Research Article

Use of Barley Residue Water Extract Combined with Pendimethalin Herbicide for Weed Control in Mungbean

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Abstract | A field trial was conducted at University Research Farm, Pir Mehr Ali Shah, Arid Agriculture University Chakwal Road, Rawalpindi to find out the influence of barley water extract alone and in combination with low doses of pendimethalin (pre-emergence) for weed control in mungbean during summer season, 2009. The treatments were: Control (weedy check), Hand weeding (30 and 45 DAS), Pendimethalin herbicide @ 1.5 kg a.i. ha^{-1} (recommended dose), Barley W.E. @ 12 L ha^{-1} (20, 30, 40 and 50 DAS), Barley W.E. + pendimethalin @ 12 L ha^{-1} + 1.0 kg a.i. ha^{-1}, Barley W.E. + pendimethalin @ 12 L ha^{-1} + 0.75 kg a.i. ha^{-1}, Barley W.E. + pendimethalin @ 12 L ha^{-1} + 0.50 kg a.i. ha^{-1}. The combined effect of barley water extract with pendimethalin herbicide on weeds density and weeds biomass was more pronounced than the sole application of barley water extract. One pre-emergence spray of barley W.E. + pendimethalin @ 12 L ha^{-1} + 0.50 kg a.i. ha^{-1} reduced weeds density by 62%, fresh weight by 43% and weeds dry weight by 55% compared to control measured at 40 DAS. One pre-emergence spray of barley W.E. + pendimethalin @ 12 L ha^{-1} + 1.0 kg a.i. ha^{-1} increased grain yield by 40 % and barley W.E. + pendimethalin @ 12 L ha^{-1} + 0.50 kg a.i. ha^{-1} increased mungbean grain yield by 56% relative to control. Pendimethalin @ 0.5 kg a.i. ha^{-1} mixed with barley water extract may be utilized to control weeds efficiently and enhance mungbean yields.

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Introduction

Mungbean (*Vigna radiata* L.) is an important summer pulse crop and provides easily digestible proteins (Nazir, 1994). Weeds are a major problem in rainfed mungbean. Weeds can reduce yield of mungbean upto 67% as compared to weed free conditions (Yadav and Singh, 2005). The herbicide use for weed control is expensive and continuous use of herbicides has created problems of weed resistance and environmental pollution (Shahid et al., 2006) and can also affect the quality of many crops (Nazarko et al., 2003). Use of Allelopathic properties of crop residue for weed control is a natural and an environment-friendly practice that can decrease our reliance on synthetic herbicides (Minorsky, 2002).

Ben-Hammouda et al. (2001) reported that barley plant (*Hordeum vulgare* L.) released phytotoxins in the environment through root exudation and also by

decomposition of the plant residues. Barley (*Hordeum vulgare* L.) has water soluble allelochemicals that suppress the germination and growth of other species. Therefore, the aqueous extract of barley residue can be used for weed control (Ashrafi et al., 2008). Barley extracts decreased germination and growth of barnyard grass (*Echinochloa crus-galli* (L.) Beauv.), bristly foxtail (*Setaria parviflora* (Poir.) Kerguelen), flixweed (*Descurainia Sophia* L. Webb), stinkweed (*Thlaspi arvense* L.) and downy brome (*Bromus tectorum* L.) weeds (Dhima et al., 2006). Scientists suggested that the allelochemicals may also be used alongwith low doses of herbicides to obtain good weed control results (Jamil et al., 2005). The current study was planned to evaluate the effects of barley residue water extract in combination with reduced doses of herbicide to control weeds in rainfed mungbean.

Materials and Methods

An experiment was conducted during summer 2009 at University Research Farm, Pir Mehr Ali Shah, Arid Agriculture University Chakwal Road, Rawalpindi. The soil was sandy loam having 0.45 percent organic matter. The pH and ECe of saturated soil extract were 7.6 and 0.37 dSm^{-1}, respectively. The test variety was Chakwal Mung-2006. The seed rate was 20 kg ha^{-1}. Nitrogen and Phosphorus fertilizers were applied @ 20 and 60 kg ha^{-1}, respectively at the time of seedbed preparation. Individual plot size was 6.30 m × 12 m with row to row distance 45 cm and plant to plant distance 10 cm. The experiment was laid out in randomized complete block design (RCBD) with four replications.

