Pak. J. Weed Sci. Res. 17(3): 245-252, 2011

APPLICATION OF BIO-HERBICIDE ALTERNATIVES FOR CHEMICAL WEED CONTROL IN RICE

Imran Wazir[1], Muhammad Sadiq[1], Mohammad Safdar Baloch[1], Inayat Ullah Awan[1], Ejaz Ahmad Khan[1], Inayat Hussain Shah[2], Muhammad Amjad Nadim[2], Abdul Aziz Khakwani[1] and Imam Bakhsh[1]

ABSTRACT

An experiment was conducted to decipher the feasibility of using crop extract (bio-herbicide) as an alternative for chemical weed control in rice. After seed bed preparation, seedlings of IR-6 rice were transplanted in a randomized complete block design with four replications. The data showed that weedy check treatment recorded the maximum fresh and dry weed biomass. While application of half dose of Ryzelan + half dose of sorghum water extract (sorgaab) produced the maximum number of tillers, panicles and normal kernels. The use of sorghum water extract (alone) produced the maximum number of spikelets, 1000-grain weight and paddy yield. Based on these results, it is concluded that the use of crop extract can safely be used as a bio-herbicide for controlling weeds and obtaining better yields of rice.

Key words: Allelopathy, hand weeding, rice, sorghum, water extract, weeds, herbicide.

INTRODUCTION

Rice (*Oryza sativa* L.) is a main source of nourishment for over half the world's population. Calories from rice are particularly important in Asia, especially among the poor, where it accounts for 50-80% of daily caloric intake. About 57% of rice is grown on irrigated land, 25% on rain-fed lowland, 10% on the uplands, 6% in deepwater, and 2% in tidal wet lands in Asia (Chopra and Prakash, 2002). The annual production of rice in Pakistan is 55 million tons where Khyber Pakhtunkhwa (KPK) province contributes 0.128 million tons. The total annual rice cultivated area in the country is 2.5 million hectares and in KPK 61.7 thousand hectares with an average yield of 2212 kg ha^{-1} (Anonymous, 2008).

Rice is grown under diverse climatic and edaphic conditions in Pakistan, the temperate zones of Swat at high altitudes in mountain valleys to warmers areas of Sindh and Punjab. However, the yield obtained on farmers' fields is low in most parts of the country,

[1]Department of Agronomy, Faculty of Agriculture, Gomal University, D.I. Khan.
[2]Agricultural Research Institute, Dera Ismail Khan, Pakistan.
Corresponding author: flyingbird_wazir@yahoo.com

including Dera Ismail Khan district, on account of water shortage, high costs of inputs, non-availability of skilled labour during peak planting season, sub-optimal plant population, weeds and pest infestation, high dependence of knowledge on nearby growers and low price of rice in the local market (Baloch *et al*., 2004).

In South East Asia, weed causes yield losses of 10-46% and occasionally up to 100% in rice. Hand weeding is most common in rice in Pakistan however it is expensive and requires a large chunk of labour. The use of mechanical weed control is also limited to transplanted rice. Likewise, the application of chemicals could be an excellent alternative, but it is expensive, harmful to the environment and the current research findings are insufficient to highlight effective and safe chemical use.

In the given scenario, biological weed control appears to be the only viable alternative to reduce weed density to safe limits. In this method, leaf water extracts of allelopathic plants such as sunflower, sorghum, tobacco, millet, soybean, rice and oat are used which release toxins or allelochemicals to inhibit the growth of certain weeds during the crop cycle and thereby increase the yields (Ata and Jamil, 2001; Labrada, 2008). Khanh *et al*. (2007) reported that the synthetic herbicides eliminate the weeds, but adversely affect the humans and environment. Thus, controlling weeds by biological methods can alleviate the heavy dependence on synthetic agrochemicals and result in more sustainable agriculture. Irshad and Cheema (2005) reported that sorghum water extract is a good alternative for chemical weed control in rice, which reduced the biomass of barnyard grass up to 41% than untreated control.

The present crop management conditions in Pakistan where there is a need of intensive agriculture due to limited resources, the significance of bio-herbicides has increased manifold. Earlier research work (Jensen *et al*., 2008; Tanveer *et al*., 2008; Tesio *et al*., 2008) has provided a broad understanding for initiation of the present studies on application of bio-herbicides for chemical weed control in rice. Keeping all this in view, the present research project was initiated to investigate the effect of bio-herbicide as an alternative for chemical weed control in rice.

