounds and assessing their efficacy against *C. rotundus* in pot experiments under natural conditions.

MATERIALS AND METHODS

Our own developed root exudates trapping system was employed to collect root exudates of intact live plants of sesame (Kumar 2004, Kumar and Varshney 2008). Root zone water was collected weekly from the root zone of approximately 100 plants grown in about 20 sets of the root exudates trapping system till ripening (120–150 days). Collected water was systematically processed for recovery of allelopathic compounds. Initially, entire collected root zone water was slowly reduced to 15–20% of the original volume

[1]Senior scientist, [2]Principal Scientist. [3]Director

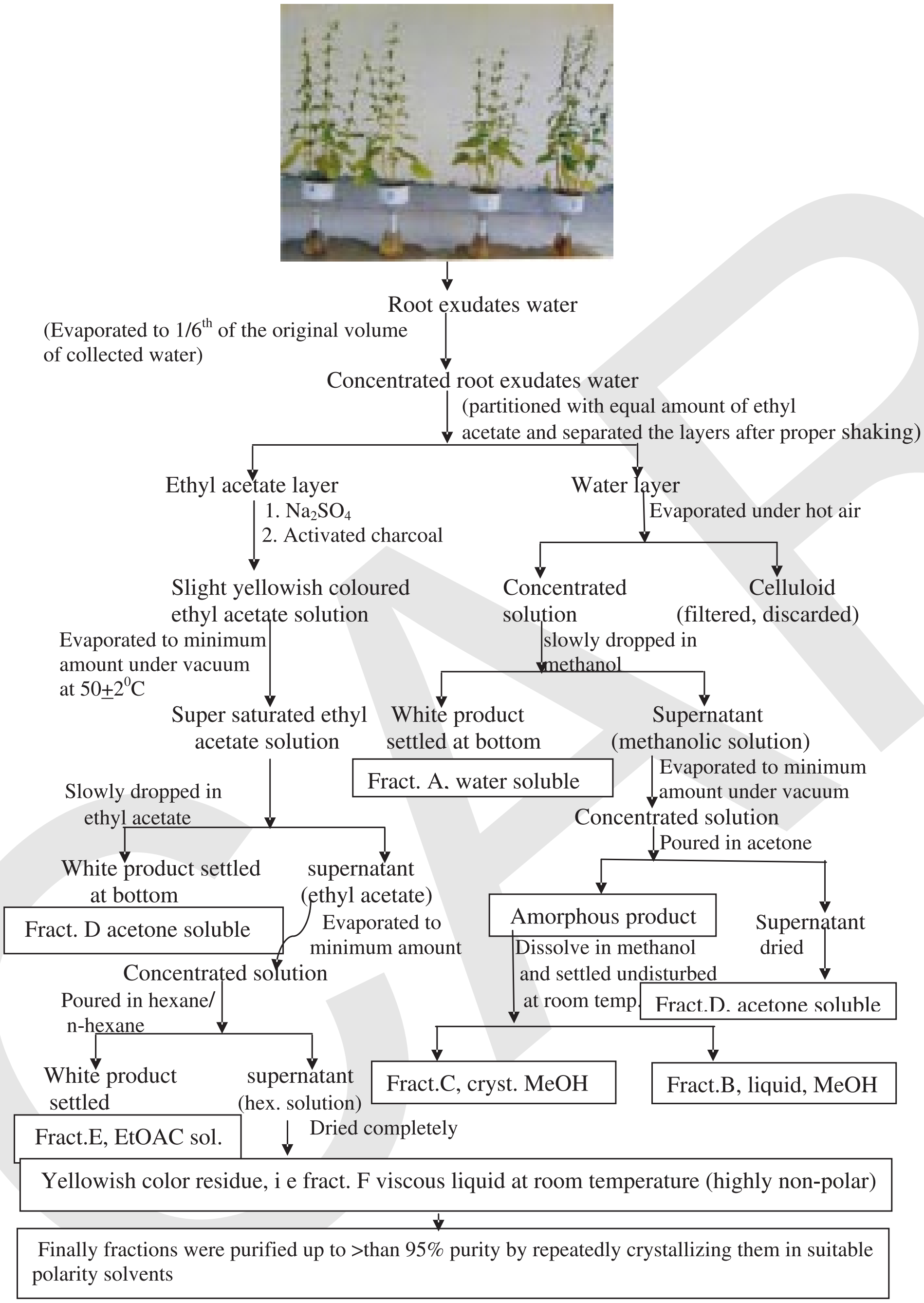

Fig 1 Extraction procedure adopted to extract the allelopatic compounds of sesame root exudates

