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New Approach to Use Rice Straw Waste for Weed Control. II. The Effect of Rice Straw Extract and Fusilade (Herbicide) on Some Weeds Infesting Soybean (*Glysin max* L.)

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ABSTRACT

A greenhouse experiment was carried out to study the combined effect of rice straw extract and fusilade herbicide on some aggressive grasses (i.e. *Echinochloa crus-galli* L. & *Echinochloa colonum* L.) associated with 3 soybean varieties. The fusilade herbicide (40 g/ feddan) and methanol extract of rice straw (3.47 - 13.9 g/ L) were sprayed as post-emergence either alone or in combination. Spraying fusilade alone was more effective in suppressing (50 - 78%) growth and development of the two weeds than applying rice straw extract alone; irrespective of the rate of application. Applying fusilade in combination with rice straw particularly at the lowest (3.47 g/ L) and moderate (6.95 g/ L) doses were the most effective treatments by all means of suppressing weed growth as well as increasing vegetative growth and yield productivity of soybeans. Combined fusilade with rice straw extract at the highest rate (13.9 g/ L) showed severe toxicity against soybean growth and yield productivity.
It has suggested that the rice straw might open the door for new strategy for controlling the aggression of grassy weeds in soybean.

Key Words: Fusilade herbicide; Rice straw; Allelopathy; Post-emergence; Weed control; Weeds; Soybean

INTRODUCTION

Fusilade is a worldwide well-known selective grass herbicide for post-emergence application in numerous broad-leaved crops (Keul *et al*., 1990). The fusilade herbicide (fluazifop-*p*-butyl) is related to aryloxyphenoxy-propionate (AOPP), which is a class of graminicides, a grass-selective herbicides acting specifically on inhibiting the enzyme Acetyl CoA carboxylase in susceptible grass species (Burton *et al*., 1989). Applying fusilade in soybean plants at 0.25 and 0.5 Kg/ ha effectively controlled several aggressive grasses e.g. (*Echinochloa crus-galli*), (*Cynodon dactylon*) and (*Digitaria ciliaris*), particularly when applied at the early stage of growth (Tiwari *et al*., 1997). However, Akhtar *et al*. (1990) found that the higher concentration of fusilade herbicide (4 L/ ha) successfully suppressed grasses in soybeans by more than 95% but the yield was decreased to some extent. Ahmed and Rashad (1996) provided similar results on the sensitivity of soybean plants to fusilade herbicide, as the crop growth was decreased with the foliar application of 400 ml/ feddan from the herbicide.

Allelopathy is a natural and environment-friendly technique, which may prove useful as a unique tool for weed management (Molish, 1937; Rice, 1984). It involves direct or in-direct (harmful or beneficial) effects of one plant upon another through the production of secondary chemical compounds that technically escape into the environment in sufficient quantity and with enough persistence to cause the enrolled effects. Cheema *et al*. (1997) reported that allelopathy phenomenon has many possible agricultural applications such as weed control, intercroppings, nutrients recycling, selection and improvement of crops for their allelopathic potential through genetic manipulation and isolation of allelochemical and their subsequent use as natural herbicides or as a new template for new herbicides (Duke *et al*., 2002). Numerous researches referred to the herbicidal potential of the extracts of wheat, maize, soybean, barley and rye crops as good suppressors to many crop and weed species. Recently, the phytotoxicity of such plants extract were attributed to containing several phenolic compounds of which 2,4–dihydroxy-1,4(2*H*)–benzoxazin-3one (DIBOA) was the most dominant and effective amongst such species (Barnies and Putman, 1987; Wu *et al*., 1998, 2000, 2001a, 2001b; Roth *et al*., 2000; Kato-Noguchi *et al*., 2002). Cheema and Kalig (2000) found a useful implication of sorghum allelochemicals to be used as natural herbicide called sorgaab, a water extract of mature sorghum obtained after soaking in water for 24 hrs, which by applying in wheat field the growth of associated weeds was reduced by 35% and the yield was increased by 10 and 21%. However, the high cost and low stability in environment as in all natural products are still discouraging (Duke, 1991). However, Duke *et al*. (2001) recently suggested that genetic engineering might have the potential for overcoming this impasse.