Barley water extract (W.E) was prepared by following the procedure devised by Cheema and Khaliq (2000). Barley crop was harvested at maturity and herbage was sundried and chaffed with fodder cutter into 2 cm pieces. Chaffed herbage was soaked in deionized water in 1:10 (1 kg of barley herbage in 10 L of water) in containers for 24 h at room temperature to dissolve barley herbage allelochemicals. The barley herbage W.E. was then filtered through a screen. The volume of filtrate was reduced twenty times by continuously boiling and was stored in glass bottle at room temperature.

The treatments applied to control weeds in rainfed mungbean were as under:

1. Control (weedy check).
2. Hand weeding at 30 and 45 DAS.
3. Pendimethalin herbicide @ 1.5 kg a.i. ha^{-1} (recommended dose) applied as pre-emergence.
4. Barley W.E. @ 12 L ha^{-1} at 20, 30, 40 and 50 DAS
5. Barley W.E. + pendimethalin @ 12 L ha^{-1} + 1.0 kg a.i. ha^{-1} (Pre-emergence).
6. Barley W.E. + pendimethalin @ 12 L ha^{-1} + 0.75 kg a.i. ha^{-1} (Pre-emergence).
7. Barley W.E. + pendimethalin @ 12 L ha^{-1} + 0.50 kg a.i. ha^{-1} (Pre-emergence).

Data about weed density and weeds biomass were recorded twice from each experimental unit from randomly selected area of one square meter at 40 and 60 DAS. Weeds were cut at ground level from randomly selected areas of one square meter at 40 and 60 DAS and fresh weight was recorded. The samples taken were dried in an oven at 70°C for 72 hours and dry weight was recorded. The weed species observed in the experimental area were *Cynodon dactylon* L., *Cyprus rutundus* L., *Sorghum halepense* L., *Dactyloctenum aegyptium* L., *Amaranthus viridis* L., *Tribulus terrestris* L., *Convolvulus arvensis* L., *Heliotropium indicum* L.

Data on plant height (cm) and number of branches per plant were recorded in 10 randomly selected plants taken from each plot. Two random samples were obtained from each plot to take 1000-grain weight. Grain yield was measured on plot basis and was converted into kg ha^{-1}. The data were subjected to analysis of variance technique. F-statistic was based on residual mean square error. The LSD at 5 % level of probability was used for comparison of treatment means (Montgomery, 2001).

Results and Discussion

Weeds density and weeds biomass

All treatments significantly reduced weeds density and weeds biomass compared with control (Table 1). The data revealed that the effect of low dose of pendimethalin combined with barley W.E. was more than that of high doses of pendimethalin + barley W.E. Although, hand weeding treatment reduced weeds density, weeds fresh weight and weeds dry weight more than that of other treatments yet it was a labor intensive and cumbersome weed management method. Pre-emergence spray of barley W.E. + pendimethalin @ 12 L ha^{-1} + 0.50 kg a.i. ha^{-1} reduced weeds density by 62% and 54% relative to control at 40 and 60 DAS and it was statistically similar or better than spray of pendimethalin at its full dose (1.5 kg a.i. ha^{-1}).

Table 1: *Influence of barley water extract alone and combined with reduced doses of pendimethalin on weed density, weeds fresh and dry weights in mungbean.*

