IMPACT OF PARTHENIUM WEED ON THE YIELD OF WHEAT CROP IN SHEIKHUPURA AND RAWALPINDI DISTRICTS OF THE PUNJAB, PAKISTAN

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ABSTRACT

Parthenium is a challenging invasive weed in the world, including Pakistan, may reduce the yield of any crop. The main purpose was to analyze the empirical impact of parthenium weed on the yield of wheat crop in districts Sheikhupura (SKP) and Rawalpindi (RWP). For this purpose, wheat acreage and yield estimation surveys were conducted. Descriptive statistics were also applied to explore the yield variable and independent samples t-test was employed to analyze the difference between the mean of the yields. Results revealed that in district SKP, wheat yield from fields with parthenium weed (WY_{wp}) was 16.48 percent less as compare to the wheat yield of weed free fields (WY_{wop}) which showed that on average 0.55 ton/ha yield might decrease due to parthenium. In district RWP, the yield drop due to parthenium weed was observed 17.96% less as compare to WY_{wop} . It showed that parthenium might reduce the wheat yield up to 0.277 ton/ha in RWP. The yield reduction ratio due to parthenium weed in RWP was (1.48%) higher as compare to the situation in district SKP which showed that the intensity of parthenium wheat in RWP was high. It was reported that intensity of parthenium weed plants was more at corners of the wheat fields and its impact was observe from 2 to 3% decreased in the yield. It is, therefore, suggested that farmers' awareness programs should be arranged in all Punjab and launch a campaign on radio and smart phone to remove parthenium weed and to increase wheat production.

KEYWORDS: Parthenium, Weed, Wheat, Yield Gap, Punjab

1. INTRODUCTION

Punjab in Pakistan is the major food producing province and for the country's more than 220 million people. Wheat is the major cereal crop produced in Punjab, putting Pakistan 8th among the wheat producing countries. Punjab province of Pakistan is the leading province, which covers about 69% of total cropped area. Punjab is thickly populated province with population of about 110,012,442 as of 2017. Punjab shares 52.95 % of total population of Pakistan. Pakistan's population has more than doubled in the past two decades, growing at a rate of approximately 2% per year and is expected to further increase to 244 million by 2030 and 300 million by 2050.

In agriculture, weeds produce significant losses in crop yield with the increase of agricultural inputs such as new seed varieties, irrigation, pesticides and fertilizers (Ameta et al., 2016). In cropped area, the said agriculture inputs are helpful for the growth of weeds and these weeds compete with crops for air, light, moisture and other nutrients. But in general, the direct impacts of the weeds on the yield of many crops and the total loss in agriculture productivity are not measured. Parthenium is also a problematic invasive weed about 40 countries in the world (Bajwa et al., 2018), including Pakistan. It infests major crops such as wheat, maize and sugarcane; and it also causes considerable yield losses. Parthenium weed has bad impact on the growth and yield of several crops at all stages (Bajwa et al., 2018).

Parthenium weeds can damage crop, public health and environment; hence, researchers realize that this species are serious threats for food crops and environment (Masum et al., 2013). Parthenium is the most challenging and toxic weed; it is not only danger to agriculture but also harmful to animal and human health (Kohli and Rani, 1994). It has the ability to germinate and grow at any time throughout the year with warm temperature and rainfall (Tamado et al., 2002). Its germination rate is also quicker than that of other weeds present (Prasad, 2007) and it can erect up to 1 meter in height with long tap root, extensive branching, well-expanded leaves and a stiff stem (Bajwa et al. 2018).

In Pakistan, 50% loss in yield of maize crop was reported at 20 parthenium plants per square meter (Rwomushana et al, 2019). In Ethiopia, parthenium weed reduced sorghum grain yield from 40% to 97% and at the density of three plants per meter square, parthenium weed can reduce up to 69% yield of sorghum (Tamado et al. 2002). Bajwa et al., (2018) obtained biomass of maize plants from the plots where parthenium weed has grown for two weeks. They observed that parthenium weed had significant (P<0.05) impact on the leaf area index, number of ears per plant, 100-grain weight and biological yield of maize. Grain yield can significantly be reduced (up to 15.5%) if parthenium weed are not removed from the plot throughout the crop season. It is reported that the weeds, including parthenium, reduce the yield of wheat crop up to 25.35% (Dangwal et al. 2010). Tiwari and Parihar (1993) also reported that weeds reduced the wheat yield by 34.3%.