A promising model of reducing herbicidal use by plant extracts was suggested by El-Shazely *et al*. (1980), who found that using crude extract of three common weeds in wheat e.g. white clover (*Melilotus* sp.), toothed beer clover (*Medicago lipida*) and cocklebur (*Xanthium stramarium*) in combination with brominal and igran herbicides has resulted in much more toxicity against wheat seedlings used in bioassay test rather than applying either two herbicides alone. Abdul-Rahman and Habib (1986) examined the herbicidal potential of several weed extracts for controlling dodder (*Cuscuta planiflora*), which aggressively infested alfalfa, suggesting that the potency of such extracts in controlling dodder was equal to DCPA or glyphosate, the most popular herbicides in controlling *Cuscuta* weed species.

Rice cultivars of high allelopathic potential can suppress both mono and dicot weeds. Dilday *et al*. (1991) found that 3.5% of 10,000 rice accessions examined for their allelopathic potential against ducksalad (*Hetherantera limosa*) were highly allelopathic as they had a weed free radius at the base of the rice plant > 10 cm. Several studies referred to the herbicidal potential of rice cultivars against weeds growth, which involved a wide range of mono and dicot weed species such as barnyard-grass, *Echinochloa crus-galli*; umbrella plant, *Cyperus difformis* and red-stem, *Purple ammania* (Hassan *et al*., 1994, 1995, 1998; Dilday *et al*., 1998; Takeuchi *et al*., 2001). Chung *et al*. (2003) provide evidence regarding the phytotoxicity of rice body parts including leaves, straw and hull against seed germination and seedling development of barnyard-grass weed, suggesting that such body parts may be a good source of natural herbicides. Olofsdotter *et al*. (2002b) showed that several putative allelochemicals (e.g. *p*-hydroxybenzoic acid, coumaric acid and ferulic acid) were recognized in extracts of rice leaves, intact straw, decomposed straw and rice soils (i.e. paddy soil), with regard to the fact that the concentration and composition of such allelochemicals were differed based on the type of rice cultivars. Similarly, Mattice *et al*. (1997) found significantly higher levels of the phenols 3-hydroxybenzoic acid, 4-hydroxybenzoic acid, 4-hydroxyhydrocinnamic acid, 3-4 dihydroxycinnamic acid and tentatively identified 4-hydroxyphenylacetic acid in water from rice allelopathic cultivars when compared with the non-allelopathic types. However, Olofsdotter *et al*. (1997) stated that the very selective mode of action seen in field testing of allelopathic cultivars dogmatized that the allelochemicals in rice should be specific and not so common as phenolic acids, suggesting that more than one chemical or other group of chemicals are to be responsible for such allelopathic effect.

The present work was aimed to study the combined effect of rice straw extract and fusilade herbicide on two aggressive grass weeds in soybean and to minimize the herbicidal dose for environmental safety.

MATERIALS AND METHODS

Seeds of three cultivars of soybean (*Glysin max*, cv. Giza 21, Giza 22 & Giza 111) were obtained from Agricultural Research Centre, Egypt. Eighty-one pots (30 cm diameter) were filled with silty clay soil. The pots were infested with two grass weed species barnyard-grass (*Echinochloa crus-galli*) and jungle rice (*Echinochloa colonum*) at 10 seeds/ pot. The crop seeds (10 seeds/ pot) were sown simultaneously and mixed thoroughly at 2 cm from the soil. The pots were maintained under greenhouse conditions and watered as required. The soybean seedlings were thinned to 6 plants after three weeks from sowing. Ammonium nitrate and super phosphate (2:1 w/ w) were added for each pot during plant growth.

Dry rice straw (*Oryza sativa* c.v. Sakha 101, 500 g) was collected from rice fields at harvest stage, ground in a grinder and soaked in methanol (2 L) for 48 hrs at room temperature (25^{o}C). The methanol extract was evaporated to dryness by using rotary evaporator (50^{o}C), and the dry residue was re-dissolved in distilled water to make up three concentrations (3.47, 6.95, 13.9 g/ L).

