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Raza Ejaz
Institute of Agricultural Extension
and Rural Development,
University of Agriculture,
Faisalabad, Pakistan

Khalid Mahmood Chaudhary
Institute of Agricultural Extension
and Rural Development,
University of Agriculture,
Faisalabad, Pakistan

Umair Talib
Department of Agricultural
Extension, PMAS-Arid Agriculture
University, Rawalpindi, Pakistan

Inayatullah
Balochistan Agriculture College
Quetta, Pakistan

Corresponding Author:
Umair Talib
Department of Agricultural
Extension, PMAS-Arid Agriculture
University, Rawalpindi, Pakistan

Effectiveness of various chemical and non-chemical weed management practices as perceived by the farmers under cotton wheat cropping system in the Punjab

Raza Ejaz, Khalid Mahmood Chaudhary, Umair Talib and Inayatullah

Abstract

Present study was conducted at Institute of Agricultural Extension and Rural Development, University of Agriculture Faisalabad, Pakistan in 2018 in order to explore the effectiveness of different chemical and non-chemical weed management practices adopted by the farmers under cotton-wheat cropping system. Weeds are unwanted plants that compete with the crops grown and responsible for severe losses in crop production. Weed infestation is one of the major among various factors that result in reducing crop production and responsible for economic losses to the farming community. Multistage random sampling technique was used for the selection of sample of 130 respondents. The data were collected through a reliable and validated interview schedule. And were analyzed using statistical package for social sciences (SPSS). Descriptive and inferential statistical techniques were used for data analysis. Results indicate that among non-chemical weed management practices under cotton-wheat cropping system, using clean and quality seed, proper tillage operations, crop rotation, hand hoeing and ploughing were ranked most effective with a mean value of 4.07, 4.09, 3.94 4.14 and 3.96 respectively. Among chemical weed management practices in wheat, Bromoxynil + MCPA, Puma Super (Fenoxaprop P-ethyl) and Atlantis (Mesosulfuron Methyl- Iodosulfuron methyl sodium) were reported to be the most effective weedicides with mean value of 4.2, 4.1 and 3.98 respectively. While, in case of cotton, Pendimethalin and Dual Gold (S-metolachlor) were declared most effective pre-emergence weedicides with mean value of 4.12 and 3.88 respectively. Similarly, gramoxone (Paraquat) and Round Up (Glyphosate) were reported to be the most effective post-emergence weedicides of cotton with mean value of 4.3 and 3.99 respectively.

Keywords: Cotton-wheat cropping system, weeds infestation, pendimethalin, Bromoxynil MCPA

Introduction

Weeds are the main problem which can influence the production and quality of any crop (Khan *et al.*, 2011) [6]. The process of removing undesired plants from any of the cropped area with an aim of minimizing yield losses and gaining economic profit is known as weed management. To control yield losses as a result of weed infestation there are different methods for weed management such as preventive measures, mechanical control measures, cultural control methods, biological control methods, chemical control measures, different cropping techniques and cropping patterns for controlling infestation of weeds (Gerhards *et al.*, 2011; Tanveer *et al.*, 2005) [4, 11].

Among different weed controlling strategies being practiced by the farming communities, chemical control measures are considered the most valuable (Govt. of Punjab 2010a; Acker, 2009; Kotile and Martin, 2000) [5, 1, 7]. Although, chemical control provides better results, still there is requirement of producing genetically modified varieties for different crops having resistance against weeds for minimizing the yield losses (Rubiales *et al.*, 2009) [9].

Von (2004) [12] argued that plant protection measures involving chemicals were found responsible for making notable advances in effectiveness of measures taken in this regard. Along with increasing effectiveness it had also been responsible to minimize undesired side effects. Furthermore, increase in growth, increasing demand for food and requirements for raw materials results in further increase in crop production that is not possible to attain without the help of chemical measures of plant protection.

Ehsanullah *et al.* (2014) ^[2] reported that high seed rates, changing orientation of rows, restricted row spacing and selecting aggressive cultivars has been appraised as effective Integrated Weed Management (IWM) tools to intensify the crop competitiveness. Smith *et al.* (2015) ^[10] claimed that in terms of controlling weeds, cover crops play a vital role for managing weeds of different crops and these are also used as filter crops for reducing population of weeds.

