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Chemical management of *Phalaris minor* and *Avena sativa* exotic weeds in wheat crops

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Abstract

Phalaris minor and Avena sativa are exotic invasive weed plant in wheat cropland in Punjab-Pakistan. These weed plants negatively affected on the native wheat crops. The present study was conducted to control invasiveness by the foliar applications of five different herbicides i.e. (T-1; Clodinophop Proporgyl @ 300 gha^{-1}), (T-2; Sulfosulfuran 75% WDG @ 400 gha^{-1}), (T-3; Penoxadin 50EC & Metsulfuran+Idosulfuron @ 825 mlha^{-1}), (T-4; Methyl Sodium 6% WG @ 375 gha^{-1}), (T-5; Pyroxulum 45% OD @ 34 gha^{-1}) parallel to the control treatments during 2021 at Chak Himta, Tehsil and District Lodhran, Punjab-Pakistan. The basic goal was to evaluate the efficacy of different herbicides used against exotic weeds in wheat crops in paired comparisons. The data showed that maximum mortality of exotic weed population were found in T-1 (68%) followed by T-5 (65%) and T-4 (55%). Although, all the herbicides were effective for controlling these invasive weeds significantly (P<0.05), however, maximum effect was found in T-1 in their paired scattered plots. Highly significant (P<0.01) loss of weed abundance m^{-2} was recorded in T-1 (48%) followed by T-5 (46.47%) and T-2 (40.91%). There is a significant difference between control and treated population were recorded highly significant (P<0.05) result in T-2 followed by T-5 and T-1. The paired difference between T-3 and T-4 recorded non-significant (P>0.05) results between control and treated treatments after foliar applications. There is a strong highly significant (P<0.01) relationship of foliar application of herbicides with every application. The foliar application of T-3 and T-4 showed strong positive impact on T-2 and T-3 studied herbicides in the present niche.

Keywords: Herbicides; Efficacy; Narrow leaved; Invader, Punjab-Pakistan

Introduction

The wheat crop (Poaceae family) provided edible grains for human use. Cereals provide half of the calories in human meals, making them one of the most direct sources of human nutrition in Pakistan, where they account for 66 percent of cropped land. Wheat is produced on 9.06 million hectares in Pakistan, with a total production of 23.42 million tonnes and an average yield of 2585 kilogrammes per hectare. It adds 13.1 percent to agricultural value added and 2.8 percent to GDP (Anonymous, 2009). Weed infestation is one of the factors that has a negative impact on wheat productivity. Weeds fight with agricultural plants for abiotic factors food, and a variety of other growth elements through competition and allelopathy, resulting in a direct loss of yield and quality (Gupta, 2004). Crop losses caused by weed competition are larger than those caused by insects and illnesses combined. Weeds can promote the spread of diseases, provide refuge, and act as a pest's alternate host (Marwat et al., 2005). Weed infestation is one of the leading reasons of low wheat yields not just in Pakistan but around the world, reducing wheat output by 37-50 percent (Baluch, 1993; Nayyar et al., 1995; Waheed et al., 2009). As a result, chemical weed treatment has been shown to be a more efficient and cost-effective way of weed control (Marwat et al., 2008). The second most serious danger to natural biodiversity and ecosystem functioning is invasive alien weed plants (Iqbal et al, 2020) Wheat yields were lowered as a result of this. Weed control is vital because weeds cause a significant loss of national revenues. Weeds must therefore be controlled in order to improve wheat quality and output. Weeds were previously controlled manually; however this was a time-consuming and costly strategy due to rising labour costs. Furthermore, draught animals and implements were used to control weeds (Iqbal, 1994). Weeds are now controlled chemically, resulting in significant time and input cost savings. However, choosing the best herbicides, applying them at the right time, and using the right dose of herbicide are crucial for attaining the best results (Cheema et al., 2005). All herbicides reduced weed populations, resulting in greater output and profitability (Hussain et al., 2003). Pakistan is one of the top 10 wheat producers in the world (Khan, 2003). Wheat consumption per inhabitant in the country is 125 kg per year, equating to 18064 million tonnes of national demand. As a result, the purpose of this study was to assess the efficacy of several pre- and post-emergence herbicides to a control in paired comparisons.