The rice extract was applied alone at the three concentrations or in combination with fusilade (40 g/ feddan, < recommended dose) herbicide [fluazifop-*p*-butyl, 12.5% Zeneca-England] with molecular formula: (R)–2[4-[{5-(trifluoromethyl)2-pyridinyl}oxy-phenoxy] propionic acid. The herbicide and rice solutions were applied as foliar application 30 days after sowing. Samples of weeds and soybean plants were collected 20 and 40 days after spraying i.e. at vegetative and flowering growth stages (50 & 70 days from sowing, respectively). Associated weeds collected from each treatment were washed thoroughly with tap water and the fresh and dry weights (g) were recorded. Some morphological and growth characteristics of soybean plants were recorded including plant height (cm) and shoot biomass (fresh & dry weights, g). Soybean yield and its components including, number of pods/ plant, weight of seeds/ pod, weight of seeds/ plant and weight of 100 seeds were also estimated for each treatment. Three replicates were used for each treatment and control in a completely randomized design. The biological activity of rice extract and herbicide were estimated either on crop or weed growth according to the equations of El-Shazely *et al*. (1980) and Itokawa *et al*. (1982). The data were subjected to statistical analysis as described by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

Effect of fusilade and rice extract on growth and development of weeds. The effect of fusilade and rice straw extract at different concentrations on some grassy weeds in soybean varieties is shown in (Table I). It was found that foliar application of fusilade and rice extract potentially controlled barnyard-grass (*Echinochloa crus-galli*) and jungle rice (*Echinochloa colonum*) weeds in soybean varieties. However, applying fusilade alone at (40 g/ fed.) was more effective in controlling such weeds than applying rice straw extract alone, irrespective of rates of application. Spraying fusilade alone at (40 g/ fed.) substantially inhibited

Table I. Effect of fusilade and rice straw extract on growth and development of some grass weeds infested soybeans

Treatments	Conc.	Weeds development																							
		50 days from sowing												70 days from sowing											
		Fresh weight (g)			Inhibition (%) of control			Dry weight (g)			Inhibition (%) of control			Fresh weight (g)			Inhibition (%) of control			Dry weight (g)			Inhibition (%) of control		
		Giza 21	Giza 22	Giza 111	Giza 21	Giza 22	Giza 111	Giza 21	Giza 22	Giza 111	Giza 21	Giza 22	Giza 111	Giza 21	Giza 22	Giza 111	Giza 21	Giza 22	Giza 111	Giza 21	Giza 22	Giza 111	Giza 21	Giza 22	Giza 111
Control	0.0	5.00	4.85	5.20	-	-	-	1.18	1.22	1.00	-	-	-	7.49	7.69	6.65	-	-	-	1.90	1.89	1.95	-	-	-
Hand-weeded	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fusilade (alone)	40 g/fed.*	1.08	1.79	1.40	78.40	63.09	73.07	0.26	0.45	0.27	77.96	63.11	73.00	2.88	3.82	1.53	61.54	50.32	76.99	0.73	0.94	0.45	61.57	50.26	76.92
Rice straw extract (alone)	3.47 g/L	2.83	3.20	3.26	43.34	34.02	37.30	0.67	0.78	0.68	43.22	36.06	32.00	5.36	5.75	5.90	28.43	25.22	11.27	1.36	1.42	1.50	28.42	24.86	23.07
	6.95 g/L	2.16	2.89	3.04	56.80	40.41	41.53	0.51	0.65	0.56	56.77	46.72	44.00	3.78	4.03	5.69	49.53	47.59	14.43	0.96	1.20	1.27	49.47	36.50	34.87
	13.9 g/L	1.65	2.33	2.65	67.00	51.95	49.03	0.39	0.60	0.50	66.94	50.81	50.00	2.75	3.48	4.81	63.28	54.74	27.66	0.90	1.07	1.11	52.63	43.38	43.07
Fusilade + rice straw extract (combination)	40 g/fed.+ 3.47 g/L	Nil	Nil	Nil	100	100	100	Nil	Nil	Nil	100	100	100	Nil	Nil	Nil	100	100	100	Nil	Nil	Nil	100	100	100
	40 g/fed.+ 6.95 g/L	Nil	Nil	Nil	100	100	100	Nil	Nil	Nil	100	100	100	Nil	Nil	Nil	100	100	100	Nil	Nil	Nil	100	100	100
	40 g/fed.+ 13.90 g/L	Nil	Nil	Nil	100	100	100	Nil	Nil	Nil	100	100	100	Nil	Nil	Nil	100	100	100	Nil	Nil	Nil	100	100	100
	L.S.D. $_{0.05}$	0.25	0.32	0.48	--	--	--	0.06	0.09	0.09	--	--	--	0.15	0.26	0.32	--	--	--	0.15	0.07	0.06	--	--	--

* Feddan=4200 m^2

the growth and development of the two weeds by reducing the fresh and dry weights of weeds, which was estimated by (50.32 - 78.80% & 50.26 - 77.96%, respectively) at the two stages of growth as compared with control. Fusilade did not show any significant differences on controlling barnyard-grass and jungle rice weeds within the different soybean varieties.

