*Pak. J. Weed Sci. Res., 22(2): 285-294, 2016*

# BIOHERBICIDAL POTENTIAL OF PLANT EXTRACTS AGAINST WEEDS OF WHEAT CROP UNDER AGRO-CLIMATIC CONDITIONS OF PESHAWAR-PAKISTAN

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## ABSTRACT

*The possible ill effects of herbicides usage in agriculture have increased the interest of farming and researchers community to explore new ways of weed control. Bioherbicides (Allelochemicals) are considered as an available option for weed management. In order to test the potential of some allelopathic plant water extracts as a weed management tool in wheat crop, a field trial was carried out during winter 2011-12 at NDF, The University of Agriculture Peshawar Pakistan. The experimental design was RCBD having split plot arrangement. The main plots assigned to time of treatment application (pre emergence and post emergence) of plant extracts, while there were eight sub plots consisting of different weed control measures i.e. sorghum water extract {Sorghum bicolor (L.) Moench}, sunflower extract (Helianthus annuus L.), Parthenium extract (Parthenium hysterophorus L.), common reed extract {Phragmites australis (Cav) Trin}, Johnson grass extract {Sorghum halepense (L.) Pers}, Rice straw extract (Oryza sativa L.), herbicide (Logran Extra) and control. The results demonstrated that the pre emergence application of all the plant water extracts proved to be superior in action to their post application regarding weed control. Among the plant water extracts (treatments) the pre emergence application of both P. australis and H. annuus gave the minimum weed density of 89.50 and 113.50 $m^2$ respectively compared to control plot (280.0 $m^2$). Tallest (113.9 cm) plant height and outmost grains spike$^{-1}$ (64) was computed for H. annuus. In addition, the P. australis and herbicide (Logran extra) both proved superior for 1000 grain weight, however the leaf area of wheat remained non-significant under all examined treatments. The present results suggest that P. australis and H. annuus could be successfully incorporated in weed management approaches in wheat. Currently allelopathy is passing through experimental stages. Thus, further*

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*comprehensive studies are suggested to explore the possibility and feasibility for commercializing the extracts of these two species.*

**Key words:** Allelopathy, *Phragmites australis*, weed control, wheat.

**Citation:** Khan, R., M.A. Khan, S. Shah, S. Uddin, S. Ali and M. Ilyas. 2016. Bioherbicidal potential of plant extracts against weeds of wheat crop under agro-climatic conditions of Peshawar-Pakistan. Pak. J. Weed Sci. Res. 22(2): 285-294.

## INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most important among cereal crops in Pakistan. On country basis, during 2010-11 the total area under wheat crop was 8.90 million ha having a total production of 25.21 million tons. While, in the same year, the total area and production in Khyber Pakhtunkhwa province was 0.724 million ha and 1.155 million tons, respectively (Anonymous, 2012). Unfortunately the grain yield of wheat is very low in Pakistan due to so many factors. Among the other pests, weed infestation is one of the major causes of lower yield. Weed infestation is a serious problem in wheat crop and uncontrolled weeds can reduce wheat yield by 25-30% in Pakistan (Nayyar *et al.,* 1994). Basically, the weeds compete with the crop plants for light, moisture, space and nutrients therefore, cause severe losses to grain yield. In wheat crop the weeds are generally controlled with cultural practices and herbicides.

Cultural weed management is greatly influenced by weather conditions, while herbicides are not environment friendly and may contaminate the nutritional quality of crops (Kassasion, 1971). Weed management approaches like chemical application and manual hoeing are effective for weed suppression but in certain cases these seems to be un-economical due to higher costs (Cheema *et al.,* 2003b). Non judicious use of herbicides has caused serious environmental and health problems in the recent years (Jabran *et al.,* 2008). Among other opportunities, allelopathy (bioherbicides) has been extensively reviewed in the last few decades by conducting trials to demonstrate the nature of allelopathic impacts of weeds on crop plants (Putnam and Duke, 1974). Weed control techniques currently in use are either expensive or dangerous to both health and environment that ultimately leads to pollution (Batish *et al.,* 2007). Similarly, hand weeding is laborious, time consuming and expensive in many conditions. Therefore such circumstances demanding to develop an alternative and eco friendly approach for weed management. Cheema *et al.* (2003a) concluded that herbicide in combination with sorghum water extract in wheat and maize have shown good results by suppressing weeds. Thus keeping under consideration the importance of weeds, harmful effects of herbicides and the renowned importance of alleopathy in weed management, a field trial was carried out under the agro climatic conditions of district Peshawar to screen different plants water extracts for their herbicidal potential against weeds of wheat.