Rubiales *et al.* (2009) ^[9] examined that the major weeds in Mediterranean and tropical agriculture that were creating problems were parasitic weed and the sources that were available for controlling them were un-sufficient. Various agronomic practices such as use of resistant crops and using a variety of herbicides were main strategies that were practiced in terms of controlling weeds. Chemically controlled measures were preferred because they ensured better results but still it was mandatory to produce some varieties (genetically modified) for the purpose of managing parasitic weeds for minimizing losses in yield.

Acker (2009) ^[1] claimed that different weed controlling practices were used by the farmers based upon their initial awareness from different sources and as a result of making observations regarding characteristics of different weeds. It was observed that population of weeds was continuously increasing resulting in different problems because of development of resistance against various herbicides/weedicides and thus there was need to develop some effective management strategies after getting a detailed knowledge regarding biology of weeds. Farmers may get benefit if they have information about the period of emergence of weeds and thus can be controlled in a better way by using pre-seeding tillage or by applying herbicides. Herbicide application was found more effective during autumn as compared to that of spring season in terms of controlling weeds. It is obvious that knowledge about biology of weeds not only saves efforts but money also and leads towards better weed management strategies.

Gerhards *et al.* (2011) ^[4] argued that weed control measures were aimed to reduce the negative influences on growth and yield of different crops. Experts had to take decisions according to extent of spreading of weeds. It was concluded that different preventive measures such as controlling weeds by using chemicals were quite effective for better weed control because losses in yield of different crops were also reported. Furthermore, it was also claimed that there is a linkage between the loss in yield and leaf area of the respective weeds. Weed species were found responsible for yield losses in case of maize, winter barley and winter wheat. Experiments revealed that competition by weed species, conductivity of soil and applying different herbicides had affected the quality and yield of grain. While, grassy weed was reported having strong competition in case of maize crop. However, the practice of site-specific weed control was notable and had great economic advantages when herbicide savings resulted in managing and compensating the costs for mapping of weed, detecting of weed and patch spraying. The application of different herbicides/weedicides resulted in notable increase in yield where there was high density of weeds infestation.

Olorunmaiye (2011) ^[8] argued that proper management of weeds ensured initial cost saving and return interests in an ecological zone of southern Guinea savanna situated in Nigeria. With the help of IWM (integrated weed management practices) applied in case of inter cropping system of cassava (*Manihot esculenta*) and maize. Different weed management skills such as crop competition, tillage and hoe-weeding, use of pre-emergence

weedicides, usage of post-emergence weedicides, legume cover crops and dynamics of seed bank were also studied. Concluding remarks were given that the above-mentioned weed management techniques were very helpful for farming community. It was also claimed that farmers can get excellent crop yield by adopting the described weed controlling strategies.

Garrison *et al.* (2014) ^[3] studied that weed competition can be destroyed quite effectively by using the technique of crop rotation and it resulted in a great sustainability in terms of controlling weeds. Further it was declared that this technique is one of the ideal practices for minimizing the weeds in various crops. It was also observed that by increasing successive plants of a stacked crop in numbers within a rotation results in increased weed-weed competition thus decreasing seed bank size by compelling different weeds to develop a competition among them. Results of this study showed that population of weeds was reduced more in stacked crops as compared to those rotations which were without stacking during the season as competition of weeds was increased.

FAO (2004) described that there are 08 different types of farming systems being practiced in Pakistan such as pulses-wheat, rice wheat, maize-wheat-oilseed, cotton-wheat, maize-wheat, mixed crops, peri-urban and orchards/vegetable-wheat. Cotton-wheat cropping system was the most commonly practiced among all these systems in rural areas of Punjab (southern) and Sindh. Wheat (*Triticum aestivum* L.) is an important cereal crop and is gaining popularity all over the world and especially in Pakistan. Due to increase in population and food prices, higher yield of the wheat can play a vital role in stabilizing the food prices directly or indirectly. Management of many factors can significantly contribute in increasing the grain yield of wheat in Pakistan. Among these factors, weed management is an important factor and can increase the wheat yield by more than one million ton in Pakistan. Weeds are an important obstacle to crop production, particularly in low-input and organic systems (Clark *et al.*, 1998; Penfold *et al.*, 1995; Stonehouse *et al.*, 1996). Cotton production is hampered by many factors like sowing at optimum time, germination, stand establishment, nutrient management and weeds infestation. Due to high competition for water, nutrients, light and space, weeds drastically affect the production of crop (Mubeen *et al.*, 2009). Both these crops (cotton and wheat) are majorly grown in district Punjab under cotton-wheat cropping system. High yield of these crops is directly associated with the increased livelihoods and betterment of the farmers. That is why the present study was planned to discover about the effectiveness of various chemical and non-chemical weed management practices adopted by the farming community. It was supposed that the findings of the study would be beneficial in identifying the effectiveness of different weed controlling measures and would also provide guide-line to government authorities (extension organizations) for planning a reasonable strategy in future for improved extension working regarding weed control measures.