Foliar application of rice straw extract alone at different concentrations (3.47, 6.95, 13.9 g/ L) and their subsequent influence on growth and development of grassy weeds indicated that rice straw remarkably inhibited the fresh and dry weights of the weeds by (11.27 - 67%), irrespective of the rate of application. However, applying the rice straw extract at the higher concentration (13.9 g/ L) was more effective in controlling such weeds when compared with lower and moderate concentrations (3.47; 6.95 g/ L) at the vegetative and flowering stages of soybean plants (Table I).

The effect of spraying fusilade in combination with rice straw extract at different concentrations against barnyard-grass and jungle rice weeds is given in (Table I). Foliar application of the mixture at different concentrations entirely killed both weeds object of the study, irrespective of rates of application as compared with control or other treatments. This definitely referring to the established fact that the combination of fusilade herbicide and rice straw extract were more superior on controlling such assayed grassy weeds in soybean plants than applying either two components alone and even at the higher concentrations.

Effect of fusilade and rice extract on growth and development of soybean plants. It was obvious that foliar application of fusilade herbicide alone at (40 g/ fed.) slightly decreased the fresh and dry weights of the three soybean cultivars as compared with corresponding controls. A slight decrease was also observed on the shoot elongation of all soybean cultivars at the two stages of growth (Table II & III). Applying the rice straw extract alone significantly stimulated the shoot elongation and shoot biomass of the three cultivars of soybean plants particularly at the lower (3.47 g/ L) and moderate (6.95 g/ L) concentrations at both vegetative and flowering stages of growth, however, slight inhibition was noticed with the higher concentration (13.9 g/ L) as compared with control.

Applying rice straw extract at the highest rate (13.9 g/ L) in combination with fusilade at (40 g/ fed.) significantly inhibited the growth and development of the three soybean cultivars by reducing the shoot elongation by (7.89 - 10.41%) and fresh and dry weights by (9.50 - 29.16%) at the two stages of growth as compared with control or other treatments. However, the lower and moderate concentrations (3.47; 6.95 g/ L, respectively) of rice straw extract combined with fusilade at (40 g/ fed.) significantly increased the shoot elongation and shoot biomass of all soybean cultivars, which was estimated by (6.84 - 34.21%) and (16.26 - 84.61%), respectively at the two stages of growth, vegetative and flowering stages.

On the other hand, spraying the extract of rice straw alone at the higher concentration significantly reduced plant height by (0.87 - 4.10%), and fresh and dry weights of shoot biomass by (0.97 - 6.30%) of the three soybean cultivars and at the different stages of growth. However, the lower and moderate concentrations (3.47; 6.95 g/ L) significantly induced the growth and development of the three cultivars by increasing the plant elongation at (4.10 - 20.26) and fresh and dry weights of shoot biomass at (2.30 - 28.80%) as compared with control.

Effect of fusilade and rice extract on soybean yield and yield components. The influence of fusilade and rice straw extract on soybean yield and its components is shown in (Table IV). It was obvious that the rice straw extract either applied alone or in combination with fusilade at different concentrations significantly increased the seed yield/ plant of the three soybean varieties as compared with control. Similar trend was also observed in this regard with the yield

Table II. Effect of fusilade and rice straw extract on the growth and development of soybean cultivars