## MATERIALS AND METHODS

Experiment entitled "Bioherbicidal potential of plant extract against weeds of wheat crop under agro climatic condition of Peshawar, Khyber Pakhtunkhwa-Pakistan" was conducted at NDF, The University of Agriculture, Peshawar Pakistan during winter 2011-12. The trial was laid out in randomized complete (RCB) design arranged in split plots, having two main plots and eight sub plots repeated thrice. The main plots assigned to time of treatment application (pre emergence and post emergence) of plant extracts to wheat and weeds, while the sub plots allocated to different weed control measures including plant extracts and a herbicide application. Wheat variety "Ata-Habib" was planted at seed rate of 120 kg ha$^{-1}$ and the recommended rate of NP (nitrogen and phosphorus) fertilizer (120: 60 kg ha$^{-1}$) was applied. The size of each sole treatment was 1.50 m x 3 m. The extracts of below given plant extracts were sprayed as pre emergence and post emergence for weed suppression in wheat. The details of the treatments are as under.

| Treatments | | Rate |
|---|---|---|
| $T_1$ | *Parthenium hysterophorus* L. | 488.88 kg ha$^{-1}$ |
| $T_2$ | *Sorghum bicolor* (L.) Moench | 488.88 kg ha$^{-1}$ |
| $T_3$ | *Helianthus annuus* L. | 488.88 kg ha$^{-1}$ |
| $T_4$ | *Sorghum halepense* (L.) Pers | 488.88 kg ha$^{-1}$ |
| $T_5$ | *Oryza sativa* L. | 488.88 kg ha$^{-1}$ |
| $T_6$ | *Phragmites australis* (Cav) Trin | 488.88 kg ha$^{-1}$ |
| $T_7$ | Logran Extra 64 WG | 100 g ha$^{-1}$ |
| $T_8$ | Weedy check | --- |

The above stated plants were collected at maturity, cleaned and dried in oven (Wiseven) for 72 hours at 65$^0$C. After that all the collected plants were ground separately by using mechanical grinder and recorded the weight by using electrical balance. A ground sample of 110 g was soaked in 1 liter of tape water for 24 hours of each plant to prepare the mixture. After that the mixture of plants powder and water were filtered through muslin cloth and were bottled for further use in experimentation. After planting of the wheat crop, water extracts of the plants were individually sprayed as per treatment by using knap sack sprayer, while the post emergence spray was applied after emergence of weeds and crop at 30 days after sowing (DAS) of the wheat crop. During the experimentation, the data were recorded on weed density $m^{-2}$ (15 DAS), tiller height (cm), leaf area ($cm^2$), number of grains $spike^{-1}$ and thousand grain weight (g).

## RESULTS AND DISCUSSION

### Weed density $m^{-2}$ (50 days after sowing)

Data presented in Table-1 showed significant differences for time of application of weed control techniques. It was observed that at 50 days after sowing (DAS) there was a significant decrease were noted in the weed density for both pre and post-application plots. After the toxic action of plant extracts many weeds were killed which resulted in decreased weed density at 50 DAS (Table-1). The means data showed in Table-1 presented that outmost weed density (280) $m^{-2}$ was noted in control plot which was statistically at par with *S. bicolor* (154.50) weeds $m^{-2}$. Minimum (89.50) weed density $m^{-2}$ was calculated for *P. australis* that was comparable with Logran extra (118.33 $m^{-2}$), *H. annuus* (117.83 $m^{-2}$), *P. hysterophorus* (113.50 $m^{-2}$), *O. sativa* (136.0 $m^{-2}$) and *S. bicolor* (154.50 $m^{-2}$). Interaction of plant water extracts and their time of application was also significant. The highest weed density $m^{-2}$ (349) was found in the combination of weedy check x pre-application and minimum weed density $m^{-2}$ (96) was recorded for *P. australis* x pre-application. The current findings revealed that after the foliar application of water extract it disturbed the normal physiology of weed that resulted in death or retardation of weed plant. James *et al.* (2003) stated that some allelochemicals affect the cell division, nutrient uptake, photosynthesis, pollen germination and particular enzyme function inside a plant.