Treatments	Weed Density (Weeds m^{-2})		Weeds Fresh Weight (g m^{-2})		Weeds Dry Weight (g m^{-2})	
	40DAS	60DAS	40DAS	60DAS	40DAS	60DAS
Control (weedy check)	36.63 a (----)	38.00 a (----)	80.43 a (----)	86.25 a (----)	24.44 a (----)	21.41 a (----)
Hand weeding at 30 and 45 DAS	10.25 d (72.02)	4.33 d (88.61)	13.88 d (82.74)	10.21 d (88.16)	3.46 d (85.84)	2.88 f (86.55)
Pendimethalin herbicide @ 1.5 kg a.i. ha^{-1} (recommended dose)	27.00 b (26.29)	19.32 c (49.16)	38.63 c (51.97)	78.72 c (8.73)	11.68 c (52.21)	16.81 b (21.49)
Barley W.E. @ 12 L ha^{-1} at 20, 30, 40 and 50 DAS	30.75 b (16.05)	21.00 b (44.74)	46.66 b (41.99)	55.75 c (35.36)	14.31 b (41.45)	12.43 d (41.94)
Barley W.E. + pendimethalin @ 12 L ha^{-1} + 1.0 kg a.i. ha^{-1}	22.00 c (39.94)	17.50 b (53.95)	47.20 b (41.32)	67.67 c (37.45)	13.93 b (43.00)	15.68 bc (26.76)
Barley W.E. + pendimethalin @ 12 L ha^{-1} + 0.75 kg a.i. ha^{-1}	14.75 d (59.73)	30.33 c (20.18)	38.40 c (52.26)	50.84 b (41.06)	11.52 c (52.86)	12.82 cd (40.12)
Barley W.E. + pendimethalin @ 12 L ha^{-1} + 0.50 kg a.i. ha^{-1}	14.00 d (61.78)	17.63 c (53.61)	45.94 b (42.88)	57.13 c (33.76)	10.95 c (55.20)	9.28 e (56.66)
Significance level	**	**	**	**	**	**
LSD (0.05)	4.58	1.84	5.62	3.61	1.84	2.92

Any two means not sharing a letter in common in a column differ significantly at 5% probability level. Figures given in parenthesis show percent decrease over control. **DAS:** *Days after sowing* **W.E.:** *Water extract;* **$LSD_{(0.05)}$:** *Least significant difference at 5% probability level.* ****:** *Significant at 1% probability level.*

Table 2: *Influence of barley water extract alone and combined with reduced doses of pendimethalin on plant height, number of pods per plant, 1000-seed weight, biological yield and grain yield of mungbean.*

Treatments	Plant Height (cm)	Pods Per Plant	1000-Seed Wt. (g)	Bio. Yield (Kg ha^{-1})	Grain Yield (Kg ha^{-1})
Control (weedy check)	44.37cd	11.75 b	44.60	1792 d (----)	225.0 d(----)
Hand weeding at 30 and 45 DAS	48.30 b	14.57 a	47.26	2833 a (58.09)	360.0 a(60.00)
Pendimethalin herbicide @ 1.5 kg a.i. ha^{-1} (recommended dose)	46.40 bc	15.70 a	44.99	2292 b (27.90)	305.0 b(35.56)
Barley W.E. @ 12 L ha^{-1} at 20, 30, 40 and 50 DAS	52.59 a	14.63 a	48.40	2042 c (13.95)	241.0 d (7.11)
Barley W.E. + pendimethalin @ 12 L ha^{-1} + 1.0 kg a.i. ha^{-1}	41.14 e	14.45 a	48.06	2053 c (14.56)	314.0 b (39.56)
Barley W.E. + pendimethalin @ 12 L ha^{-1} + 0.75 kg a.i. ha^{-1}	42.84 de	15.48 a	49.44	2194 b (22.43)	276.1 c (22.71)
Barley W.E. + pendimethalin @ 12 L ha^{-1} + 0.50 kg a.i. ha^{-1}	45.60 bc	15.32 a	52.35	2292 b(27.90)	351.0 a(56.00)
Significance level	**	**	NS	**	**
LSD (0.05)	2.74	1.73	--	122.10	19.82

Any two means not sharing a letter in common in a column differ significantly at 5% probability level. Figures given in parenthesis show percent increase/decrease over control. **DAS:** *Days after sowing;* **W.E.:** *Water extract;* **$LSD_{(0.05)}$:** *Least significant difference at 5% probability level;* ****:** *Significant at 1% probability level;* **NS:** *Non-Significant.*

Sole spray of barley W.E. @ 12 L ha^{-1} at 20, 30, 40 and 50 DAS suppressed weeds density by 16% and 45% at 40 and 60 DAS. Barley W.E. + pendimethalin @ 12 L ha^{-1} + 0.50 kg a.i. ha^{-1} reduced weeds fresh weight by 43% and 34% at 40 and 60 DAS as compared to control. Post-emergence application of barley W.E. @ 12 L ha^{-1} at 20, 30, 40 and 50 DAS reduced weeds fresh weight by 42% and 35% recorded at 40 and 60 DAS, respectively. Pre-emergence application of barley W.E. + pendimethalin @ 12 L ha^{-1} + 0.50 kg a.i. ha^{-1} reduced weeds dry weight by 55.20% and 56.66% recorded at 40 and 60 DAS, respectively (Table 1),

while sole application of barley water extract @ 12 L ha^{-1} four times as post emergence decreased weeds dry weight by 41.45 to 45.94%. This indicated that barley W.E. combined with low doses of herbicide was more effective than the sole application of barley W.E. for weed control.