Materials and Methods

The study was conducted in Sahiwal district of Punjab Pakistan, which consists of two tehsils. Tehsil Chichawatni was selected purposively because cotton-wheat is most commonly practiced cropping system in this tehsil. Tehsil Chichawatni consists of 37 union councils out of which 33 are rural while 4 are urban UCs. Out of 33 rural UCs 5 UCs were selected. Two villages were selected from each of the selected UCs thus by making a total of 10 villages. From each of the 10 villages 13 respondents were selected thus by making a sample size of 130 respondents.

Keeping in view the objectives of the study, an interview schedule was developed for data collection. Considering the suitability of Likert Scale for assessing the effectiveness of problems, a five-point Likert scale (1= Very Low), 2= Low, 3= Medium, 4= High, 5= Very High) was used. Descriptive statistics and inferential statistic such as frequencies, means, standard deviations and rank orders were used for interpretation of data.

Results and Discussion

Effectiveness of non-chemical weed management practices in wheat under cotton-wheat cropping system

Farmers were asked to report the effectiveness of different non-chemical weed management practices. The data depicted in table 1 reveal that using clean seed appeared to be an effective strategy with WS 532 and it was ranked 1st with a mean value of 4.1 (indicating that its effectiveness is high) while, keeping irrigation channels clean was the strategy ranked 2nd with a weighted score of 521 and mean value of 3.96 (medium effectiveness tending toward high). Keeping tools and machinery clean was ranked 3rd and keeping livestock out of field appeared to be the least effective and ranked 4th with a weighted score of 436 and 241 respectively. These findings reveal the importance of clean and pure seed in farming for better production.

Cultural and ecological management practices are of a great

value for the better production. Tillage appeared to be the very prominent technique for the removal of weeds. Crop rotation makes soil healthier and minimizes the chances of weed infestation thus it is assumed equally important like tillage. Tillage was ranked 1st among cultural practices with a weighted score of 534 and a mean value of 4.2 (high effectiveness tending towards very high) and crop rotation did not get much weighted score but still it was ranked 2nd and considered as an effective strategy for controlling weeds with a weighted score of 240 and a mean value of 2.95 (effectiveness ranging between low and medium) in case of wheat.

Although, manual practices are assumed more time consuming and labor intensive but still have significant value. For instance, hand pulling of weeds appeared most effective according to the views of all the respondents. Farmers mentioned that no doubt hand pulling is labor intensive and time consuming but effective. Hand hoeing was also declared effective equally. In case of wheat weighted score for hand pulling and hand hoeing was 534 and 583 respectively with a mean value of 3.27 (medium effectiveness) and 4.40 (high effectiveness tending towards very high) respectively.

Mechanical practices like using cultivator and ploughing were also found effective. Weighted score for use of cultivator was 426 and similarly it was 522 in case of ploughing with a mean value of 3.31 (medium effectiveness) and 3.92 (medium effectiveness tending towards high) respectively.

Table 1: Effectiveness of non-chemical weed management practices in wheat under cotton-wheat cropping system

Weed management practices	Wheat			
	WS	Rank	Mean	SD
Preventive management practices				
Clean seed	532	1	4.1	0.37
Irrigation channels clean	521	2	3.96	0.07
Tools and machinery clean	436	3	3.8	0.5
Livestock out of field	241	4	3.12	0.21
Cultural and ecological management practices				
Tillage	534	1	4.2	0.41
Crop rotation	240	2	2.95	0.12
Manual management practice				
Hand hoeing	583	1	4.40	0.51
Hand pulling	534	2	3.27	0.38
Mechanical management practices				
Ploughing	522	1	3.92	0.08
Use of cultivator	426	2	3.31	0.49

Scale- 1 = Very Low, 2 = Low, 3 = Medium, 4 = High, 5 = Very High

Effectiveness of non-chemical weed management practices in cotton under cotton-wheat cropping system

Farmers were asked about effectiveness of different non-chemical weed management practices in cotton. The data depicted in table 2 reveal that using clean seed appeared to be an effective strategy with weighted score of 530 and it was ranked 1st. It got the mean value of 4.07 that indicates its high effectiveness. Keeping irrigation channels clean was the strategy ranked 2nd with a weighted score of 520 and a mean value of 3.98 that indicates its effectiveness tending from medium towards high. Keeping tools and machinery clean was ranked 3rd and keeping livestock out of field appeared to be the least effective and ranked 4th with a weighted score of 444 and 249 respectively with a mean value of 3.41 and 3.0 respectively. These findings reveal the importance of clean and pure seed in farming for better production.