The effect of weeds on wheat yield, especially parthenium weed is not measured empirically in Punjab and in Pakistan as well. Thus, it is important to measure the critical impact of parthenium weed on yield of wheat crop in the Punjab. Therefore, an experimental field survey study in two districts of the Punjab (Figure 1) is designed to analyze the impact of

parthenium weed on yield of wheat crop during the Rabi season 2018-19. Figure 1 indicates that Parthenium Plants in different fields of Wheat Crop in District SKP, Punjab. The aim of this study is categorized into two folds; To find out the intensity of parthenium weed in the fields of wheat crop in the districts Sheikhupura and Rawalpindi of the Punjab. To analyze the empirical impact of parthenium weed on the yield of wheat crop in districts Sheikhupura and Rawalpindi of the Punjab.



Fig. 1: Parthenium Plants in the different fields of Wheat Crop in District SKP, Punjab.

2. MATERIAL AND METHODS

Study Area

Two districts, Sheikhupura and Rawalpindi, of the Punjab are chosen to assess the impact of parthenium weed on yield of wheat crop for the year 2018-19. Sheikhupura district lies between latitudes 31.7167° N and longitudes 73.9850° E. In 2017-18, the area of Sheikhupura under wheat crop was 212 thousand ha, it produced 686 thousand ton wheat and average yield of wheat grain was 3.23 ton per ha. While the Rawalpindi district lies between latitudes 33.5651° N and longitudes 73.0169° E. The area of Rawalpindi under wheat crop was 104 thousand ha, it produced 156 thousand ton wheat and average yield of wheat grain was 1.50 ton per ha in 2017-18. The geo location of surveyed fields in both districts SKP and RWP are shown in fig 2 and 3.

1. METHODOLOGY

All wheat fields (SKP= 211, RWP=105, Total= 316 thousand hectare) in both the districts SKP and RWP of the Punjab for the Rabi season 2018-19. A total of 354 plots of size 2x2 m was selected for harvesting in both the districts, SKP and RWP. Random and non-random sampling techniques were used to select the requisite number of plots. Wheat acreage and yield estimation surveys were conducted in forty randomly selected villages (SKP=20, RWP=20) of both the districts SKP and RWP with the help of CRS field staff. The wheat fields were divided into two groups (I) Wheat fields with parthenium weed and (II) Wheat fields without parthenium weed. Three hundred fifty four plots were harvested in both districts to obtain the objective yield of wheat crop. From Group-I; plots were selected through non-random sampling techniques in both the districts. From Group-II; wheat yields of harvested plots (selected through systematic random sampling) in both districts were obtained by Crop Reporting Service (CRS) Punjab, Agriculture Department, Lahore.

Forty villages (n=40, SKP=20, RWP=20) are selected on the basis of CRS sample villages in both districts. CRS had computed his sample size in both districts (SKP=21, RWP=23, Total =44) on the basis of six major crop (wheat, gram, sugarcane, rice, cotton & maize) density areas. This sample size had been computed in relation to the budget and manpower strength sanctioned in particular districts by the government of Punjab in 2016. In CRS methodology, at first stage villages are selected through systematic random sampling technique on the basis of major cropped area (CRS, 2016) from each district. In second stage wheat fields (with and without parthenium weed) are selected by stratified random sampling technique and finally, at third stage, required number of plots from each selected field are demarcated for harvesting by using random number table to select the field corners.

