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EFFECTS OF *XANTHIUM STRUMARIUM* L. EXTRACT, ANILOFOS AND BUTACHLOR ON WEEDS, YIELD, YIELD ATTRIBUTES AND NUTRIENT UPTAKE OF TRANSPLANTED RICE

PK UPADHYAY, E KUMARI, A SEN*, P RAHA[1], RK SINGH, SK CHOUDHARY, RK SINGH[2] AND Y SINGH

Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University,Varanasi-221 005, India

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Abstract

Plant products and residues used for management of weeds have the potential of minimizing problem of herbicide resistance, soil and water pollution through various allelochemicals present in it which are capable of controlling weeds besides improving or maintaining soil productivity. In the present investigation application of petroleum ether extract of *X. strumarium* @ 2000 and 3000 mg/l caused significant reduction in the population and dry matter production of weeds in transplanted rice as compared to weedy check but remained at par with Anilofos and higher dose of methanol and water extract for controlling weeds in transplanted rice. Petroleum ether extract of *X. strumarium* of 2000 and 3000 mg/l recorded significantly higher yield and yield attributing characters as well as N, P and K removal by grain and straw than control, although it remained at par with Anilofos.

Rice is a poor competitor against weed. Uncontrolled weed growth in transplanted rice is reported to cause a yield loss of 15 - 45% depending upon the type of weed flora and their density. Besides yield reduction, weeds also deplete nutrients from the soil to the tune of 11.0, 3.0 and 10.0 kg/ha of N, P and K, respectively (Gautam and Mishra 1995).

Herbicides, although being major factors contributing to world crop production, are held responsible (because of its intensive use) for environmental pollution, shifting in weed flora and evolution of resistant weed biotypes, which jeopardize herbicides utility and longevity and impose threat to productivity of world agriculture (Datta and Khushi 2002). In order to minimize problem of herbicide resistance as well as soil and water pollution, plant products and plant residues are used for management of weeds through its allelochemicals which have been found to possess capacity to control weeds besides maintaining soil productivity. There are several allelochemicals present in the *X. strumarium* extract which have been used as a herbicide. The main toxic compound isolated from the plant has been identified as carboxyatractyloside, a kaurene glycoside previously called xanthostrumarium while the toxic principles of the seeds are hydroquinone (Roussakis *et al.* 1994). Its herbicidal effect on some weeds has been reported by Upadhyay *et al.* (2006).

Keeping this in view a field trial was carried out during the rainy seasons of 2011 and 2012 at the Banaras Hindu University, Varanasi, India to evaluate its effect on rice weeds. The experiment consisting of 11 herbicidal treatments *viz*. petroleum ether extract of *X. strumarium* @ 1000, 2000 and 3000 mg/l, anilofos @ 900 mg/l, butachlor @ 3000 mg/l, methanol extract of *X. strumarium* @ 1000, 2000 and 3000 mg/l, water extract of *X. strumarium* @ 1000, 2000 and 3000 mg/l and untreated control was laid out in RCBD with 3 replications.

*Author for correspondence: <avijitbhu@hotmail.com>. [1]Department of Soil Science & Agricultural Chemistry, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, PIN- 221 005, India. [2]Division of Agronomy, IARI, New Delhi, India.

100 g of *X. strumarium* biomass (stem + leaf + seed) was placed inside a thimble and loaded into the main chamber of the Soxhlet extractor. The Soxhlet extractor was placed in a flask containing 1000 ml solvent (petroleum ether or methanol) and fitted with a condenser. The solvent was heated up to 70ºC and the solvent vapour travelled up a distillation arm into the chamber housing the thimble of solid material. The condenser ensured cooling of solvent vapour which dripped back down into the chamber housing the biomass of *X. strumarium*. The Soxhlet chamber when became almost full, was automatically emptied by a siphon side arm, with the solvent running back down to the distillation flask. This cycle was allowed to continue for 5 hrs. In this way mixture of solvent and soluble compound of *X. strumarium* was collected in round bottom flask. After extraction, the solvent was removed and evaporated typically by a rotary evaporator (Zenith Glassware- complete with water bath and vacuum pump).

Water extraction was done by placing 100 g cocklebur biomass (equal proportion of stem, leaf and seed) in beaker of 1000 ml of water boiled by heater for an hr. The material was filtered with cotton cloth and filtrate containing plant extract and water was separated by using heater.

Table 1. Amount of extracts obtained from 100 g of biomass of *X. strumarium*.

Name of solvent	Volume of solvent (ml)	Extract weight (g)
Petroleum ether	1000	4.16
Methanol	1000	5.80
Water	1000	8.12

Herbicides and all *X. strumarium* extracts were applied in transplanted rice variety HUBR 2-1 as pre-emergence (of weeds) application after two days of transplanting. The biological efficacy of the treatments was assessed in terms of weed population and its dry matter production at 30, 60 and 90 days after transplanting.