The results of present study revealed that barley extract can be employed to manage weeds, however, its effectiveness can be improved with addition of pendimethalin at its lower rates. Furthermore, pendimethalin applied @ 0.75 and 0.5 kg a.i. ha^{-1} mixed with barley W.E. controlled weeds either equivalent or better than recommended dose of the herbicide. Our results confirmed the findings of Cheema et al. (2002) who reported that pre-emergence application of sorgaab @ 12 L ha^{-1} and pendimethalin @ 0.5 kg a.i. ha^{-1} reduced 50% total weed dry weight in cotton. Literature suggested that incorporation of barley cultivars reduced maximum barnyard grass and bristly foxtail fresh weight under field conditions (Dhima et al. 2006).

Yield and Yield Components of Mungbean

The data regarding yield and yield components of mungbean sown under rainfed system is presented in Table 2. Plant height of mungbean was stimulated by repeated post emergence sprays of barley water extract applied at 20-50 DAS. It produced the tallest plants (52.59 cm) followed by hand weeding (48.30 cm) and recommended dose of pendimethalin (46.40 cm). The All treatments enhanced number of pods per plant compared with control, which, may be due to weeds suppression with weed control treatments. There was no significant effect of treatments on 1000 seed weight which may be genetically controlled factor and it was not altered with the treatments. The maximum biological yield (2833 kg ha^{-1}) was recorded from hand weeding followed by recommended dose of pendimethalin (2292 kg ha^{-1}). Pendimethalin applied @ 1.50 kg a.i. ha^{-1} produced statistically similar biological yields as those obtained from barley W.E. combined with the herbicide @ 0.5-0.75 kg a.i. ha^{-1} (2194-2292 kg ha^{-1}). All treatments except post emergence application of barley W.E. improved the seed yield of mungbean compared with control. The highest seed yield (360 kg ha^{-1}) was achieved from hand weeding which was similar with barley W.E. + pendimethalin @ 12 L ha^{-1} + 0.50 kg a.i. ha^{-1} (351 kg ha^{-1}).

The results of present study depicted improvement in number of pods per plant with weed control treatments. Similar conclusions were presented by Cheema et al. (2000) who got more pods in mungbean by controlling weeds. Barley extracts increased mungbean seed yields either applied alone or mixed with pre emergence herbicide. Cheema et al. (2001) achieved 18% higher mungbean yields with two foliar sprays of sorghum extract. Weed control improved yields in our study. These results supported the findings of Mansoor et al. (2004) who reported that increased grain yield of mungbean was due to the control of weeds. Similarly, Borras et al. (2004) concluded that the increase in grain yield was due to weeds suppression that enhanced the translocation and assimilation of photosynthates towards the reproductive output. The findings also suggested that the dose of pendimethalin can be reduced from 1.5 to 0.5 kg ha^{-1} when it is mixed with barley water extract. Cheema et al. (2003) reported dose reduction of pendimethalin by 50-67% with addition of sorghum water extract in mungbean. Hence our results reinforced earlier studies and elaborated that allelopathic extracts can act in coherence with pendimethalin to manage weeds in mungbean.

The study concluded that barley water extract may be used to suppress weeds in mungbean. Furthermeore, Barley extracts can be combined with lower doses of pendimethalin (0.5 kg a.i. ha^{-1}) to achieve similar weed control and mungbean grain yields as those obtained from pendimethalin alone applied @ 1.5 kg a.i. ha^{-1}.

Author's Contribution

Muhammad Sajid Mahmood conceived the idea, conducted experiment and collected data. Muhammad Ashraf did overall management and supervised the experiment. Muhammad Aqeel Sarwar wrote abstract and provided technical input at every step. Muhammad Khubaib Abuzar and Ijaz Ahmad did statistical analysis. Sohail Latif and Waqas Ahmad wrote the article.

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