Treatments	Conc.	Soybean cultivars: 50 days from sowing, Plant height (cm)			50 days: Fresh weight (g)			50 days: Dry weight (g)			70 days from sowing, Plant height (cm)			70 days: Fresh weight (g)			70 days: Dry weight (g)		
		Giza21	Giza22	Giza111	Giza21	Giza22	Giza111	Giza21	Giza22	Giza111	Giza21	Giza22	Giza111	Giza21	Giza22	Giza111	Giza21	Giza22	Giza111
Control	0	22.80	22.70	28.00	3.90	3.53	4.20	1.03	0.85	1.20	69.00	68.80	73.00	21.00	21.20	27.50	4.45	4.06	5.87
Hand-weeded	-	30.00	29.80	34.00	5.62	4.92	6.30	1.35	1.20	1.63	83.00	85.00	87.00	26.00	27.00	34.20	5.73	5.12	7.50
Fusilade (alone)	40 g/fed.	22.30	21.90	26.50	3.50	3.30	4.10	0.96	0.80	1.05	67.20	67.00	71.50	20.20	19.10	24.70	4.32	3.90	5.70
Rice straw extract (alone)	3.47 g/L	25.50	26.00	31.00	4.23	3.70	4.43	1.16	1.00	1.30	74.00	72.50	76.40	21.50	22.00	28.30	5.15	4.30	6.24
	6.95 g/L	26.70	27.30	32.00	4.92	4.50	5.41	1.30	1.06	1.35	72.00	75.00	76.00	23.20	24.00	30.00	5.50	5.00	6.90
	13.9 g/L	22.60	22.50	27.70	3.81	3.40	4.12	1.02	0.83	1.10	67.60	67.50	70.00	20.00	20.00	26.00	4.23	3.89	5.50
Fusilade+rice straw extract (combination)	40 g /fed. + 3.47 g/L	26.60	29.40	33.10	6.00	5.33	5.90	1.50	1.20	1.53	76.00	76.20	78.00	25.00	25.20	32.00	5.80	6.10	8.30
	40 g/ fed. + 6.95 g/L	30.60	30.20	34.50	7.20	6.25	7.03	1.80	1.35	1.73	82.00	80.00	84.00	30.30	31.00	36.00	6.50	6.90	8.80
	40 g/ fed. +13.9 g/L	21.00	20.80	25.50	3.00	3.10	3.80	0.83	0.65	0.85	63.00	62.60	65.40	17.00	16.00	20.20	3.35	3.25	4.87
	L.S.D. $_{0.05}$	1.85	1.34	1.00	0.46	0.42	0.31	0.20	0.17	0.19	2.54	2.19	2.91	1.93	1.48	1.42	0.38	0.38	0.44

Table III. The biological activity of fusilade and rice straw extract on the growth and development of soybean cultivars

Treatments	Conc.	Increase (%) over control: 50 days from sowing, Plant height			50 days: Fresh weight			50 days: Dry weight			70 days from sowing, Plant height			70 days: Fresh weight			70 days: Dry weight		
		Giza21	Giza22	Giza111	Giza21	Giza22	Giza111	Giza21	Giza22	Giza111	Giza21	Giza22	Giza111	Giza21	Giza22	Giza111	Giza21	Giza22	Giza111
Hand-weeded	-	31.57	31.27	21.42	44.10	39.37	50.00	31.06	41.17	35.83	20.28	23.54	19.17	23.80	27.35	24.36	28.76	26.10	27.76
Fusilade (alone)	40 g/ fed.	2.19*	3.52*	5.35*	10.25*	6.51*	2.38*	6.79*	5.88*	12.50*	2.60*	2.61*	2.05*	3.80*	9. 90*	10.18*	2.92*	3.94*	2.89*
Rice straw extract (alone)	3.47 g/L	11.84	14.53	10.71	8.46	4.81	5.47	12.62	17.64	8.33	7.24	5.37	4.65	2.38	3.77	2.90	15.73	5.91	6.30
	6.95 g/L	17.10	20.26	14.28	26.15	27.47	28.80	26.21	24.70	12.50	4.34	9.01	4.10	10.47	13.20	9.09	23.59	23.15	17.50
	13.9 g/L	0.87*	0.88*	1.07*	2.30*	3.68*	1.90*	0.97*	2.35*	8.33*	2.02*	1.88*	4.10*	4.76*	5.66*	5.45*	4.94*	4.18*	6.30*
Fusilade+rice straw extract (combination)	40 g/fed.+ 3.47 g/L	16.66	29.51	18.21	53.84	50.99	40.47	45.63	41.17	27.50	10.14	10.75	6.84	19.04	18.86	16.36	30.33	50.24	41.39
	40 g/fed.+ 6.95 g/L	34.21	33.03	23.21	84.61	77.05	67.38	74.75	58.82	44.16	18.84	16.27	15.06	44.28	31.61	30.90	46.06	69.95	49.91
	40 g/fed.+ 13.9 g/L	7.89*	8.37*	8.52*	23.07*	12.18*	9.52*	19.41*	23.52*	29.16*	8.69*	9.01*	10.41*	19.04*	24.52*	26.54*	24.71*	19.95*	17.03*