It was observed that pre-emergence application of the plant water extract was superior to post-application due to the phytotoxicity of the few plant water extracts for weeds. *P. australis, H. annua* and *Sorghum halepense* proved the best by decreasing the weed density when applied as pre-emergence. The values in all the treatments were statistically at par when applied at post-emergence stage. The instant results revealed that pre-emergence application of the plants under study can inhibit the germination of the weed seeds. In some similar investigations Khan *et al.* (2004) observed that water extracts of several plants significantly inhibited the seed germination of wheat and their associated weeds.

**Table-1.** Impact of weed control techniques on weed density at 50 days after sowing (DAS) in pre-emergence and post-emergence application

| Treatments | Application Time | | Means |
|---|---|---|---|
| | Pre emergence | Post emergence | |
| *Parthenium hysterophorus* L. | 88 d | 147 bcd | 117.83 bc |
| *Sorghum bicolor* (L.) Moench. | 121 bcd | 188 b | 154.50 ab |
| *Helianthus annuus* L. | 111 cd | 116 bcd | 113.50 bc |
| *Sorghum halepense* (L.) Pers. | 94 d | 141 bcd | 117.50 bc |
| *Oryza sativa* L. | 96 d | 176 bc | 136.0 bc |
| *Phragmites australis* (Cav) Trin. | 81 d | 98 d | 89.50 c |
| Logran Extra 64 WG | 108 cd | 128 bcd | 118.33 bc |
| Weedy check | 284 a | 276.0 a | 280.0 a |
| Means | 122.8 b | 158.7a | |

LSD $_{(0.05)}$ for Treatment = 53.53, LSD $_{(0.05)}$ for Time of Application = 25.71, LSD $_{(0.05)}$ for Interaction = 75.71

## Tiller height at maturity (cm)

Tiller height is a very important growth parameter in wheat and highly intolerant by environmental conditions and weed management practices. Mean data (Table-2) showed that the time of application, weed management techniques and their interactions all gave significant results. In case of time of application the post application plot gave the highest value (112.90 cm) of wheat plant height and the lower value (109.21 cm) was recorded for pre application plot. Treatment means indicated that maximum plant height (113.93 cm) was calculated for *Helianthus annuus*, which was comparable with Logran extra, *Parthenium hysterophorus* and *Phragmites australis*. Minimum (106.45cm) was recorded in *Oryza sativa* that was statistically at par with *Sorghum halepense*. The interaction of time and weed control techniques also significantly effected the plant height like their individual responses. The combination of *Helianthus annuus* x post application gave maximum (116.87 cm) wheat plant height and the minimum plant height (102.90 cm) was observed for the pre application of *Oryza sativa* (Table-2). Similar results were reported by Kamal and Banu (2008). They observed increased in the plant height of wheat upon exposing to the water extract of sunflower. The instant results showed that due to weed control, the weeds were suppressed which ultimately positively affected the plant height of wheat.

**Table-2.** Effect of weed control techniques on tiller height (cm) of wheat at maturity

| Treatments | Application Time | | Means |
|---|---|---|---|
| | Pre emergence | Post emergence | |
| *Parthenium hysterophorus* L. | 112.20 cde | 114.17 abc | 113.18 ab |
| *Sorghum bicolor* (L.) Moench. | 108.30 ef | 111.30 cdef | 109.80 cd |
| *Helianthus annuus* L. | 111.00 cdef | 116.87 a | 113.93 a |
| *Sorghum halepense* (L.) Pers. | 110.13 cdef | 108.37 ef | 109.25 de |
| *Oryza sativa* L. | 102.90 g | 110.00 def | 106.45 e |
| *Phragmites australis* (Cav) Trin. | 111.83 cde | 112.73 bcd | 112.28 abc |
| Logran Extra 64 WG | 109.63 def | 116.80 ab | 113.22 ab |
| Weedy check | 107.70 f | 113.00 abcd | 110.35 bcd |
| Means | 109.21 b | 112.90a | |