Total nitrogen, phosphorus and potassium were analyzed by Micro Kjeldahl, Vanado-molybdo-phosphoric acid yellow colour and Flame Photometer method (Jackson 1967), respectively.

The dominant weed flora in the present experiment comprised of *Echinochloa colona* (L.) Link., *Echinochloa crus-galli* (L.) P. Beauv., *Cyperus rotundus* (L.), *Ammannia baccifera* (L.), *Caesulia axillaris* Roxb. and *Cynodon dactylon* (L.) Pers among others. Among the treatments application of petroleum ether extract of *X. strumarium* @ 2000 and 3000 mg/l as pre-emergence proved most effective but was at par with application of anilofos @ 900 mg/l, methanol extract @ 2000 and 3000 mg/l, butachlor @ 3000 mg/l and water extract @ 3000 mg/l in reducing the dry weight of weeds. Reduced weed emergence from these extract resulted in better rice growth which led to greater ground coverage by crop with smothering effect on weeds. The highest reduction in population and dry weight of weed was observed at 3000 mg/l followed by 2000 mg/l of petroleum ether over control (Table 2).

Increase in yield of rice by petroleum ether extract @ 2000 and 3000 mg/l was found to be 12.79 and 15.45% over control, respectively. Among the treatments application of petroleum ether extract @ 2000 and 3000 mg/l recorded maximum N, P and K uptake by grain and straw (Table 3).

The higher growth reducing capacity of stem + leaf extract on weeds might be due to higher level of abscisic acid and phaseic acid in shoot/phloem of the *Xanthium* (Zeevaart *and Boyer* 1984). Besides alkaloids, the aerial parts of the plant contain sesquiterpene lactones, *viz.* Xanthinin (Kamboj and Saluja 2010). Abscisic acid plays an important role in the closing of stomata which

Table 2. Effect of *Xanthium strumarium* extract, anilofos and butachlor on weed population and its dry weight in transplanted rice.

Treatments	Conc. of extract (mg/l)	Weed population/m²						Dry weight of weeds (g)/m²					
		30 DAT		60 DAT		90 DAT		30 DAT		60 DAT		90 DAT	
		2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Control	-	15.48	9.62	18.92	21.43	5.63	3.58	39.95	25.83	44.32	50.86	10.47	7.37
Anilofos	900	9.47	7.21	11.39	17.41	2.46	2.11	20.40	22.69	30.26	42.35	4.46	4.97
Butachlor	3000	10.06	8.01	12.73	17.97	3.11	2.76	21.28	23.97	32.57	44.90	5.49	5.11
Methanol extract of *Xanthium strumarium*	1000	13.75	9.41	16.82	19.58	4.68	3.29	37.23	24.19	41.92	46.56	9.08	6.24
Methanol extract of *Xanthium strumarium*	2000	12.08	7.99	12.53	18.36	3.83	2.76	22.62	23.97	32.90	43.33	7.26	5.10
Methanol extract of *Xanthium strumarium*	3000	11.17	7.49	11.64	18.04	3.38	2.13	23.01	23.89	32.88	43.19	6.07	5.01
Petroleum ether extract of *Xanthium strumarium*	1000	11.06	8.00	10.70	19.01	4.08	3.29	23.28	24.51	31.97	45.68	8.18	6.24
Petroleum ether extract of *Xanthium strumarium*	2000	10.83	6.99	10.23	16.49	3.40	2.11	22.99	22.83	31.26	42.52	6.29	4.97
Petroleum ether extract of *Xanthium strumarium*	3000	9.74	6.38	10.05	15.93	3.24	1.96	21.36	22.42	30.78	40.21	5.99	4.09
Water extract of *Xanthium strumarium*	1000	14.23	8.79	17.96	20.38	4.79	3.31	38.84	25.17	43.11	49.86	9.43	6.44
Water extract of *Xanthium strumarium*	2000	12.54	8.67	16.19	19.83	4.52	3.35	37.09	24.56	42.16	47.18	8.97	6.46
Water extract of *Xanthium strumarium*	3000	11.95	7.88	12.07	17.55	3.83	2.77	24.29	24.19	34.53	44.64	6.29	5.13
CD/LSD (p = 0.05)		3.81	1.42	2.20	2.31	1.12	0.78	2.88	1.34	2.65	2.29	1.54	0.97

DAT = Days after transplanting, LSD = Least significant difference - equivalent to CD i.e. critical difference.

Table 3. Effect of *Xanthium strumarium* extract, anilofos and butachlor on yield, yield attributes and nutrient uptake by transplanted rice.