*Inhibition

constituents restricted in increasing the number of pods/ plant, number of seeds/ pod, weight of seed/ pod and weight of 100 seeds. However, applying the fusilade alone at (40 g/ fed.) slightly decreased the yield/ plant and its components e.g. number of pod/ plant, number of seeds/ pod, weight of seeds/ pod and weight of 100 seeds as compared with control. Foliar application of rice straw extract alone at the lower (3.47 g/ L) and moderate (6.95 g/ L) concentrations significantly increased the seed yield by (17.92 - 30.00%), number of pods/ plant by (6.01 - 31.25%), number of seeds/ pod by (2.56 - 11.29%), weight of seeds/ pod by (3.44 - 11.29%) and weight of 100 seeds by (3.57 - 11.55%) in the three varieties as compared with corresponding controls. Conversely, applying the highest concentration of rice straw extract (13.9 g/ L) didn't show any significant increasing either in the yield or yield constituents, particularly with the varieties cvs. Giza 21 and 22.

Spraying the fusilade at (40 g/ fed.) in combination with rice straw extract at different concentrations remarkably increased the total seed yield/ plant and its constituents as compared with other treatments. Combined fusilade with the lower and moderate concentrations (3.47; 6.95 g/ L) of rice straw extract gave promising results in increasing the yield (15.10 - 55.90%) and its components as compared with other treatments and control. However, foliar spray of fusilade (40 g/ fed.) with rice straw at the highest concentration (13.9 g/L) showed some phytotoxicity, which was clearly pronounced on reducing the yield by (18.86 - 28.70%) and its components by (9.4 - 22.60%) in the three soybean varieties as compared with controls (Table IV).

Although the foliar application of fusilade alone at concentration of (40 g/ L) i.e. lower than the recommended dose (50 - 100 g/ fed.) gave promising results for controlling certain grass weeds such as barnyard-grass (*Echinochloa crus-galli*) and jungle rice (*Echinochloa colonum*), it caused a slight toxic effect on the shoot biomass of the soybean varieties, which might be attributed to inhibiting the fatty acid biosynthesis and subsequently modulate membrane lipids of the treated plants (Burton *et al*., 1989). This assumption could be reinforced by the results of Herbert *et al*. (1997), who reported that the fusilade herbicide reduced C^{14} acetate incorporation into the lipid fraction, thus inhibiting fatty acids and membrane lipids which directly threat the life of cellular recipient organs and hence the whole plant. Many authors attributed the decrease in weed

Table IV. Effect of fusilade and rice straw extract on yield and yield components of soybeans

Treatments	Conc.	Yield components														
		No. of pods/plant			Increase (%) over control			No. of seeds/pod			Increase (%) over control			Wt. of seeds/pod (g)		
		Giza 21	Giza 22	Giza111	Giza 21	Giza22	Giza111	Giza 21	Giza 22	Giza111	Giza 21	Giza 22	Giza111	Giza 21	Giza 22	Giza111
Control	0.0	32.0	17.5	28.3	--	--	--	2.48	2.12	2.34	--	--	--	0.62	0.53	0.58
Hand-weeded	-	41.5	21.0	35.3	29.7	20.0	24.7	3.42	2.80	2.82	37.9	32.1	20.5	0.83	0.70	0.70
Fusilade (alone)	40 g/fed.	31.0	17.0	27.3	1.6*	2.9*	3.5*	2.32	2.00	2.25	6.5*	5.7*	3.8*	0.58	0.50	0.56
Rice straw Extract (alone)	3.47 g/L	35.0	19.0	30.0	9.4	8.6	6.0	2.60	2.20	2.40	4.8	3.8	2.6	0.65	0.55	0.60
	6.95 g/L	42.0	22.0	31.5	31.3	25.7	11.3	2.76	2.32	2.43	11.3	9.4	3.8	0.69	0.58	0.61
	13.9 g/L	28.0	16.0	22.5	12.5*	8.6*	20.5*	2.40	2.03	2.22	3.2*	4.2*	5.1*	0.60	0.51	0.55
Fusilade + rice straw extract (combination)	40 g/fed+ 3.47 g/L	45.5	24.0	36.5	42.2	37.1	28.9	3.16	2.54	2.68	27.4	19.8	14.5	0.79	0.63	0.67
	40 g/fed+ 6.95 g/L	50.0	26.0	40.0	56.3	48.6	41.3	3.28	2.75	2.80	32.3	29.7	19.7	0.87	0.72	0.69
	40 g/fed+ 13.9 g/L	30.0	15.0	24.0	18.8*	14.3*	15.2*	2.12	1.92	2.06	14.5*	9.4*	12.0*	0.53	0.48	0.51
	L.S.D. $_{0.05}$	2.42	3.14	3.45	--	--	--	0.24	0.22	0.19	--	--	--	0.06	0.06	0.05