Tillage appeared to be the very prominent technique for the

removal of weeds among cultural management techniques in case of cotton. It was ranked 1st among cultural techniques with mean value of 4.09 in terms of effectiveness that indicates its high effectiveness. Crop rotation was ranked 2nd with a mean value of 3.94 that indicates its effectiveness is of medium level that is tending towards high.

Among manual practices, hand pulling of weeds appeared most effective according to the views of all the respondents especially in cotton. Both hand pulling and hand hoeing got the mean value of 3.23 and 4.14 respectively. It indicates that effectiveness of hand pulling is of medium level while, effectiveness of hand hoeing is high. Mechanical practices like using cultivator and ploughing were also found effective but ploughing has the mean value of 3.96 (medium effectiveness tending towards high) that is comparatively high than that of using cultivator (mean =3.20) indicating medium effectiveness in terms of weed control.

Table 2: Effectiveness of non-chemical weed management practices in cotton under cotton-wheat cropping system

Weed management practices	Cotton			
	WS	Rank	Mean	SD
Preventive management practices				
Clean seed	530	1	4.07	0.45
Irrigation channels clean	520	2	3.98	0.27
Tools and machinery clean	444	3	3.41	0.52
Livestock out of field	249	4	3.0	0.22
Cultural and ecological management practices				
Tillage	532	1	4.09	0.36
Crop rotation	209	2	3.94	0.37
Manual management practices				
Hand hoeing	575	1	4.14	0.62
Hand pulling	420	2	3.23	0.49
Mechanical management practices				
Ploughing	517	1	3.96	0.32
Use of cultivator	417	2	3.20	0.52

Scale- 1 = Very Low, 2 = Low, 3 = Medium, 4 = High, 5 = Very High

Table 3: Effectiveness of chemical weed management practices in wheat under cotton-wheat cropping system.

Chemical weed management practices in wheat		Effectiveness			
Brand Name	Common name	WS	Rank	Mean	SD
Post-emergence					
Bromoxynil + MCPA	Bromoxynil + MCPA	442	1	4.2	0.07
Puma Super	Fenoxaprop P-ethyl	390	2	4.1	0.51
Atlantis	Mesosulfuron Methyl-Iodosulfuron methyl sodium	378	3	3.98	0.30
Topik	Clodinafop propargyl	359	4	3.94	0.34
Fenoxaprop	Fenoxaprop P-ethyl	130	5	3.88	0.41
Target	Thifensulfuron-methyl	104	6	3.56	0.43

Scale- 1 = Very Low, 2 = Low, 3 = Medium, 4 = High, 5 = Very High

Effectiveness of chemical weed management practices in cotton under cotton-wheat cropping system

Table 4 indicates that among pre-emergence weedicides, Pendimethalin was mostly adopted and reported as the most effective with a weighted score of 474 and mean value of 4.12 that indicates its effectiveness of high level. Dual Gold got the 2nd rank with a weighted score of 442 and mean value of 3.88 (medium effectiveness that is tending towards high). While, Relax was reported as the least effective with a low weighted score of 82 and a mean value of 2.89 (low effectiveness tending towards medium). Among post-emergence weedicides, Gramaxone got the 1st rank with a weighted score of 505 and Round-up got 2nd rank with a weighted score of 476. Generally discussing as a whole, Gramaxone, Pendimethalin, round up, Dual Gold and Relax got 1st, 2nd, 3rd, 4th and 5th rank and Gramaxone was declared as the most effective weedicide with a weighted score of 505. It got the mean value of 4.3 in terms of effectiveness that indicates its effectiveness is high tending towards very high.