Under the supervision of Pest Warning and Quality Control of Pesticides, Lodhran, the current study was designed to evaluate the five different single and combinations of herbicides available in the local market for controlling narrow leaved weeds in wheat crops at Chak Himta, Tehsil and District Lodhran during 2021-2021.

Materials and Methods

The present study was conducted to evaluate the effectiveness of the foliar applications of five different herbicides i.e. (T-1; Clodinophop Proporgyl @ 300 gha^{-1}), (T-2; Sulfosulfuran 75% WDG @ 400 gha^{-1}), (T-3; Penoxadin 50EC & Metsulfuran+Idosulfuron @ 825 mlha^{-1}), (T-4; Methyl Sodium 6% WG @ 375 gha^{-1}), (T-5; Pyroxulum 45% OD @ 34 gha^{-1}) parallel to the control treatments during 2021 at Chak Himta, Tehsil and District Lodhran, Punjab-Pakistan. With four replications and five treatments on scattered plots, the research trial was done using a Randomized Complete Block Design. Wheat (Ghazi-2019) was planted in well-aerated soil with 225 kgha^{-1} DAP and 125 kgha^{-1} SOP using a tractor-drawn drill at the end of November in a well-prepared seed bed. The first irrigation was performed in the field in the first week of January, and after irrigation, 125 kgha^{-1} nitrogenous fertilizers were dispersed manually. These herbicides were sprayed on weeds during the 4-6 leaf stage in damp conditions. Before treatments applications paired plots were selected having significant intensity of weeds populations for proper comparison. The weeds in all selected plots were counted in (100 cm x 100 cm) quadrat and noted before spraying of each foliar application in the scattered plots. On January 20, 2021, these herbicides were sprayed in each scattered plot except control using a manually powered backpack hand sprayer with a volume of water of 300 litres per hectare. To eliminate bias, all other ecological measures were kept consistent. The abundance of weed populations between paired quadrats analyzed and their differences were calculated by Student *t-test* and their relationship was recorded by Pearson's correlations between control and foliar treatments (Iqbal et al, 2020). Pair-wise weed populations were recorded and analyzed by one way analysis of variance keeping $P<0.05$ and graphical representations were calculated through sigma plot graph 14 software (Iqbal et al, 2019). The number of weeds m^{-2} counted before after herbicide application at one-week intervals until the fourth week after the herbicide treatment; and weed mortality (percent) was estimated using the competition intensity (loss percent) calculation.

$$\text{Loss } (\%) = \frac{\textbf{Control} - \textbf{treated}}{\textbf{Control}} \times \textbf{100}$$

Results and Discussion

The data showed that maximum mortality of exotic weed population were found in T-1 (68%) followed by T-5 (65%) and T-4 (55%), the lowest mortality was recorded in T-3 (37%) in their foliar treatments recorded on the basis of competition intensity during four weeks of the measurements. Although all the herbicides were effective for controlling these invasive weeds significantly ($P<0.05$), however maximum effect was found in T-1 followed by T-5 and T-4 through one way analysis of variance keeping $P<0.05$ in their paired scattered plots (Fig. 1). Highly significant ($P<0.01$) loss of plant abundance was recorded in T-1 (48%) followed by T-5 (46.47%) and T-2 (40.91%) calculated (Table-1).

Table 1 Impacts of the invasive plants on abundance/m^2 of co-occurring plants between invaded and non-invaded quadrats at different chemical treatments

Locations	Invaded quadrat (mean±SE)	Non-invaded quadrat (mean±SE)	Difference in abundance
T-1	5.31+0.60	2.75+0.59	*
T-2	5.50±0.39	3.25±0.50	**
T-3	4.88±0.51	3.56±0.50	NS
T-4	4.60±0.37	3.18±0.56	NS
T-5	5.38±0.50	2.88±0.46	**