LSD $_{(0.05)}$ for treatment = 2.877, LSD $_{(0.05)}$ for Application = 2.360,
LSD $_{(0.05)}$ for Interaction = 4.069

## Leaf area plant$^{-1}$ (cm$^2$)

The data regarding leaf area (cm$^2$) plant$^{-1}$ is presented in Table-3. The ANOVA revealed that different weed control techniques, application time and their interaction showed non-significant results for leaf area (cm$^2$) plant$^{-1}$. The pre-emergence plot gave a leaf area of (60.29 cm$^2$), while the post plot gave leaf area of 59.12 cm$^{-2}$. Means of the treatments showed that maximum value for leaf area (cm$^2$) plant$^{-1}$ was recorded under the application of *Helianthus annuus* (60.75 cm$^2$) followed by *Sorghum halepense* (60.68 cm$^2$), whereas the minimum (57.90) leaf area (cm$^2$) plant$^{-1}$ was computed for weedy check (Table-3). Similar results were reported by Baghestani *et al.* (2006). They observed non-significant effect in the LAI (Leaf area index) for wheat genotype- 6618 in comparison with genotype-M-75-5 under both weed infested and weed free and the conditions.

**Table-3.** Impact of weed control techniques on leaf area (cm$^2$) plant$^{-1}$ of wheat

| Treatments | Application Time | | Means |
|---|---|---|---|
| | Pre emergence | Post emergence | |
| *Parthenium hysterophorus* L. | 61.56 | 57.53 | 59.55 |
| *Sorghum bicolor* (L.) Moench. | 60.70 | 56.53 | 58.61 |
| *Helianthus annuus* L. | 60.83 | 60.66 | 60.75 |
| *Sorghum halepense* (L.) Pers. | 60.33 | 61.03 | 60.68 |
| *Oryza sativa* L. | 60.26 | 59.26 | 59.76 |
| *Phragmites australis* (Cav) Trin. | 59.73 | 60.33 | 60.03 |
| Logran Extra 64 WG | 61.40 | 59.33 | 60.36 |
| Weedy check | 57.53 | 58.26 | 57.90 |
| Means | 60.29 | 59.12 | |

LSD $_{(0.05)}$ for treatment = NS, LSD $_{(0.05)}$ for Application = NS,
LSD $_{(0.05\ )}$ for Interaction = NS

**Number of grain spike$^{-1}$**

ANOVA revealed that different treatments had significant effect on number of grains spike$^{-1}$ (Table-4) and the time of application had non-significant effect on number of grains spike$^{-1}$. Means of time of application indicated that maximum (61.25) number of grains spike$^{-1}$ was recorded in pr-emergence application plots and minimum (59.87) number of grains spike$^{-1}$ was recorded in post-emergence plots. From the perusal of data in Table-4, it was observed that plots treated with *Helianthus annuus* had the highest (64.00) number of grains spike$^{-1}$ followed by *Parthenium hysterophorus* 62.50. The minimum 56.0 numbers of grains spike$^{-1}$ were recorded in control plots which was comparable with *Oryza sativa*. The logic behind increased number of grain spike$^{-1}$ is due to the effective weed control in those treatments and consequently wheat crop efficiently utilized all the available resources. The interaction of time of application and weed control techniques exhibited that the pre application of *Helianthus annuus* produced the highest (66.0) number of grains spike$^{-1}$ and the lowest was recorded for the post application of *Oryza sativa* and (57.00) number of grains spike$^{-1}$. Cheema *et al.* (2003b) also communicated analogous findings in wheat. They reported that grain number spike$^{-1}$ was significantly increased with the application of sorghum, sunflower and eucalyptus water extracts. In another study Khan and Hassan (2006) reported the minimum grain number spike$^{-1}$ in wild oat infested plots and maximum in wild oat free plots.