Table 4: Effectiveness of chemical weed management practices in cotton under cotton-wheat cropping system

Chemical weed management practices in wheat		Effectiveness			
Brand Name	Common name	WS	Rank	Mean	SD
Pre-emergence					
Pendimethalin	Pendimethalin	474	1	4.12	0.63
Dual Gold	S-metolachlor	442	2	3.88	0.31
Relax	Acetachlor	82	3	2.89	0.35
Post-emergence					
Gramaxone	Paraquat	505	1	4.3	0.43
Round up	Glyphosate	476	2	3.99	0.36

Scale- 1 = Very Low, 2 = Low, 3 = Medium, 4 = High, 5 = Very High

Effectiveness of chemical weed management practices in wheat under cotton-wheat cropping system

Data given in the table 3 indicate that Bromoxynil + MCPA got 1st rank in terms of effectiveness with a weighted score of 452 and a mean value 4.2 (high effectiveness) while, Puma Super, Atlantis and Topik were ranked 2nd, 3rd and 4th with a weighted score of 390, 378 and 359 and a mean value of 4.1 (high effectiveness), 3.98 (medium effectiveness tending towards high) and 3.94 (medium effectiveness tending towards high). Fenoxaprop and Target got 5th and 6th rank with a weighted score of 130 and 104 and mean value of 3.88 (medium effectiveness tending towards high) and 3.56 (medium effectiveness tending towards the high effectiveness) respectively. Thus according to this Bromoxynil + MCPA appeared to be the most effective weedicide with a mean value of 4.2 that indicates its high effectiveness.

Conclusions

Effectiveness of non-chemical weed management practices in wheat and cotton under cotton-wheat cropping system

Among preventive management practices using clean seed and keeping irrigation channels clean were rated high. Both these steps were claimed to be the most important in terms of effective weed control. Keeping tools and machinery clean along with keeping livestock out of field were reported as preventive measures of secondary level.

Among cultural and ecological weed management practices tillage was ranked above all. Although, crop rotation was declared effective equally but the risk factor associated with crop rotation brings it at number second when compared with the practice of tillage.

Hand hoeing was ranked on top among manual management practices. Hand pulling was also declared as an effective weed control measure but both these measures were reported as labor intensive and small farmers reported that they were not in a position to afford these measures. Moreover, both these practices were more effective in case of cotton rather than wheat.

Among mechanical weed management practices, ploughing was declared most effective weed control strategy. Effectiveness of cultivator was ranked second in this regard. Moreover, it was associated with the availability of cultivator. Small farmers were supposed not to afford the cultivator on equal basis.

Effectiveness of Chemical Weed Management Practices in Wheat

Among post-emergence weedicides, Bromoxynil + MCPA was ranked on top. It was reported that Bromoxynil + MCPA was most effective post-emergence weedicide in case of wheat.

Puma Super (Fenoxaprop P-ethyl), Atlantis (Mesusulfuron Methyl), Topik (Clodinafop propargyl), Fenoxaprop (Fenoxaprop P-ethyl) and Target (Thifensulfuron-methyl) were ranked 2nd, 3rd, 4th, 5th and 6th respectively.

A small percentage of the farmers (9%) reported that they were not getting desired results while using Topik (Clodinafop propargyl) for the last two to three years. according to their perception, it was because of adulteration.

Effectiveness of chemical weed management practices in cotton

Among pre-emergence weedicides of cotton, Pendimethalin was reported to be the most effective as compared to the other weedicides. Pendimethalin was one of the most credible products among the farming community when it comes about the weeds control. Dual Gold (S-metolachlor) was ranked 2nd among the weedicides and its effectiveness was reported as medium tending towards high. Relax (Acetochlor) was reported to be the least effective among the pre-emergence weedicides of the cotton.

Among post emergence weedicides of cotton, Gramaxone (Paraquat) was ranked on top in terms of its effectiveness while, round up (Glyphosate) was ranked 2nd in this regard. Farmers were satisfied about the working efficiency of both these weedicides as a whole.

Recommendations

On the basis of data collected from the farmers during the research study including questioning farmers, having discussions with them and discovering about their perceptions; following are the recommendations to improve the situation in this regard.

- Although, effectiveness of the non-chemical weed management practices is un-match able but due to non-availability of labor and higher labor cost, farmers are forced to get assistance from the chemical weed management practices.
- Farmers need to be provided with subsidies on purchasing weedicides because, weedicides are the only suitable and somehow affordable option for them to control the weedicides.
- Farmers mostly rely on chemical weed control practices thus there is dire need to ensure check and balance in this regard to prevent the adulteration in the weedicides.
- Adulteration in weedicides not only results in financial losses for the farmers but it is also responsible for lower production ultimately effecting the quality and productivity of the crops all over the country thus the issue needs to be addressed on priority basis.
- Farmers need to be provided with the awareness to use both chemical and non-chemical weed control measures in a combination rather than focusing on a single approach to control the weeds.

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