by pouring the exudates water in Petri-plates and passing over them either a stream of hot air or resting them undisturbed under continuously moving fan. In present experiments we observed more than 50% reduction in the original volume of water within 24 hr when the water was kept ideally under continuously moving fan, whereas in two three days the desired workable volume was obtained. The concentrated root zone water was transferred to a separating funnel and partitioned with equal amount of ethyl acetate. In this process allelocompounds got fractionated into two major groups, viz polar (water layer) and non-polar (ethyl acetate layer). Minute amount of water and other coloring substances remained with ethyl acetate layer was removed by passing the layer through anhydrous sodium sulphate and activated charcoal. Different allelocompounds present in both of the layers were recovered by fractionally crystallizing the layers in suitable polarity of solvents as per the fractionation scheme represented in Fig 1. Prior to fractional crystallization vital information such as total number of compounds present in each layer, their polarity and concentration etc. were being generated on TLC. Further fractionation of both the groups resulted in total six different fractions, viz A, B, C (polar i e water layer), D, E and F (non-polar, ethyl acetate layer) in purity of > 95% as a single pure compound. Fraction F was found completely soluble in highly non-polar solvents, such as hexane and n-hexane (elotropic value 0), whereas fraction E is also non-polar and found completely soluble in ethyl acetate and all other solvents of elotropic values ranging from (3.0–4.0). Fractions D, C and B were found soluble in medium polarity of solvents such as acetone, methanol (elotropic value 4.5–5.0). Fraction A was observed of completely polar nature and found soluble in water (elotropic value 7.0).

For bioassay 10% emulsifiable concentrate (EC) and emulsion concentrate (EW) formulations were developed by emulsification of the required quantity (10%) of allelocompounds and by taking uniformly the tween-80 (10%) as emulsifier and cyclohexanone and water as a solvent for EC and EW formulations, respectively. Organic soluble or non-polar fractions, viz F, E and D were converted into EC formulations, whereas polar fractions, i e A, B, and C were converted into EW formulations. Finally emulsification of both the kind of formulations was obtained by vigorously agitating the appropriate mixtures at 45±2°C for an hour.

The test solutions of different concentrations (15, 30, 45, 60, 75, 90, 120, 135, 150, 180, 225 and 270 µg/g) were prepared by taking the appropriate amount of the EC and EW formulations and diluting in a definite volume of water so as to get the desired concentration in soil.

Small pot experiments were conducted to confirm the bioefficacy potentials of isolated compounds under natural environment. Pots were filled to the capacity (1.25 kg) with the normal soil collected from IIPR Farm (alluvial). Two uniform size tubers of *C. rotundus* were sown in each pot. Pots were treated twice at an interval of 15 days with the 75 ml solution of different dilutions, viz 250, 500, 750, 1 000, 1 250, 1 500, 1 750, 2 000, 2 250, 2 500, 3 000, 3 750 and 4 500 ppm prepared by taking appropriate amount of 10% emulsifiable concentrate and emulsive water formulations of allelocompounds to get a concentration of 15, 30, 45, 60, 75, 90, 120, 135, 150, 180, 225 and 270 µg/g of soil filled in pots. First treatment was made after seven days or proper germination of tubers, whereas second treatment was made exactly after 27 days of sowing. Experiments were maintained in three replications along with an untreated set of control for two-and-a half months at ambient condition. During the period, sufficient moisture in pots was maintained by applying necessary water as and when required. After two months of treatment, plants were taken out from the pots by exposing the pots under running water tap and the observations were taken on root and shoot biomass, total biomass, tuber formation and newly formed tuber biomass etc.