Notes: Mean + 1 SE (Mean+1 Standard Error). *, P < 0.05,**, P < 0.01, NS (Non-significant), whereas T-1 (Clodinophop Proporgyl @ 300 gha^{-1}), T-2 (Sulfosulfuran 75% WDG @ 400 gha^{-1}), T-3 (Penoxadin 50EC & Metsulfuran+Idosulfuron @ 825 mlha^{-1}), T-4 (Methyl Sodium 6% WG @ 375 gha^{-1}), T-5 (Pyroxulum 45% OD @ 34 gha^{-1})

There is a significant difference between control and treated population were recorded highly significant (P<0.05) result in T-2 (t = 4.03 and P<0.01) followed by T-5 (t = 3.69, P <0.01) and T-1 (t = 2.93, P<0.05). The paired difference between T-3 and T-4 recorded non-significant (P>0.05) investigations between control and treated treatments after foliar applications.

There is a strong highly significant (P<0.01) relationship of foliar application of herbicides with every application in the control both exotic weeds invaders in studied ecosystem. The foliar application of T-3 and T-4 showed strong positive impact on T-2 and T-3 studied herbicides in the present niche (Table-2).

Table 2 Pearson's correlation of the invasive plants on abundance m^{-2} of co-occurring plants between invaded (foliar treatment) and non-invaded (control) quadrats at different chemical treatments

	T-1C	T-2C	T-3C	T-4C	T-5C	T-1F	T-2F	T-3F	T-4F	T-5F
T-1C	1									
T-2C	0.062	1								
T-3C	-0.209	0.064	1							
T-4C	-0.037	-0.053	**0.533***	1						
T-5C	0.142	0.066	0.465	0.138	1					
T-1F	-0.079	-0.037	-0.063	0.249	0.253	1				
T-2F	0.038	0.217	0.124	0.186	0.317	**0.772****	1			
T-3F	-0.218	0.291	-0.031	0.191	0.011	**0.741****	**0.769****	1		
T-4F	-0.219	0.029	-0.155	-0.128	-0.047	**0.800****	**0.748****	**0.758****	1	
T-5F	-0.309	-0.095	-0.149	-0.265	-0.023	**0.599****	0.360	0.295	**0.768****	1

Notes: C (Control), F (Foliar applications of herbicides), T-1 (Clodinofop Proporgyl 50WP), T-2 (Sulfosulfuron 75% WDG), T-3 (Penoxadin 50 EC & Metsulfuron +Idosulfuron), T-4 (Methyl Sodium 6%WG), T-5 (Pyroxulum 45% OD). Data are Pearson's correlation coefficient. * (P < 0.05), ** (P < 0.01)

