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INFLUENCE OF SOME PLANT WATER EXTRACTS ON THE GERMINATION AND SEEDLING GROWTH OF BARNYARD GRASS (*ECHINOCHOLA CRUS-GALLI* (L.)BEAUV)

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Water extracts of rice husk (*Oryza sativa* L.), above ground foliage of barnyard grass (*Echinochola crus-galli* (L.) Beauv) and sorghum stalk (*Sorghum bicolor* L.) were used to investigate their allelopathic effects on the germination and seedling growth of barnyard grass in a laboratory study. All the water extracts exhibited suppressive effects on the germination and seedling growth of barnyard grass. The order of suppression was rice > sorghum barnyard grass. Regression analysis showed that better germination had the beneficial effect on the later growth of the seedling.

Key words: Allelopathy, Rice husk, Barnyard grass, Sorghum.

Introduction

The presence of allelopathic chemical compounds (allelochemicals) in various crop and weed species, have already been well established (Putnam and Duke 1978; Rice 1984). These exist in virtually all plant tissues, including leaves, flowers, fruits, stems, roots, rhizomes and seeds. These chemical compounds are released into the soil by processes like volatilization, root exudation, leaching and decomposition of plant residues (Rice 1984). Such chemicals affect plant growth and development. Allelochemicals inhibit seed germination by blocking hydrolysis of nutrients reserve and cell division. Allelochemicals enter agro ecosystem through crops, weeds or decomposition of plant materials.

In Pakistan rice is grown on about 10% of the total cropped area every year. Among many yield-diminishing factors weed interference is an important one. Weeds are always present in agricultural fields in association with crops. Yield losses due to weeds are estimated up to 10-70% (Shad *et al* 1986). Out of all rice weeds, barnyard grass is the most important weed because it is adapted for better growth being an efficient plant under wet conditions. The threat of this weed has forced the farmers to use herbicides as a possible control measure to cope with this weed. Some workers demonstrating the allelopathic potential of rice cultivars and their residues have used extract bioassay. Chou and Lin (1976) reported that aqueous extracts of decomposing rice residues in soil inhibited root growth of lettuce and rice seedlings. Phenolic compounds such as *p*-hydroxybenzoic, vanillic, ferulic, *p*-coumeric and *o*-hydroxyphenylacetic acids were identified from rice residues (Chou and Lin 1976). In a later study (Chou *et al* 1981), syringic acid was also identified. These allelopathic cultivars could supplement the use of herbicides. Cultivars showing allelopathy against important rice weeds have been identified in the United States (Dilday *et al* 1991), Japan (Fujii 1992), Egypt (Hassan *et al* 1995) and Philippines (Olofsdotter and Navarez 1996). Some allelopathic cultivars strongly inhibit root elongation of barnyard grass but weakly effect the shoot growth (Navarez and Olofsdotter 1996). Similarly, in Egypt (Hassan *et al* 1995) identified rice cultivars that expressed allelopathic effect after plants reached the 3-leaf stage and such varieties inhibited root development and emergence of the first or second leaf of barnyard grass. In addition Park *et al* (1993) reported the suppressive effect of rice husk on the rice weeds. The autointoxication effect of some plants has also been studied by many workers (Chou and Lin 1976; Chou *et al* 1981).

Sorghum (*Sorghum bicolor* L.) allelopathy has recently been manipulated in natural weed management. It was observed that sorghum water extract or sorghum mulch suppressed weeds up to 40-50% in maize, mungbean and wheat (Cheema and Khaliq 2000; Cheema *et al* 2000). Mature sorghum has allelochemicals in it namely benzoic acid, *p*-hydroxybenzoic acid, vanillic acid, *m*-comedic acid, *p*-coumaric acid, gallic acid, caffeic acid, ferulic acid and chlorogenic acid (Cheema 1988). These allelochemicals by inhibiting or promoting germination of crops and weeds may influence plant densities, their distribution and growth in the cropping systems.

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In the light of the proceeding facts, preliminary laboratory trials were conducted to investigate the allelopathic effects of rice husk, barnyard grass and sorghum water extracts on the germination and seedling growth of barnyard grass, a common rice weed.

Materials and Methods

A laboratory study was conducted in the Weed Science Laboratory, Department of Agronomy, University of Agriculture, Faisalabad and laid out in completely randomized design with 4 replications. Barnyard grass seeds were collected form the physiology section, Ayub Agriculture, Research Institute, Faisalabad, Pakistan. To prepare water extracts, mature sorghum plants were harvested from ground level, barnyard grass plants were collected at maturity from rice fields and rice husk was obtained from a rice mill. These materials were dried for a few days and chopped, except rice husk, into 5 cm pieces with fodder cutter. These materials were soaked in distilled water overnight at room temperature (30°C ± 4) in a ratio of 1:10 (W: V). The extracts (filtrates) were taken with the help of sieves (10 and 60 mesh) and used afresh either as such or stored in freezer for further use .The pH of the extracts were found in range of 6.5 to 6.9. These extracts were used to test the seed germination response of barnyard grass in petre dishes of 9 cm diameter using filter paper Whitman No 42 as a medium of germination. In each petre dish, 15 seeds were placed and 5 ml of each extract was used, while 5 ml of distilled water was used in control treatments. Seed germination was counted and seedling growth was measured after a period of 10 days. Root and shoot lengths were measured with the help of a measuring tape and fresh and dry weights were measured with electric balance before and after drying (70°C oven dry until constant weight). The experiment was repeated twice with the same treatments.