RESULTS AND DISCUSSION

A grave impact of all the six formulations developed from 95% purified allelofractions, viz F, E, D, C, B and A of different solubility ranging from highly non-polar to completely polar nature of sesame root exudates was observed in several respects. Developed formulations was not only found effective in reducing the vegetative growth of weed but also observed to be predominately effective in drastically reducing the root development and their new tuber formation tendencies. The activities of the developed formulation in all these respects varied greatly as per the chemical nature of the allelofractions used and the dose of a particular formulation. Bioefficacy action of all the developed formulations on vegetative growth and root and tuber development of purple nutsedge are discussed below under separate heads.

Effect of developed formulations on vegetative growth

All the assayed formulations were found active in different capacities against the test weed, however the formulations developed from completely non-polar fractions, viz hexane (F) and ethyl acetate (E) soluble compounds were found extremely toxic at very low doses of chemicals ranging from 15–90 µg/g of soil. Compared to control, these two non-polar fraction-based formulations caused approximately up to 90% reduction in total biomass of plants at their highest concentration (90 µg/g of soil) tested (Table 1). At the same dose, both of the formulations were also caused approximately the same amounts of reduction in shoot biomass of the weed. The said reduction effect in both of the parameters, ie total biomass and shoot biomass gradually goes down in treatments of the emulsifiable concentrate and emulsive water formulations developed by taking in orderly increase polarity (D < C < B and < A) of the extracted fractions. Therefore, approximately double concentration (180 µg/g gram of soil) of formulations, developed from the medium polar fractions, viz D, C, and B was required to bring out only 60–70% reduction in both of the parameters. Whereas the formulation developed from the completely polar fraction, i e A (water soluble) caused only 50–55% reduction in both of the parameters that too at much higher concentration, ie 270 µg/g of soil, the highest concentration of the formulation tested. The reduction in shoot biomass of treated plants via all the six formulations and their different treatments seems to be observed by being virtue of two factors, ie the growth retarding effect of allelochemicals as well as the less number of shoots induced by plants in treated pots (Fig 2). Since the experiments were maintained for sufficient longer period (two-and-a half months) hence up to the time of observation, apart from the originated two shoots generated by the tubers originally sown in pots, many more new shoots were emerged out due to the germination of newly formed and timely matured tubers. Therefore, this factor is also considered as an important parameter for

Table 1 Efficacy of sesame allelochemicals on vegetative growth of *Cyprus rotundas* (purple nut sedge)