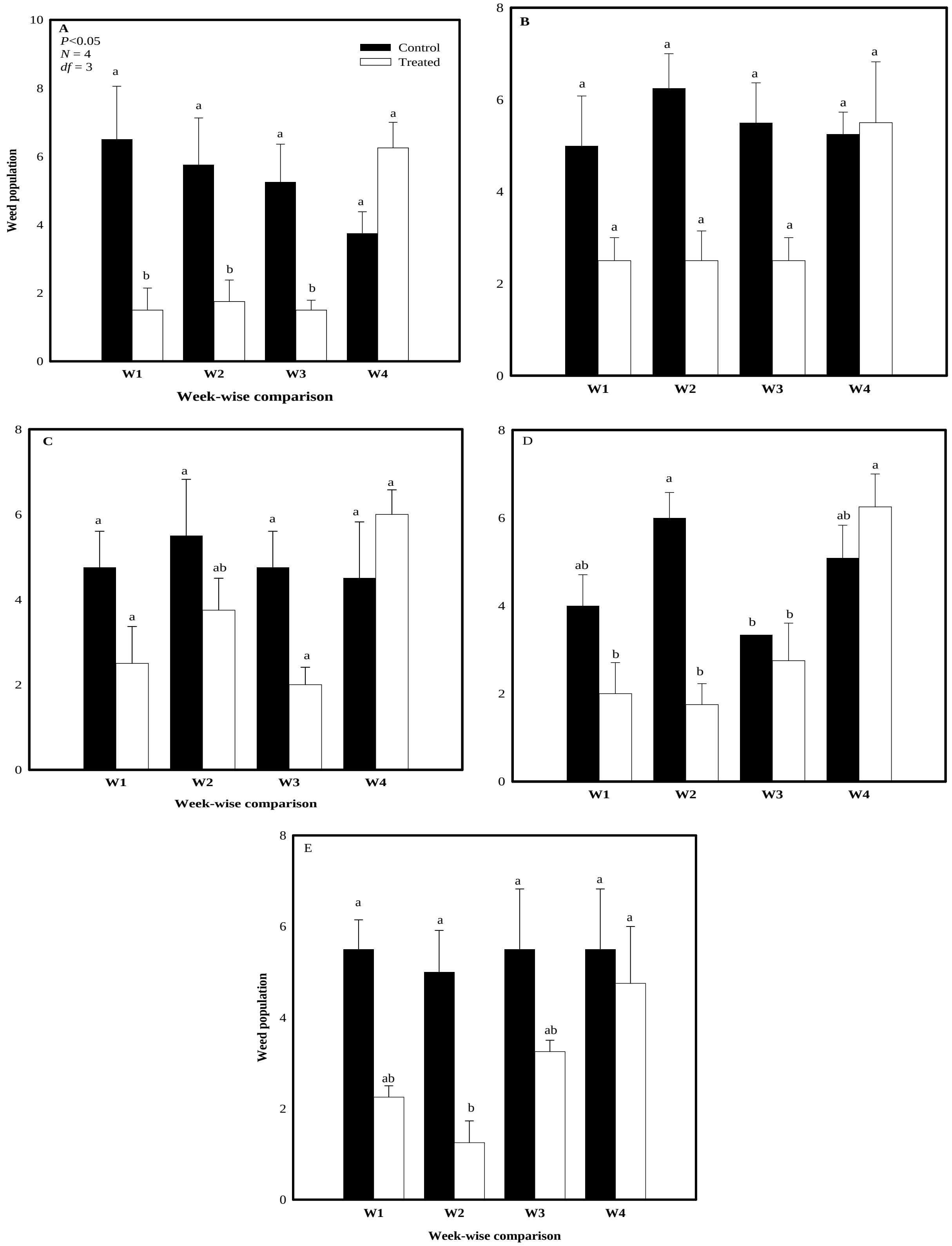

Figure 1 showing week-wise paired comparisons of treated versus control by different foliar treatments at Himta, Lodhran, Whereas A (Clodinofop Proporgyl 50WP), B (Sulfosulfuron 75% WDG), C (Penoxadin 50 EC & Metsulfuron +Idosulfuron), D (Methyl Sodium 6% WG @ 375 gha^{-1}), E (Pyroxulum 45% OD), W1 (27-January), W2 (03-February), W3 (10-February), W4 (17-February)

These findings contradicted those of Faryad et al. (1998), who found that combining narrow and broad leaved herbicides for weed control in wheat fields yielded better results than using them separately (Faryad et al., 1998). These findings were also countered by researchers who claimed that using a mixture of herbicides rather than individual herbicides was the most effective way to control a wide range of weeds (Bostrom and Fogelfores, 2002, Khan et al, 2001). These results are in agreement with Hashim et al. (2002) and Khan et al. (2003) foliar pesticide spray reduced broad and narrow leaved weeds to varied degrees, sometimes up to 100% control.

Conclusion

Finally, it was determined that all herbicides were significantly successful in controlling these exotic weeds, with the greatest effect reported in T-1 (Clodinofop Proporgyl 50WP @ 300 gha^{-1}), T-2 (Sulfosulfuron 75% WDG @ 400 gha^{-1}), T-3 (Penoxadin 50 EC & Metsulfuron +Idosulfuron @ 825 mlha^{-1}) in paired scattered plots. The farmers of this region are advised to use these herbicides for better controlling of invasive *Phalaris minor* and *Avena sativa* plants in wheat crops.

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Conflict of interest

All authors declared that they have no competing interests and that they have thoroughly read the final version of the work.

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