Analysis of variance was performed for all data using computer package MSTATC (Anon 1986) and mean values were separated on the basis of least significant difference (LSD) at the 0.05 probability level. The regression analysis was performed for the germination percentage and seedling growth parameters.

Results and Discussion

Data revealed that all the plant water extracts significantly affected germination and seedling growth of barnyard grass (Table 1A, 1B & 1C).

The germination of barnyard grass was significantly less in the presence of the plant water extracts in both the trials as compared to control. However, some variation in the effects among the extracts in both trials was observed. Maximum inhibitory effect was observed in trial I (73.91%) with sorghum water extract, while rice husk water extract showed maximum inhibition in trial II (68.68%). This variation may be attributed to the temperature difference in the laboratory (Einhellig and Echrich 1983). Barnyard grass water extracts have shown similar trend in both trials, i.e. reduction in germination was in range of 33-34%. Chou and Lin (1976) also reported the autotoxic effects of certain plants. The inhibition of barnyard grass germination with sorghum water extract ranged between 45-74%, while the inhibition with rice husk water extract was between 60-69% in both trials. The inhibition of germination by the extracts may be due to the presence of allelochemicals. These findings are in line with Nak *et al* (1987) who stated that stem extracts from buckwheat and perilla inhibited seed germination and seedling growth in barnyard grass.

Root length in both trials was significantly suppressed. Rice husk water extract caused greater reduction of root length than did the others in both trials (48-92%). Sorghum water extract was effective in reducing the root length, however in the trial II, its effect was at par with that of barnyard grass water extract. Barnyard grass water extract suppressed root length (26-42%) but to a lesser extent than the other two extracts. A positive relationship between germination percentage and root length was observed (Table 2) indicating 78.4%, 99.5% and 64.2% of linear determination during trial I, II and of pooled, respectively. Barnyard grass water extract had the minimum suppressive effect (16-41%) on the shoot length in both trials. In trial I, rice husk and sorghum water extracts were statistically equal in decreasing the shoot length, while in trial II, maximum reduction was observed with rice husk water extract (59.52%) followed by sorghum water extract (42.51%). Almost similar performances of the plant water extracts were presented by Suseelamma and Raju (1994). Similarly, Cheema and Randhawa (1996) stated that sorghum water extract had a suppressive effect on the root and shoot length of *Trianthema portulacastrum*. Regression equation showed a linear increase in shoot length with successive increase in germination percentage with a determination coefficient of 96.6% and 92.9% for trials I and II, and 85.5% for pooled of both trials.

Sorghum and rice husk water extracts significantly influenced the root/shoot ratio. Maximum ratio was associated with the sorghum water extract in trial I, and with rice husk water extract in trial II where the ratio was not statistically different between rice husk and sorghum water extracts. The minimum root/ shoot ratio was observed in trial I where rice husk water was applied. The maximum ratio was seen in the treatments where more root growth or less shoot growth occurred as compared to the other treatments. These results were in good

Table 1A

Effect of rice husk, barnyard grass and sorghum water extracts on germination percentage and root length of barnyard grass

Treatments	Germination percentage				Root length (cm)			
	Trial I		Trial II		Trial I		Trial II	
T_1= Control	38.14a	-	47.83a	-	1.37a	-	2.60a	-
T_2= Rice husk water extract	14.95c	(60.80)	14.98d	(68.68)	0.11d	(91.97)	1.34c	(48.46)
T_3= Barnyard grass water extract	24.95b	(34.58)	31.63b	(33.87)	0.80b	(41.61)	1.93b	(25.76)
T_4= Sorghum water extract	9.95d	(73.91)	25.99c	(45.66)	0.52c	(62.04)	1.80b	(30.77)
LSD (0.05)	1.96		3.55		0.09		0.16	

Table 1B

Effect of rice husk, barnyard grass and sorghum water extracts on short length percentage and root shoot ratio of barnyard grass