MATERIALS AND METHODS

The experiment was conducted at the Agricultural Research Institute, Dera Ismail Khan (31º49’ N, 70°55’ E), Pakistan during 2009 using a randomized complete block design with four replications. The plot size of each treatment was 2 m x 5 m having 10 rows each 20 cm apart. The weed management practices included in the experiment were:

T_1: Weedy check (untreated control)
T_2: Ryzelan (penaxolam; full recommended dose 30 mL ha^{-1})
T_3: Sorghum water extract (full recommended dose 15 L ha^{-1})
T_4: Ryzelan (15 mL ha^{-1}) + sorghum extract (7.5 L ha^{-1})
T_5: Hand weeding (50 DAT)

The recommended dose of Ryzelan (penaxolam; 30 mL ha^{-1}) was applied 15 days after transplanting. This herbicide was launched by Dow AgroSciences (USA) for controlling broadleaf and annual grasses in rice. Sorghum water extract (sorgaab) was obtained from University of Agriculture, Faisalabad, Pakistan which was prepared by soaking sorghum leaves in distilled water in a ratio of 1:5 for 36 h. It was then filtered to collect the respective extract. After proper seed bed preparation, seedlings of rice cv. IR-6 were transplanted in mid June. Fertilizers were applied @ 120:90:60 NPK kg ha^{-1}. Half of nitrogen with full dose of potash and phosphorus were applied at seed bed preparation, while remaining half dose of nitrogen was applied in two equal splits i.e. 25 and 45 days after transplantation (DAT). The experimental site was silty clay, the pH = 8 and the organic matter content 0.68%. The electrical conductivity was 400 Ec 10^{-6}. Table-1 showed the climatic conditions during the crop growth season.

Data were recorded on number of tillers (m^{-2}), number of panicles (m^{-2}), number of spikelets ($panicle^{-1}$), normal kernel (%), 1000-grain weight (g), paddy yield (t ha^{-1}) and were analyzed statistically using the analysis of variance technique and significant means were separated using the least significant difference test for comparing the treatment means (Steel and Torrie, 1980).

Table-1. Meteorological data recorded at the Agricultural Research Institute, Dera Ismail Khan during 2009

Month	Temperature (^{0}C)		Relative Humidity		Rainfall (mm)
	Max	Min	0800 Hrs.	1400 Hrs.	
May	42	24	69	35	29
June	42	27	60	34	10
July	20	27	66	37	--
August	39	27	67	38	5
September	34	22	64	37	21
October	32	17	63	40	11

RESULTS AND DISCUSSION

Fresh and dry weed biomass (g m^{-2})

Data on fresh weed biomass (g) are presented in Table-2, which showed that fresh weed biomass was not significantly affected by weed management practices. However, among treatments, there was found a visible difference wherein T_1 had the maximum (132.7 g m^{-2}) fresh weed biomass as compared to T_4 (81.68 g m^{-2}). This might

be the interactive effect of both Ryzelan and sorghum water extract. These results are in line with those of Cheema *et al.* (2002) who applied sorghum water extract and recorded minimum fresh weed biomass. Parvis and Jessop (1985) found sorghum water extract a successful inhibiter for controlling the growth of weeds.

Data on dry weed biomass are shown in Table-2. The data showed non-significant difference among weed management practices. The maximum (36.92 g m^{-2}) was recorded in T1, while T_3 showed minimum dry weed biomass numerically. Anwar *et al.* (2004) reported that the use of sorghum water extract not only reduced weed number and weed weight but also improved fresh and dry weight of crop.

Number of tillers (m^{-2})

Data revealed that weed management practices had significant effect on number of tillers (Table-3). It is obvious from the data that the maximum number of tillers (358.5) were recorded in T_4 followed by T_5 (329.0). However, both the treatments were statistically at par. The minimum number of tillers (284.3) was recorded in weedy check. The higher number of tillers in T_4 and T_5 was probably due to availability of sufficient amount of nutrients to rice plants on account of less competition among crop plants and low weed flora which boosted the tillers production. The higher number of tillers in T_4 indicated that the use of herbicide plus half dose of concentration of bio-herbicide could increase number of tillers in rice. These findings are coincided with Cheema *et al.* (2003) who obtained increased number of tillers when herbicide was applied in combination with natural allelopathic water extract (sorgaab).

Number of panicles (m^{-2})

The number of panicles m^{-2} was significantly affected by weed management practices (Table-3). The highest number of panicles was obtained in T_4 (360.8) whereas weedy check produced minimum number of panicles (257.3). The higher number of panicles in T_4 (half dose of Ryzelan with half dose of sorghum water extract) suggested that the combination of Ryzelan plus sorghum water extract was as effective as the sole application of chemical herbicide. Mukhapadhyay and Gosh (1980) also reported the reduction of weeds by the application of water extract plus herbicide and significant increase in the formation of panicles as compared to mechanical weed control in rice.

Number of spikelets (panicle^{-1})

Data on number of spikelets (panicle-1) are presented in Table-4. The data revealed that weed management practices had significant impact on number of spikelets. The maximum number of spikelets (157.8) were recorded in T_3 (sorghum water extract) which was statistically at par with T_2 (full dose of Ryzelan). This represents that

sorghum water extract is a good alternative for chemical weed control in rice. The minimum number of spikelets (135.1) was obtained in weedy check. The higher number of spikelets recorded in sorghum water extract treatment explained that the use of bio-herbicide is a good alternative to chemical weed control which increased the number of spikelets in rice. The weedy check treatment gave minimum number of spikelets probably due to higher weed population. Irshad and Cheema (2005) reported that sorghum water extract significantly reduced barnyard grass as compared to weedy check which led to maximum number of spikelets.