Yield components									Seed yield/plant					
Increase (%) over control			Wt. of 100seeds (g)			Increase (%) over control			(g)			Increase (%) over control		
Giza 21	Giza22	Giza111	Giza 21	Giza 22	Giza111	Giza 21	Giza 22	Giza111	Giza 21	Giza 22	Giza111	Giza 21	Giza22	Giza111
--	--	--	20.60	17.64	19.32	--	--	--	15.33	8.50	10.60	--	--	--
33.9	32.1	20.7	27.31	23.30	23.32	32.6	32.1	20.7	22.60	11.93	14.80	47.4	40.4	39.6
6.5*	5.7*	3.4*	19.31	16.65	18.18	6.3*	5.6*	5.9*	14.20	7.97	9.18	7.4*	6.2*	13.4*
4.8	3.8	3.4	21.65	18.32	20.01	5.1	3.9	3.6	18.60	10.20	12.50	21.3	20.0	17.9
11.3	9.4	5.2	22.98	18.98	20.32	11.6	7.6	5.2	19.93	10.60	13.60	30.0	24.7	28.5
3.2*	0.0	5.2	19.98	17.14	18.72	3.0*	2.8*	3.1*	14.57	7.70	10.22	4.9*	9.4*	3.6*
27.4	18.9	15.5	26.30	20.98	22.24	27.7	18.9	15.1	22.90	12.20	15.40	49.4	43.5	45.3
40.3	35.8	18.9	28.30	23.98	22.96	37.4	35.9	18.8	23.90	13.00	16.50	55.9	52.9	55.7
14.5*	9.4*	12.1*	17.4	15.3	17.1	15.3*	13.2*	11.5*	10.93	6.10	8.60	28.7*	28.2*	18.9*
--	--	--	2.1	2.00	1.68	--	--	--	1.19	0.81	1.26	--	--	--

*Inhibition

growth due to the herbicide fusilade to its effect on the enzyme Acetyl CoA carboxylase, which is responsible for lipid biosynthesis (Bradely *et al*., 2001). In this context, Ahmed and Rashad (1996) indicated that application of the fusilade herbicide (400 ml/ fed.) caused a slight decrease of growth potential in soybean plants. Supporting evidence was obtained by Novo *et al*. (1998) who found fusilade (187 g/ ha) as a growth retardant for peanut plants and several other phytotoxic symptoms were also appeared which are all together translated by end in reducing shoot biomass and symbiotic nitrogen fraction and hence yield productivity. On the other hand, Tiwari *et al*. (1997) indicated that foliar application of fusilade at 0.25 and 0.5 kg/ ha, 20 or 30 days after soybean sowing effectively controlled *Echinochloa crus-galli*, *Cynodon dactylon* and *Digitaria ciliaris*. Similar results were found by Tesar (1995), Yasin *et al*. (1995) and Avav (2000) for controlling weeds (e.g. *Imperata cylindrica*) infested soybean, chickpea, lentil and different other forage crops by using fusilade at rate of 0.35 - 0.5 kg/ ha.

Obviously, the present work indicated that foliar application of rice straw extract alone at different concentrations superiorly suppressed the growth and development of *E. crus-galli* and *E. colonum* grassy weeds particularly at the highest concentration (13.9 g/ L). Such results might suggest that the inhibitory effect of rice straw extract on controlling the weeds associated with soybean varieties might be partially due to the extract contains certain phytotoxin compound(s) which can be released by the residues or even intact plants overstepping growth stages and other agro-ecosystem affecting factors into the soil medium to affect weed growth existed in their vicinity. These evidences can be reconcile with our results in previous article, which revealed that rice straw contain some phenolic compounds and/ or certain soluble allelochemicals, which are considered the key factor of allelopathic activity in rice straw for suppressing growth and development of a wide range of broad and narrow leave weeds in many crops. Hassan *et al*. (1994; 1995; 1998) screened 1000 rice varieties in Egypt and found that more than 30 varieties, provided 50 to 90% control of *E. crus-galli* and 15 were allelopathic (30 - 75% growth reduction) against *Cyperus difformis*, suggesting that several chemical compounds with selective action against weeds are responsible for such toxicity in rice cultivars. Supporting results were obtained by Pramanik *et al*. (2001) who mentioned that rice straw extracts contain growth inhibitors against milk vetch (*Astragalus sinicus*) weed seedlings. Ebana *et al*. (2001) assumed that the phytotoxicity within the allelopathic cultivar (PI 312777) against growth of ducksalad weed