Treatments	Conc. of extract (mg/l)	No. of panicles/m^2		No. of grain/panicle		Grain yield kg/ha		Straw yield kg/ha		Nitrogen uptake (kg/ha)				Phosphorus uptake (kg/ha)				Potassium uptake (kg/ha)			
										2011		2012		2011		2012		2011		2012	
		2011	2012	2011	2012	2011	2012	2011	2012	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
Control	-	258.3	260.8	132.4	146.3	3684	4130	4517	5304	43.73	26.47	49.56	35.51	6.94	3.38	8.26	4.24	10.31	79.38	11.98	103.8
Cnilofos	900	294.5	268.2	152.4	154.5	4081	4760	4965	5647	50.61	37.34	58.54	42.86	9.80	4.92	10.94	5.02	14.28	106.9	15.71	115.6
Butachlor	3000	284.6	262.5	148.0	152.2	3879	4640	4743	5595	47.32	32.47	56.14	40.24	8.53	4.22	10.20	4.86	13.19	92.97	13.92	111.8
Methanol extract of *X. strumarium*	1000	269.3	261.0	143.6	149.5	3782	4263	4553	5393	45.39	27.56	51.56	37.73	7.19	3.73	8.95	4.47	11.35	82.50	12.35	105.6
Methanol extract of *X. strumarium*	2000	286.4	264.1	150.3	152.5	3954	4450	4777	5424	48.51	33.76	54.29	39.56	9.09	4.38	9.34	4.55	13.44	95.47	13.35	108.9
Methanol extract of *X. strumarium*	3000	289.3	265.3	153.5	152.9	3980	4467	4956	5503	48.95	35.28	54.41	40.72	9.15	4.66	9.81	4.68	13.53	101.1	14.14	111.7
Petroleum ether extract of *X. strumarium*	1000	271.3	260.3	140.5	150.6	3796	4560	4582	5533	45.55	28.06	55.17	39.81	7.46	3.88	9.58	4.64	11.39	83.48	14.79	109.4
Petroleum ether extract of *X. strumarium*	2000	292.4	267.9	148.8	153.4	4038	4776	4969	5684	50.08	36.32	58.19	42.60	9.69	4.77	10.97	4.99	14.13	104.9	15.49	115.3
Petroleum ether extract of *X. strumarium*	3000	302.3	269.0	149.6	155.2	4173	4849	5003	5779	51.89	39.61	59.99	45.58	10.43	5.59	11.62	5.19	14.61	108.7	14.52	120.0
Water extract of *X. strumarium*	1000	258.4	259.4	134.6	147.3	3751	4274	4525	5293	44.51	27.04	51.66	37.03	7.13	3.45	8.97	4.39	10.88	80.77	12.87	103.6
Water extract of *X. strumarium*	2000	268.5	261.2	136.9	150.9	3769	4295	4540	5318	44.86	27.29	52.33	38.76	7.16	3.57	9.01	4.51	10.93	81.64	12.89	104.6
Water extract of *X. strumarium*	3000	283.5	262.4	146.4	152.1	3854	4348	4720	5443	47.02	31.38	52.94	39.71	8.09	4.12	9.55	4.68	13.10	88.91	13.02	108.2
CD ($p = 0.05$)	16.6	1.76	12.5	2.45	163	40	184	89	2.03	2.91	2.76	3.57	0.88	0.53	0.72	0.87	0.60	7.45	3.44	2.75	

leads to the inhibition of photosynthesis and consequent reduction in growth. Cell division and elongation are also inhibited by abscisic acid because of which it is known as a growth inhibitor (Pandey and Sinha 2001). Extracts from seed and stem + leaf of *Xanthium* with higher level of abscisic acid therefore, inhibited the growth of weeds.

In general, total weed dry matter increased progressively up to 60 DAT (days after transplanting) after which a decreasing trend was noticed. Growth of weed gradually decreases with the time as it completes its life cycle before the crop and this ultimately reduces total dry matter accumulation (Rao 2000). Reduction in dry weight of shoot of different weeds along with higher phytotoxicity (injurious to plant life or life process) was found in petroleum ether extract followed by methanol and water extract application. Presence of high level of bioactive low polar lipid compounds (oil, terpenoid, steroid etc.) in petroleum ether extract were the possible herbicidal ingredients in *X. strumarium* extracts which brought about this effect (Ma *et al.* 1998). The GCMS study showed the presence of bornyl acetate, limonene and β-selinene in the oil of *X. strumarium* (Esmaeili *et al.* 2006). Fats and lipids in cells obstruct absorption of nutrient from solution by increasing osmotic gradient (Karadjova *et al*. 2000). As a result of this herbicidal effect was found to be more in low polar solvent i.e. petroleum ether extracts in comparison to methanol and water extract with increasing polarity.

Maximum N, P and K uptake by grain and straw was due to lower weed competition in rice which provided congenial environment for more availability of moisture and nutrient to rice and restricted uptake of nutrients by weeds. This in turn encouraged better plant growth, bold grains and finally higher yield leading to higher uptake of N, P and K. Nanjappa and Krishnamurthy (1980) reported that N, P and K uptake by rice crop was inversely proportional to the N, P and K uptake by weeds.

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