For analysis of parthenium weed impact on wheat, the convenience sampling technique is used to select wheat fields with parthenium weed (WFwp) due to less number of availability of WFwp. Therefore, the current study is based on the survey in forty villages in the districts Sheikhupura and Rawalpindi of the Punjab. Some adjacent of CRS villages are also surveyed for parthenium weed presence in the fields wheat for yield estimation. Wheat fields with their respective villages are divided into two groups. First, wheat fields without parthenium weed (WFwop) and (II) Wheat fields with parthenium weed (WFwp). From Group-I, three fields are selected randomly and two plots of size 15x20 ft form each selected fields are demarcated for yield estimation by random umber tables. From

Group-II, one or two or three fields are selected from each village and one plots of size 2x2 meter from each selected fields are demarcated for yield estimation through convenience sampling. The yield from all harvested plots is weighted in kg/plot of size 2x2 meter. It is assumed that farming practices, use of agriculture inputs such as seed varieties, fertilizer, irrigation, pesticides, soil fertility, and other climate variables are same for both groups. Sample size was large (n>30), therefore, the data distribution assumed to be normal.



Fig. 2: Geo Location of Wheat Fields (with parthenium) in District SKP, Punjab.



Fig. 3: Geo Location of Wheat Fields (with parthenium) in District RWP, Punjab

3.1. Descriptive Statistics of Field Survey

Descriptive statistics were applied to explore the yield variable and independent samples t-test was employed to analyze the difference between the mean of the yields of both groups. To find out the wheat fields containing parthenium all tehsils of both districts, Sheikhupura and Rawalpindi are surveyed with the help of field staff of CRS, Punjab (Table 1). Sixty (60) wheat fields in district Sheikhupura and forty eight (48) wheat fields in Rawalpindi are marked with presence of parthenium weed inside or corner sides of the fields with geo location during the acreage survey of wheat crop 2019. During acreage survey it is observed that most of parthenium weed plants are found at the corners of wheat fields or little bit inside the fields as well. Therefore, one hundred twenty (SKP=60, RWP=60, Total=120) plots from both districts are harvested to obtain the objective yield from wheat fields of 234 plots of both districts are taken from CRS.

Districts	No. of Villages	No. of Fields with parthenium	No. of plots from Group- I	No. of plots from group- II*	Total Harvested Plots
Sheikhupura	20	60	60	108	168
Rawalpindi	20	48	60	126	186
Total	40	108	n ₁ =120	n ₂ =234	n=354

Table-1: District Wise Breakup of Surveyed Villages, Wheat Fields &

 Harvested Plots

*Source: CRS, Punjab

2. RESULTS AND DISCUSSION

1.1. Trend of Wheat Crop in Punjab districts, Pakistan

Wheat is an important food crop of Rabi season in the Punjab, Pakistan and it plays a key role in the economy and agricultural policy of the Punjab. The area under wheat crop in the Punjab was 6.56 million ha which produced 19.18 million ton wheat grain and the average yield was 2.92 ton/ha in 2017-18 (CRS, 2018). In 2018-19, the planted area under wheat crop is about 6.54 million hectare in Punjab and targeted production is at 19.37 million tons while 2.77 ton/ha yield due to adverse impact of inclement weather (Fig4, 5).

1.2. Yield Gap in District Sheikhupura

Yield of wheat fields containing parthenium weed is 16.48 percent (Table 2) less as compare to the weed free yield which showed a serious alarming situation. It shows that on average 0.55 ton/ha yield may decrease if parthenium weed left untreated (Fig. 6).

District/Tehsil	WY _{wp} (ton/ha)	WY _{wop} (ton/ha)	% Change Over Weed Free Yield
District SKP	2.799	3.351	-16.48
Ferozwala	2.633	2.818	-6.54
Muridke	2.918	2.971	-1.78
Safdarabad	2.966	3.721	-20.31
Sharaqpur	2.825	4.129	-31.59
Sheikhupura	2.793	3.402	-17.89

Table 2. Tehsil Wise Yield Reduction Due to Parthenium Weed in DistrictSKP, Punjab

In Sharqpur tehsil, the yield gap is much higher that is 31.59%. However, in Muridke and Ferozwala, the impact of parthenium weed is less which is 2 to 7%, it may be assumed that in these harvested fields weed is located at the corners/edge borders of wheat field because it is reported that parthenium doesn't have serious impact on wheat yield when it is present at corners only (Table 3).