Isolated fraction	Treatment													CV	SEM	CD
	Cont.	15 (µg/g)	30 (µg/g)	45 (µg/g)	60 (µg/g)	75 (µg/g)	90 (µg/g)	120 (µg/g)	135 (µg/g)	150 (µg/g)	180 (µg/g)	225 (µg/g)	270 (µg/g)			
Effect on induction of new shoots (no. of new shoots emerged out)																
Fraction F	2□ 16 (00)*	2□ 13 (18.75)	2□ 14 (12.50)	2□ 11 (31.25)	2□ 9 (43.75)	2□ 9 (43.75)	2□ 6 (62.50)							24.10	2.210	4.820
Fraction E	2□ 16 (00)	2□ 12 (25.00)	2□ 12 (25.00)	2□ 10 (37.50)	2□ 9 (43.75)	2□ 6 (62.50)	2□ 4 (75.00)							14.71	1.191	2.598
Fraction D	2□ 16 (00)		2□ 14 (12.50)		2□ 12 (25.00)		2□ 7 (56.25)	2□ 7 (56.25)		2□ 7 (56.25)	2□ 4 (75.00)			19.81	1.548	3.374
Fraction C	2□ 23 (00)		2□ 14 (39.10)		2□ 11 (52.17)		2□ 11 (52.17)	2□ 8 (65.21)		2□ 12 (47.83)	2□ 7 (69.56)			13.18	1.327	2.893
Fraction B	2□ 23 (00)		2□ 14 (39.13)		2□ 13 (43.48)		2□ 11 (52.17)	2□ 10 (56.52)		2□ 7 (69.56)	2□ 7 (69.56)			12.58	1.247	2.718
Fraction A	2□ 14 (00)			2□ 13 (7.14)			2□ 11 (21.43)		2□ 10 (28.57)	–	2□ 11 (21.43)	2□ 14 (0.0)	2□ 10 (28.57)	153	21.86	47.66
Effect on shoot biomass (average shoot biomass in g)																
Fraction F	3.21 (00)	1.98 (38.31)	1.67 (47.97)	1.63 (49.22)	1.28 (60.12)	1.03 (67.91)	.051 (84.11)							16.37	0.216	0.470
Fraction E	3.21 (100)	2.32 (27.75)	2.15 (33.00)	1.96 (38.94)	1.62 (49.53)	0.75 (76.63)	0.33 (89.71)							17.90	0.258	0.562
Fraction D	3.21 (00)		2.50 (22.11)		2.14 (33.33)		2.00 (37.69)	1.80 (43.92)		1.71 (46.72)	1.08 (66.35)			13.64	0.229	0.500
Fraction C	3.44 (00)		2.96 (13.95)		2.65 (22.96)		2.09 (39.24)	1.94 (43.60)		1.73 (49.70)	1.33 (61.33)			15.62	0.294	0.641
Fraction B	3.44 (00)		2.83 (17.73)		2.48 (27.90)		1.73 (49.70)	1.64 (52.32)		1.13 (67.15)	1.06 (69.18)			12.29	0.205	0.447
Fraction A	5.00 (00)			4.35 (13.00)			4.25 (15.00)		4.24 (15.00)		3.92 (21.60)	3.01 (39.80)	2.46 (50.80)	5.01	0.159	0.347
Effect on total biomass (average total biomass in g)																
Fraction F	12.00 (00)	8.66 (27.83)	6.16 (48.66)	5.27 (56.08)	3.44 (71.33)	2.88 (76.00)	2.16 (82.00)							18.71	0.885	1.930
Fraction E	12 (00)	9.95 (17.08)	7.90 (33.46)	6.37 (46.91)	5.07 (57.75)	2.58 (78.50)	1.08 (91.58)							15.06	0.789	1.721
Fraction D	12.00 (00)		10.11 (15.75)		9.03 (24.75)		8.80 (26.66)	8.11 (32.41)		7.40 (38.33)	2.94 (75.05)			12.98	0.884	1.927
Fraction C	12.60 (00)		10.47 (16.90)		9.52 (24.44)		7.58 (39.84)	7.34 (41.74)		6.33 (49.76)	3.90 (69.04)			4.19	0.282	0.614
Fraction B	12.60 (00)		10.68 (15.23)		9.60 (23.80)		7.92 (37.14)	6.02 (52.22)		5.78 (54.12)	4.11 (67.38)			4.31	0.285	0.622
Fraction A	10.43 (00)			9.23 (11.50)			8.41 (19.36)		7.98 (23.48)		7.42 (28.85)	5.70 (45.34)	4.75 (54.45)	4.65	0.292	0.637

Figures in parentheses indicate per cent reduction

assessing the efficacy of developed formulations. Nearly 60–70% reduction in such kind of newly induced shoots was observed uniformly in all the EC and EW formulations prepared from organic solvents soluble fractions, viz F, E, D, C and B at their respective highest concentrations (90, 90, 180, 180 and 180µg/g of soil), whereas this effect was found less pronounced in all the tested concentrations of EW formulation exclusively developed from completely polar fraction (A, water soluble). Since in this respect, the data obtained from the emulsive water formulation of water soluble fraction was found highly insignificant, therefore no much impact of the formulation can be assumed. Reduction in shoots may either be assumed by the poor germination of newly formed tubers as the severe impact of allelochemicals as germination inhibitor was also confirmed by us in our previous studies (Kumar and Varshney 2004, 2008) or may be partially by the loose in germination viability of newly formed tubers though that has not been confirmed yet. Apart from inhibitory effect, the emulsifiable concentrate formulation exclusively developed

Fig 2 Effect of formulations E and F on roots and tuber development and vegetative growth of purple nutdedge, *A.* Effect of formulation *E* on vegetative growth, *B*, effect of formulation *F* on phenology, *C* roots and tuber development of plants

from the highly non-polar fraction (F) also exhibited severe impact on the morphology of the plants. At higher concentrations, ie 60/µg gram and above, though, it severally prohibited the plants to induce new shoots but instigated them to elongate their main shoots abruptly which ultimately forced the treated plants to fluorescence in very short period of time (Fig 2), this clear-cut indicates the role of certain allelochemicals of sesame root exudates in imparting their toxicity via modifying the phenological processes of purple nut sedge plants.