Normal kernel (%)

The data pertaining to normal kernel percentage are given in Table-4. The data indicated higher normal kernel percentage in T_4, which was statistically at par with T_1 and T_2. The lower normal kernel percentage was recorded in T_5. The higher normal kernels recorded in T_4 advocated that the application of bio-herbicide along with commercial herbicide is a useful proposition for increasing normal kernel (%) in rice. The use of sorghum water extract gave comparatively lower normal kernels, which showed that the use of sorghum water extract alone had less positive effect on kernels production.

1000-grain weight (g)

Data on 1000-grain weight of paddy as affected by different weed control treatments are presented in Table-5. Grain weight is the key to higher yield. Analysis of the data revealed that wed control treatments had significant effect on grains weight. All the weed control treatments significantly increased grain weight; however, T_3 recorded maximum (27.60g) grain weight. Whereas, weedy check (25.61g), full dose of Ryzelan (24.64g), half dose of Ryzelan plus half dose of sorghum water extract (25.38g) and hand weeding (23.94g) were at par statistically. The higher grain weight recorded in sorghum water extract might be due to presence of essentials nutrients in T_3 which significantly increased grain weight. Xuan *et al.* (2004) reported that plant water extracts successfully enhanced grain weight of rice. Similar results were also obtained by Salisbury and Ross (1978) who found that sorghum extract increased grain weight by suppressing the vegetative growth.

Paddy yield (t ha^{-1})

Data recorded on paddy yield are presented in Table-5. The statistical analysis of the data revealed that weed control treatments had non significant effect on paddy yield. Among treatments, weedy check produced minimum (5.988 t ha^{-1}) paddy yield while the maximum (6.738 t ha^{-1}) was produced in sorghum extract applied treatment. This might be due to the fact that all yield components

were higher in plants treated with herbicide and/or sorghum water extract that increased the yield per unit area. The possible reason for high paddy yield in the different weed control treatment might be attributed to increased availability of nutrients and reduced competition which stimulated vegetative growth and resulted in better panicle population and more grains panicle^{-1} and ultimately higher paddy yield. Jensen *et al*. (2008) and Khanh *et al*. (2007) also conducted such allelopathic studies on rice.

Table-2. Effect of weed management practices on fresh and dry weed biomass (g m^{-2}) in rice.

Treatment		Fresh weed biomass (g m^{-2})	Dry weed biomass (g m^{-2})
T_1	Weedy check	132.7^{NS}	36.92^{NS}
T_2	Ryzelan (30 mL ha^{-1})	113.4	27.32
T_3	Sorghum water extract (15 L ha^{-1})	97.90	21.89
T_4	Ryzelan (15 mL ha^{-1}) + Sorghum water extract (7.5 L ha^{-1})	81.68	24.09
T_5	Hand weeding (50 days after transplanting)	86.29	22.93

NS = Non-significant

Table-3. Effect of weed management practices on number of tillers and panicles (m^{-2}) in rice.

Treatment		Number of tillers (m^{-2})	Number of panicles (m^{-2})
T_1	Weedy check	284.3 c	257.3 d
T_2	Ryzelan (30 mL ha^{-1})	309.5 bc	298.8 c
T_3	Sorghum water extract (15 L ha^{-1})	318.8 bc	317.5 bc
T_4	Ryzelan (15 mL ha^{-1}) + Sorghum water extract (7.5 L ha^{-1})	358.5 a	360.8 a
T_5	Hand weeding (50 days after transplanting)	329.0 ab	330.0 b
	$LSD_{0.05}$	34.77	28.39

Means followed by different letter(s) in a column are significant at 5% level of probability.

Table-4. Effect of weed management practices on number of spikelets (panicle^{-1}) and normal kernels (%) in rice.

Treatment		Number of spikelets (panicle^{-1})	Normal kernels (%)
T_1	Weedy check	135.1 b	75.00 a
T_2	Ryzelan (30 mL ha^{-1})	154.0 a	74.75 a
T_3	Sorghum water extract (15 L ha^{-1})	157.8 a	73.50 ab
T_4	Ryzelan (15 mL ha^{-1}) + Sorghum water extract (7.5 L ha^{-1})	148.2 ab	75.50 a
T_5	Hand weeding (50 days after transplanting)	141.9 ab	70.25 b
	$LSD_{0.05}$	18.77	4.428

Means followed by different letter(s) in a column are significant at 5% level of probability.

Table-5. Effect of weed management practices on 1000-grain weight (g) and paddy yield (t ha^{-1}) in rice

Treatment		1000-grain weight (g)	Paddy yield (t ha^{-1})
T_1	Weedy check	23.94 b	5.988^{NS}
T_2	Ryzelan (30 mL ha^{-1})	24.64 b	6.637
T_3	Sorghum water extract (15 L ha^{-1})	27.60 a	6.738
T_4	Ryzelan (15 mL ha^{-1}) + Sorghum water extract (7.5 L ha^{-1})	25.38 b	6.238
T_5	Hand weeding (50 days after transplanting)	25.61 b	6.262
	$LSD_{0.05}$	1.760	---

Means followed by different letter(s) in a column are significant at 5% level of probability. NS = Non-significant.

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