Fig. 4: Map of Wheat Area in the Punjab 2019

Fig. 5 Map of Avg. Yield of Wheat in the Punjab2019



Fig. 6: Yield Gap due to Parthenium Weed in District SKP, Punjab

Items	District/Tehsil	No.	Yield in kg/plot (size 2x2m)				
		of	Mini	Maxi	Mean	SD	
		Plots					
WYwp	District SKP	60	0.852	1.326	1.120	0.140	
	Ferozwala	10	0.852	1.256	1.053	0.145	
	Muridke	9	0.952	1.296	1.167	0.123	
	Safdarabad	3	1.119	1.235	1.186	0.060	
	Sharaqpur	10	0.852	1.326	1.130	0.152	
	Sheikhupura	28	0.886	1.318	1.117	0.143	
WYwop	District SKP	108	0.592	2.365	1.341	0.321	
	Ferozwala	12	0.670	1.515	1.127	0.278	
	Muridke	30	0.666	1.858	1.189	0.274	
	Safdarabad	18	1.188	1.831	1.489	0.183	
	Sharaqpur	12	0.975	2.365	1.652	0.309	
	Sheikhupura	36	0.592	1.901	1.361	0.320	

Table 3.	Tehsil	Wise	Average	Wheat Y	/ield in	District	SKP	Puni	iah
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 WY_{wp} = Wheat Yield with parthenium, WY_{wop} = Wheat Yield without parthenium, SD= Standard deviation Source: Researcher & CRS, 2019

1.3. Yield Gap in District Rawalpindi

In district RWP (see Table-A3, Figure B2), the yield gap is 17.96 % (Table 5)which is 1.48% higher as compare to the situation in district SKP. This gap shows that the intensity of parthenium weed is much high in district RWP and it may reduce the wheat yield up to 0.277 ton/ha (Fig.7). The impact of parthenium weed in Kotli Sattian tehsil is up to 34.56% which is the worst situation in both districts (Table 4).

Items	District/Tehsil	No.	Yield in kg/plot (size 2x2m)					
		of	Mini	Maxi	Mean	SD		
		Plots						
WYwp	District RWP	60	0.183	0.857	0.507	0.121		
	Gujar Khan	9	0.505	0.679	0.570	0.055		
	Islamabad	15	0.271	0.596	0.456	0.093		
	Kahuta	3	0.478	0.611	0.556	0.069		
	Kallar Sayedan	6	0.498	0.668	0.566	0.060		
	Kotli Sattian	3	0.183	0.337	0.257	0.077		
	Murree	3	0.239	0.362	0.313	0.065		
	Rawalpindi	15	0.411	0.857	0.579	0.111		
	Taxila	6	0.429	0.559	0.504	0.054		
WYwop	District RWP	126	0.284	1.098	0.619	0.163		
	Gujar Khan	18	0.557	0.793	0.669	0.071		
	Islamabad	30	0.360	1.098	0.690	0.204		
	Kahuta	6	0.498	0.663	0.573	0.065		
	Kallar Sayedan	12	0.524	0.812	0.671	0.093		
	Kotli Sattian	6	0.294	0.450	0.392	0.062		
	Murree	12	0.284	0.521	0.420	0.069		
	Rawalpindi	30	0.405	1.026	0.622	0.159		
	Taxila	12	0.512	0.763	0.638	0.076		

Table 1: Tehsil Wise Average Wheat Yield in District RWP, Punjab

Table 2: Tehsil Wise Yield Reduction Due to Parthenium Weed in DistrictRWP, Punjab.