Effect of developed formulations on root growth and tuber development

Comparatively predominant effect of all the assayed six emulsifiable concentrate and emulsive water formulations was observed on the growth of roots and the tuber development tendency of the of purple nut sedge plants. Here again polarity factor of extracted fractions played key role in imparting their toxicity towards various root concern growth-limiting parameters of purple nut sedge plants. To assess the toxicity of prepared formulations in totality observations were recorded on average total biomass of roots received by retaining newly formed tubers and biomass of roots excluding the tubers weight, total number of tubers newly formed and their average biomass and average biomass of each tuber (specific biomass of developed tubers). In all these respects, all the developed formulations were found quite effective at their different tested concentrations. Emulsifiable concentrate formulations, especially developed from highly non-polar (F) and non-polar (E) fractions revealed a drastic reduction in total biomass of roots (including tubers) and in total number of tubers newly developed on roots (Fig 2). Reduction effect in both the parameters was found concentration dependent in treatments of both the emulsifiable concentrate formulations, ie increase in concentration caused more reduction. Compared to control, approximately 15–20% reduction in both of the parameters in treatments of both of the formulations was observed at their lowest concentration (15 µg/g of soil) tested, which increased linearly with increase in concentration of the formulations (Table 2). Approximately, compared to control 80–90% and up to 95–99% respective reduction in total root biomass and tuber development tendency of roots was noticed at highest concentration (90µg/g of soil) of both of the formulations. Obtained data also revealed a grave impact of the highly non polar fraction (F) - based emulsifiable concentrate formulation on average biomass of tubers newly formed and survived in treated pots that was reduced from 0.175 g in case of control to 0.009 g (94% reduction) at 90µg/g of soil concentration. Though on this aspect, no much impact was observed in the treatments of second non-polar (E) fraction-based formulation. Emulsifiable Concentrate formulation developed from fraction D (acetone soluble) and emulsive water formulations developed from fractions C and B (methanol soluble) come under the category of medium polarity, all these three formulations caused around 70–75% reduction in total number of tubers and total biomass of roots at their highest concentration, ie 180 µg/g soil, applied, which is exactly double in comparison to the applied highest concentration of non-polar fractions based emulsifiable concentrate formulations. Whereas, emulsive water formulation developed from water soluble fraction caused only 58% reduction in both the parameters that too at very high concentration, viz 270 µg/g soils. Though all these four formulations in their different treatments showed quite good impact in reducing the number of tubers on roots and their average biomass but did not exhibit any significant impact on the specific biomass of newly developed tubers in no one of their treatments. Severe reduction in specific biomass of tubers can lead to poor germination properties as expected by such kind of undeveloped tubers, therefore such kind of impact of medium polar and polar fractions formulations can not be assumed. Whereas, severe reduction (94%) in specific weight of tuber and up to 97% reduction in tuber numbers at 90 µg/g soil concentration of highly non-polar fraction (F)-based formulation gave a clearcut indication about its grave role in severe reduction in the propagation properties of this obnoxious weed by both, ie first by not allowing the nut sedge plants to form much tubers on their roots and secondly loose in the germination viability of such scanty tubers, if formed. The severe reduction in biomass of roots and their tuber formation tendencies seem mainly due to the degradations

Table 2 Efficacy of sesame allelochemicals on roots and tuber development of *Cyprus rotundas* (purple nut sedge).