**Table-4.** Impact of weed control techniques on no. of grains spike$^{-1}$

| Treatments | Application Time | | Means |
|---|---|---|---|
| | Pre emergence | Post emergence | |
| *Parthenium hysterophorus* L. | 63.50 | 61.50 | 62.50 ab |
| *Sorghum bicolor* (L.) Moench. | 59.50 | 61.50 | 60.500 bc |
| *Helianthus annuus* L. | 66.00 | 62.00 | 64.000 a |
| *Sorghum halepense* (L.) Pers. | 63.00 | 57.50 | 60.250 bc |
| *Oryza sativa* L. | 61.00 | 57.00 | 59.000 cd |
| *Phragmites australis* (Cav) Trin. | 60.00 | 61.50 | 60.750 bc |
| Logran Extra 64 WG | 58.50 | 60.50 | 59.500 bc |
| Weedy check | 58.50 | 57.50 | 58.000 d |
| **Means** | 61.250 | 59.875 | |

LSD $_{(0.05)}$ for treatment = 2.1449, LSD $_{(0.05)}$ for Application = NS,
LSD $_{(0.05)}$ for Interaction = NS

**1000 grain weight (g)**

1000 grain weight is an important yield component and greatly affects the economic yield. Statistical analysis of the data show that different weed control measures had significant effect, while the time of application and the interaction between application time and weed control measures had a non significant effect on 1000 grain weight (Table-5). Both the main plots gave the average 1000 grain weight of 35.37 and 35.79 g for pre and post application, respectively. Data exhibited that maximum 1000 grain weight (40.15 g) was recorded under the application of Logran Extra 64 WG that was statistically comparable with *Parthenium hysterophorus* (38.21), *Oryza sativa* and *Phragmites australis* (37.16). The minimum 1000 grain weight (30.58 g) was observed for weedy check followed by *Helianthus annuus* (31.64 g) and *Sorghum bicolor* (33.92 g). Interaction data showed that the highest value for 1000 grain weight (44.15 g) was observed in the plots treated with the post application of *Parthenium hysterophorus*; however, the lower 1000 grain weight (31.40 g) was computed for *Helianthus annuus* x pre-emergence application (Table 10). While similar results were reported by Hassan *et al.* (2003) who observed an increased in the 1000 grain weight significantly compared to weedy check after using the different herbicides in their trial. In another study Cheema and Akhtar (2005) also concluded that weed control techniques effectively increased 1000 grain weight in wheat.

**Table-5.** Impact of weed control techniques on 1000 grain weight (g) of wheat

| Treatments | Application Time | | Means |
|---|---|---|---|
| | Pre emergence | Post emergence | |
| *Parthenium hysterophorus* L. | 32.26 | 44.15 | 38.21 ab |
| *Sorghum bicolor* (L.) Moench. | 35.46 | 32.38 | 33.92 bcd |
| *Helianthus annuus* L. | 31.40 | 31.89 | 31.64 cd |
| *Sorghum halepense* (L.) Pers. | 37.80 | 34.87 | 36.33 abc |
| *Oryza sativa* L. | 37.13 | 36.13 | 36.63 abc |
| *Phragmites australis* (Cav) Trin. | 39.43 | 36.88 | 40.16 ab |
| Logran Extra 64 WG | 40.93 | 39.38 | 40.15 a |
| Weedy check | 30.53 | 30.62 | 30.58 d |
| Means | 35.37 | 35.79 | |

LSD (0.05) for treatment = 5.142, LSD (0.05) for Application = NS,
LSD (0.05) for Interaction = NS

## CONCLUSION

For weed suppression physical/mechanical or cultural control are safe but not economical or acceptable all the times. While the application of herbicides leads to so many problems including herbicide resistance in weeds and health hazards issues. Herbicide exposure seems at a high risk in Pakistan because there is no consciousness about the safe use of agro chemicals especially herbicides. Therefore, instead of using other weed control methods, the application of allelochemicals (bioherbicides) seems to be more economical and eco-friendly. The outcome of the present study revealed that nearly all the tested plant water extracts especially *Phragmites australis* and *Helianthus annuus* are the stronger and effective candidates to be used for weed suppression in wheat crop in future. However, proper training will be required for the collection, preparation and application of these bioherbicides.

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