under field conditions was mainly due to several water-soluble compounds (i.e. phenolics), which distributed in all body parts of the plant and routinely exist at different stages of growth when compared with the non-allelopathic phenotype Rexmont (Takeuchi *et al*., 2001). Recently, further supporting results were obtained by Chung *et al*., (2003) who found that the phytotoxicity of water extracts coming from different parts of rice plant as well as straw residues was promising on inhibiting the seed germination and seedling growth of *Echinochloa crus-galli*. In subsequent study the chemical analysis revealed that several allelochemicals were involved in rice allelopathy of which *p*-hydroxybenzoic acid, *p*-coumaric acid and ferulic acid were the most superior in the quantity they are produce and the efficiency in controlling barnyard-grass weed (Chung *et al*., 2001). However, Olofsdotter *et al*. (2002a) declared that the allelochemicals responsible for the growth inhibition of rice associated weeds have not been identified for certain, although phenolic acids are often mentioned as putative allelochemicals. This idea about the dissimilarity of rice phytotoxins has recently been confirmed for rightness by Olofsdotter *et al*. (2002b). On the other hand, Chon *et al*. (2003) attributed the highly allelopathic herbicidal potential of some plant extracts of the family *Compositae* to the presence of causative allelopathic substances e.g. coumarin, *trans*-cinnamic acid, *o*-coumaric acid and *p*-coumaric acid.
Since, the response of rice extract on the soybean varieties was varied at the three concentrations and since the low and moderate concentrations showed stimulatory effect on the growth and development of soybean plant rather than at the highest concentration which inhibited the plant growth, it would seem to suggest that rice straw contains certain bioactive substances that may stimulate the soybeans growth if they exist in low enough concentrations and/ or the extract has a selective features. Asplund (1968) reported that most monoterpenes stimulate germination of many plant species at low concentrations and inhibit it at higher concentrations. Olofsdotter *et al*. (2002b) found that the rates of which rice plants released phenolic acids substantially differed between varieties grown in submerged anaerobic soils and those grown in aerobic soils, since it was found that phenolic acids are normally greater in submerged than in aerobic soils, and such response will reflected directly on the content and phytotoxicity of such phytotoxins within rice cultivars.

The potential effect of foliar application of fusilade herbicide in combination with the rice extract on controlling barnyard-grass and jungle rice weeds, without causing any phytotoxicity on the three soybean varieties, particularly at the lower and moderate concentrations might be related to that synergistic or perhaps addition effects emerged from the corporation between rice phytotoxin components and the active ingredient of fusilade herbicide. El-Shazely *et al*. (1980) found that mixing certain herbicides such as igran or brominal with extracts of some weeds (e.g. *Melilotus* sp., *Medicago lipida, Xanthium stramarium*) gave more phytotoxicity to wheat assayed seedlings than applying either of the two herbicides alone. Similar conclusions were attained by Macias *et al*., (1997) who lined the relation between the phytotoxicity of 13 allelochemicals and the combined herbicidal product terbutryn+trisulfuron against seed germination, radical and shoot elongation of *Lactuca sativa*, *L. sativum*, *Allium cepa*, and *Hordium vulgaris*, suggesting that allelochemicals have better profiles of activity in terms of concentrations and intensity in comparison with the herbicide. Abdul-Rahman and Habib (1986) obtained promising results for controlling dodder (*Cuscuta campestris*) in alfalfa (*Medicago sativa*) plants by using extract from different weed species such as bermuda-grass (*Cynodon dactylon*), johnson-grass (*Sorghum halepense*) and thimble pigweed (*Amaranthus albus*). The author attributed such phytotoxicity to certain un-identified toxic substances, which could be equal or more effective than the synthetic herbicides glyphosate and dimethyl-tetrachloroterephthlate widely used in controlling such troublesome weed.

Thus, our current work suggest that rice straw may have an excellent source of allelochemicals that could be useful in multidisciplinary approaches; as potential herbicides or indirectly by having a synergistic effect with synthetic herbicides, either for controlling weeds and/or minimizing the herbicidal doses. Overall, such studies might indicate that using the straw wastes for controlling a large number of weeds in many crops might be considered one of the remarkable achievements for recycling the rice straw wastes in the rice producing countries, which will be reflected on reducing the environmental pollution impact.

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