Isolated fraction	Treatment															
	Cont.	15 (µg/g)	30 (µg/g)	45 (µg/g)	60 (µg/g)	75 (µg/g)	90 (µg/g)	120 (µg/g)	135 (µg/g)	150 (µg/g)	180 (µg/g)	225 (µg/g)	270 (µg/g)	CV	SEM	CD
Tubers newly formed (no.)																
Fraction F	22 (100)	18 (18.18)	14 (36.36)	9 (59.09)	7 (68.18)	5 (77.27)	0.66 (97.00)							19.9	1.759	3.83
Fraction E	22 (100)	16 (27.27)	15 (31.82)	11 (50.00)	10 (54.55)	3 (86.36)	2 (90.90)							18.7	1.727	3.765
Fraction D	22 (100)		23 (0.00)		18 (18.18)		17 (22.72)	20 (9.10)		13 (40.91)	5 (77.27)			14.77	0.202	0.439
Fraction C	28 (100)		22 (21.42)		20 (28.57)		17 (39.28)	16 (42.85)		12 (57.14)	7 (75.00)			17.68	2.516	5.485
Fraction B	29 (100)		23 (20.68)		18 (37.93)		16 (44.82)	14 (51.72)		9 (68.96)	7 (75.86)			14.43	1.935	4.219
Fraction A	18 (100)			17 (5.55)			20		16		15	13	13	10.48	1.368	2.983
Av. Tuber biomass (g)																
Fraction F	3.78 (100)	3.44 (8.99)	1.85 (51.05)	1.64 (56.61)	0.64 (83.06)	0.48 (87.30)	0.006 (99.89)							19.9	0.275	0.599
Fraction E	3.78 (100)	3.03 (19.84)	2.47 (34.65)	1.74 (53.96)	1.25 (66.93)	0.67 (82.27)	0.25 (93.38)							12.23	0.188	0.410
Fraction D	3.78 (100)		3.87 (0.00)		3.41 (9.79)		3.03 (19.84)	3.07 (18.78)		2.41 (36.24)	0.57 (84.92)			15.92	0.374	0.816
Fraction C	3.39 (100)		2.92 (13.86)		2.72 (19.76)		2.14 (36.87)	1.89 (44.24)		1.21 (64.30)	0.83 (75.51)			18.47	0.325	0.709
Fraction B	3.39 (100)		3.48 (0.00)		2.91 (14.16)		2.33 (31.21)	2.33 (31.21)		1.67 (50.73)	1.20 (64.60)			13.03	0.263	0.573
Fraction A	2.48 (100)			2.14 (13.70)			2.10 (15.32)		1.85 (25.40)		1.79 (27.82)	1.38 (44.35)	1.02 (58.87)	10.94	0.163	0.355
Av. Biomass of each tuber (g)																
Fraction F	0.175 (100)	0.193 (0.00)	0.134 (23.43)	0.188 (0.00)	0.097 (44.57)	0.099 (43.43)	0.009 (94.85)							32.4	0.338	0.737
Fraction E	0.175 (100)	0.190 (0.00)	0.164 (4.65)	0.157 (8.72)	0.125 (27.32)	0.232 (0.00)	0.131 (23.83)							15.5	0.021	0.046
Fraction D	0.175 (100)		0.168 (2.32)		0.198 (0.00)		0.178 (0.00)	0.153 (11.04)		0.186 (0.00)	0.112 (34.88)			13.45	0.018	0.040
Fraction C	0.120 (100)	(0.00)	0.133		0.136 (0.00)		0.124 (0.00)	0.117 (2.5)		0.101 (15.83)	0.120 (0.00)			6.55	0.006	0.014
Fraction B	0.120 (100)		0.151 (0.00)		0.161 (0.00)		0.145 (0.00)	0.167 (0.00)		0.189 (0.00)	0.177 (0.00)			10.21	0.013	0.029
Fraction A	0.138 (100)			0.126 (8.69)			0.105 (23.91)		0.115 (16.66)		0.119 (13.77)	0.106 (23.19)	0.079 (42.75)	6.26	0.006	0.013
Av. Biomass of roots by including tubers weight																
Fraction F	8.79 (100)	6.68 (24.00)	4.57 (48.00)	3.64 (58.58)	2.15 (75.54)	1.85 (78.95)	1.65 (81.22)							13.21	0.542	0.985
Fraction E	8.79 (100)	7.62 (13.31)	5.75 (34.58)	4.41 (49.82)	3.44 (60.86)	1.82 (79.29)	0.64 (92.71)							9.50	0.359	0.784
Fraction D	8.79 (100)		7.60 (13.54)		6.89 (21.61)		6.80 (22.64)	6.30 (28.33)		5.69 (35.27)	1.86 (78.84)			8.06	0.413	0.899
Fraction C	9.16 (100)		7.51 (18.01)		6.86 (25.10)		5.48 (40.17)	5.40 (41.04)		4.60 (49.78)	2.57 (71.94)			6.88	0.334	0.727
Fraction B	9.16 (100)		7.85 (14.30)		7.11 (22.37)		6.18 (32.53)	4.65 (49.23)		4.37 (52.29)	3.05 (66.70)			8.61	0.419	0.915
Fraction A	5.43 (100)			4.88 (10.12)			4.16 (23.38)		3.74 (31.12)		3.50 (35.54)	2.68 (50.64)	2.28 (58.01)	5.84	0.182	0.396
Av. Biomass of roots deducing tubers weight																
Fraction F	5.01 (100)	3.24 (35.32)	2.72 (45.70)	2.00 (60.07)	1.51 (69.86)	1.37 (72.65)	1.64 (67.26)							28.0	0.572	1.246
Fraction E	5.01 (100)	4.59 (8.38)	3.28 (34.53)	2.67 (46.70)	2.19 (56.28)	2.15 (77.04)	0.39 (90.41)							9.88	0.145	0.317
Fraction D	5.01 (100)		3.73 (25.55)		3.48 (30.54)		3.77 (24.75)	3.23 (35.53)		3.28 (34.53)	1.29 (74.25)			9.13	0.253	0.553
Fraction C	5.77 (100)		4.59 (20.45)		4.13 (28.24)		3.34 (42.11)	3.51 (39.34)		3.39 (41.24)	1.74 (70.00)			3.96	0.122	0.266
Fraction B	5.77 (100)		4.37 (24.43)		4.20 (27.20)		3.85 (33.27)	2.32 (59.79)		2.70 (53.03)	1.85 (67.93)			4.06	0.119	0.259
Fraction A	2.95 (100)			2.74 (7.11)			2.06 (30.16)		1.89 (36.27)		1.71 (42.03)	1.30 (55.93)	1.26 (57.62)	10.13	0.165	0.361