District/Tehsil	WY _{wp} (Ton/Ha)	WY _{wop} (Ton/Ha)	% Change Over Weed Free Yield
District RWP	1.269	1.546	-17.96
Gujar Khan	1.426	1.673	-14.76
Islamabad	1.14	1.725	-33.91
Kahuta	1.389	1.432	-3.00
Kallar Sayedan	1.414	1.677	-15.68
Kotli Sattian	0.642	0.981	-34.56
Murree	0.782	1.05	-25.52
Rawalpindi	1.447	1.554	-6.89
Taxila	1.259	1.595	-21.07





1.4. Yield Gap in Study Area

In study area (see Table-A4) the yield reduction due to parthenium weed in the tehsils of both districts is recorded from 1.78% to 34.56%. Wheat yield in district RWP is much affected as compare to the yield in district SKP. The Figure-B3 shows, parthenium weed may reduce the yield of wheat crop by 14.52% that mean 0.35 ton/ha (142 kg/acre) loss to the growers.



Fig. 8: Yield Gap due to Parthenium Weed in Study Area of the Punjab

Figure-8 shows, in study area, parthenium weed may reduce the yield of wheat crop by 14.52% that mean 0.35 ton/ha (142 kg/acre) loss to the growers. In Pak rupees it may be up to 5000 per acre. The yield results in over-all study area are listed below in table-6.

Table 3: Yield Reduction due to Parthenium Weed in Study Area								
ltems	Districts	No. of plots	Yield In Kg/Plot (2x2m)	SD	Yield In Ton/Ha	%age Redu ce		
WYwp	RWP	60	0.507	0.121	1.27	-17.96		
	SKP	60	1.120	0.140	2.80	-16.48		
WY _{wo}	RWP	126	0.619	0.163	1.55			
	SKP	108	1.341	0.321	3.35			
WYwp	Total	120	0.814	0.334	2.03	-14.52		
WY _{wo}	Total	234	0.952	0.438	2.38			

The Table-A5 shows the results of independent samples t-test for both districts and the total are as well. The results indicate that the empirical impact on the yield of wheat crop is significant in both the districts, SKP (t=-5.06, df=166, p<0.01) and RWP (t=-4.706, df=184, p<0.01). Similarly, in total study area, the harmful effect of parthenium weed on wheat yield is also significant (t=-3.03, df= 352, p<0.05). Singh, et al. (2010) found that weeds were serious contestant of the crops. They concluded that weeds had significant effect on the crop yield. In their study area, they reported that weed reduced the wheat yield by 25.35% and cause big loss to the growers. This study shows that the loss in wheat yield due to parthenium weed is up to 14.52% in study area. It is also observed that in Kotli Sattian this loss is up 34.56%. Therefore, the current study validates the results of weed effects on wheat yield as described by Singh et al. (2010). Bajwa et al. (2016) and Safdar et al. (2016) studied about impact of parthenium weed on the growth and yield of maize crop for long period. They found that it had negative effect on growth and yield of Maize crop. Rwomushana et al., (2019) described 50% loss in yield of maize crop at 20 parthenium plants per square meter in Pakistan. Similarly, in Ethiopia, Tamado et al., (2002) reported that parthenium weed had reduced sorghum grain yield from 40% to 97%. The current study also shows that the same type but in less fraction effect of parthenium weed on the yield of wheat crop in the Punjab.

2. CONCLUSION

The main goal of the study is to analyze the impact of parthenium weed on the yield of wheat crop in districts Sheikhupura and Rawalpindi of the Punjab for the year 2018-19. For this purpose, wheat acreage and yield estimation surveys in forty villages of both said districts are surveyed. The objective yields of wheat crop from the fields containing parthenium weed and from weed free fields are obtained. The impact of parthenium weed

on wheat yield is inverse and significant in both the districts. Parthenium weed in wheat fields may reduce the yield of wheat crop by 14.52% and causes 0.35 ton/ha (3.79 mds/acre) loss to the growers. This impact becomes more severe if the weed is left untreated throughout the crop season because it can spread form corner to inside the fields. Its presence at corners of the fields has no serious impact (2 to 3 %) on the yield of wheat crop. It is, therefore, suggested that farmers' awareness programs should be arranged to remove parthenium weed and to increase wheat production in the Province.

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