Treatments	Shoot length (cm)				Root shoot ratio			
	Trial I		Trial II		Trial I		Trial II	
T_1= Control	5.97a	-	8.82a	-	0.23b	-	0.30b	-
T_2= Rice husk water extract	1.30c	(78.22)	3.57d	(59.52)	0.08c	(65.22)	0.38a	(+26.67)
T_3= Barnyard grass water extract	3.53b	(40.80)	7.38b	(16.33)	0.23b	(0.00)	0.26b	(13.33)
T_4= Sorghum water extract	1.41C	(76.38)	5.07c	(42.51)	0.37a	(+37.0)	0.36a	(+20.0)
LSD (0.05)	0.20		0.70		0.06		0.05	

Table 1C

Effect of rice husk, barnyard grass and sorghum water extracts on fresh and dry weight of barnyard grass

Treatments	Fresh weight (g)				Dry weight (g)			
	Trial I		Trial II		Trial I		Trial II	
T_1= Control	0.0470a	-	0.0700a	-	0.0067a	-	0.0100a	-
T_2= Rice husk water extract	0.0052d	(88.94)	0.0175d	(75.00)	0.0007d	(89.55)	0.0027c	(73.0)
T_2= Barnyard grass water extract	0.0232b	(50.64)	0.0375b	(46.43)	0.0033b	(50.74)	0.0046b	(54.0)
T_4= Sorghum water extract	0.0091c	(80.64)	0.0325c	(53.57)	0.0013c	(80.69)	0.0028c	(72.0)
LSD (0.05)	0.002		0.0048		0.0003		0.0004	

Note: Means not sharing a letter in common in a column differ significantly at the 0.05 probability level.
Values given in parenthesis shows the percent decrease over control while the values with sign + shows the percent increase over control. LSD = Least significant difference.

agreement with those reported by Olofsdotter (1998) who showed that some rice cultivars strongly reduced the root length of barnyard grass rather than the shoot length. A cubic response was observed between germination percentage and root/shoot ratio giving the R^2 values as 81.1%, 93.8% and 59.5% for trials I, II and pooled data, respectively (Table 2).

Rice husk water extract showed the strongest depressing effect on fresh weight (75-89%), which was followed by sorghum water extract (54.81%) in both trials, while the effect of barnyard grass water extract was rather weak. Irshad and Cheema (2002) also reported the suppressive effect of rice husk, barnyard grass and sorghum water extracts on fresh weight of rice seedlings. Regression equations (Table 2) showed the positive association between germination percentage and fresh weight and the variation can be explained by 93.3% and 92.0% determination coefficient for trial I,

Table 2
Regression analysis of the germination to the seedling growth parameters

Seedling growth		Regression Equations	R^2
Root length	[1]Trial 1	Y = 7.46 + 20.8 X	78.4%
	[1] Trial 2	Y = - 20.1 + 26.2 X	99.5%
	[1] Pooled	Y = 9.46 + 12.7 X	64.2%
Shoot length	[1]Trial 1	Y = 5.01 + 5.57 X	96.6%
	[1] Trial 2	Y = -4.90 + 5.64 X	92.9%
	[1] Pooled	Y = 5.61 + 4.41 X	85.5%
Root Shoot ratio	[2]Trial 1	Y = -13.10 + 412 X +	81.1%
	948X^2	Y = -550 + 3893 X-	93.8%
	[2]Trial 2		59.5%
	6361X^2		
Fresh weight	[2]Pooled	Y = -19.7 + 475 X -	93.3%
	1011X^2		92.0%
			92.0%
Dry weight	[1]Trial1	Y = 8.55 + 636 X	
	[1]Trial 2	Y = 6.73 + 594X	93.3%
	[1]Pooled	Y = 59.0 + 577 X	87.4%
			90.5%
	[1]Trial 1	Y = 8.61 + 4473 X	
	[1]Trial2	Y = 11.5 + 3720 X	
	[1]Pooled	Y = 10.0 + 4006 X	

1= Regression Equation $Y = a + bX$
2= Regression Equation $Y = a + bX + cX^2$

trial II, while 92.0% of pooled data. Similar to fresh weight, rice husk water extract showed the maximum suppressive effect on the dry weight of the barnyard grass seedlings (73-90%). In trial I sorghum water extract also showed statistically similar effect as that of rice husk water extract. Barnyard grass water extract showed suppressive effect on dry weight but to a lesser extent. The reduction in dry weight of seedlings was possibly due to the suppressive allelopathic effects of all the water extracts used in the study, indicating the presence of water-soluble phytotoxic allelochemicals. Ahmad *et al* (1995) also found the maximum reduction in dry weight of cotton seedlings by rice and sorghum water extracts. The linear regression equations (Table 2) showed the 93.3%, 87.4% and 90.5% determination coefficient between germination percentage and dry weight for trial I, II and pooled data, respectively.

From the above discussion it could be concluded that all the three water extracts (rice husk, sorghum stalk and barnyard grass stalk) used in the present studies inhibited the germination and seedling growth of barnyard grass. Rice husk and sorghum water extracts were more effective than barnyard grass water extract.

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