*Figures in parenthesis indicate per cent reduction of roots of purple nut sedges by the influence of allelochemicals. The effect is also confirmed and reported previously by us in our previous Petri-plate experiments conducting against this weed as well as the some other weeds (Kumar and Varshney 2008).

Therefore, obtained bioefficacy data strongly suggested that isolated allelopathic compounds of sesame root exudates possess potential herbicidal activity against purple nut sedge in all respects. The extracted allelocompounds not only have their effect in delaying and completely loosing the germination viability of tubers and inhibiting the vegetative growth of purple nut sedge but also possess tremendous ability to destroy the weed via degrading their roots and not allowing the survived roots to form many tubers on them. All these together certainly would lead to break the propagation cycle of this weed which is very much required for effective management of this weed since it is propagated in fields by continuously forming the tubers. Hence, the allelochemical belong to sesame root exudates could be good candidate for the development of new herbicidal model for nut sedge control in agricultural crops. To prove this hypothesis chemical structure determination of all the six extracted molecules is immensely required and presently efforts have focused on this direction in our laboratory.

REFERENCES

Chandrasekhar C N, Manian K and Kandasamy O S. 1998. Studies on allelopathic potential of sesame haulm on physiology and growth of purple nutsedge (*Cyperus rotundus*) and Bermuda grass (*Cynodon dactylon*). *Indian Journal of Weed Sciences* **30** (1–2): 94–5.

Neeser C. and. Varshney Jay G. 2001. Purple nutsedge Biology and principles for management without herbicides. *Indian Journal of Pulses Research* **14** (1): 10–19.

Kumar L. 2004. IIPR technique for the extraction, separation and purification of allelocompounds from plant species. Full length paper in the proceeding of *International Workshop on Protocols and Methodologies in Allelopathy*, pp 34–42, held during 2–4 April 2004 at CSKHPKV Agriculture University Palampur.

Kumar L and Varshney J G. 2004. Efficacy of allelochemicals extracted from sesame against *Cyprus rotundus*. Paper presented in the *International Workshop on Protocols and Methodologies in Allelopathy,* held during 2–4 April 2004 at CSKHPKV Agriculture University Palampur.

Kumar L and Varshney J G. 2008. Efficacy of sesame (*Sesamum indicum*) root exudates against major weeds of pulse crops. *The Indian Journal of Agricultural Sciences* **78** (9): 842–7.

Kumar L and Varshney J G. (2008). Isolation of allelocompounds from sesame root exudates and their efficacy against purple nut sedge (*Cyperus rotundus*). *Indian Journal of Weed Sciences* **40** (1&21): 23–7.