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RESIDUAL IMPACT OF PESTICIDES ON ENVIRONMENT AND HEALTH OF SUGARCANE FARMERS IN PUNJAB WITH SPECIAL REFERENCE TO INTEGRATED PEST MANAGEMENT

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Pesticides have a negative impact not only on the environment but also on human health. Therefore, alternative method of integrated pest management (IPM) is a suitable technique used to control insect pest and to protect the environment for the betterment of human health. It is a combination of biological, chemical, cultural and mechanical methods. All these methods are essentially integrated with each other. The purpose of the study was to identify the residual impact of pesticides on environment and health of sugarcane farmers; with special reference to integrated pest management. The study was conducted in District Rahim Yar Khan was taken randomly as a universe of the study from the province of Punjab. Tehsil Sadiqabd was selected randomly from District Rahim Yar Khan. Out of twenty-nine rural Union Councils (RUCs) of Tehsil Sadiqabad, two RUCs were selected purposively due to high production of sugarcane. From each selected Union Council, two villages were selected into account to investigate the health-related issues of sugarcane growers and its holistic effects on environment. A pre-tested and well-structured interview schedule was developed for the collection of information from sugarcane farmers. Data were analyzed using both descriptive and inferential statistics through the Statistical Package for Social Sciences. The results indicated that various diseases were present among sugarcane workers due to residual impact of pesticides. The diseases were skin burning, skin infection, nausea, chest pain, diarrhea, respiratory problems, hypertension, convulsion, bleeding, cramping, nausea, asthma, fever, dizziness and vomiting. It also indicated that pesticides affects the natural enemies of sugarcane, physical structure of soil, climatic condition, increase resistant in sugarcane pests and cause environmental pollution. The results revealed that the majority of the respondents were unable to practice IPM due to lack of technical knowledge, practical skills and awareness related to the identification of sugarcane pest and their management. Results indicated that IPM technology is a source of reduction of pesticides, protect environment and human health. The study recommended that awareness regarding integrated pest management should be promoted through proper campaigns to overcome the blind use of pesticides for mitigation insect pest of sugarcane.

Keywords: Sugarcane, pesticide, environment, trichogramma, metarhizium, entopathogenic, parasitoid, awareness campaigns

INTRODUCTION

Sugarcane is an important cash crop grown all over the world. It plays an important role in the Pakistani economy. It is a basic source of sucrose in the human diet of the country**.** It is also used for making brown sugar, white sugar and jiggery (Raza *et al.*, 2018). There are many by-products of sugarcane like bagasse and molasses. The crop is grown on an area of approximately 1,313 thousand hectares and its production nearly 81.102 million tons (GOP, 2017). Sugarcane production is very low in Pakistan compared to other sugarcane producing countries. Similarly, its per acre yield is very low in Punjab as compared to other provinces of the country and is due to different factors (Cheema *et al.,* 2002). Sugarcane pests is one the important factors which adversely affect the production of sugarcane (Raza *et al.,* 2019). Therefore, Sugarcane farmers are frequently using toxic chemicals to control the insect pest population. Due to the frequent usage of insecticides, insects are becoming tolerant against chemicals (Singh *et al.,* 2011). Usage of excessive insecticides is threatened to the environment, health of sugarcane farmers and also kills natural enemies of the pest as well as disturbs the natural ecosystem. It is estimated that nearly three million cases of pesticide intoxication occur each year worldwide, resulting in the death of 220,000 people (Gupta *et al.,* 2014). In Pakistan high pesticide costs, health,

environmental risks and the elimination of beneficial of sugarcane pests due to excess usage of pesticides have become serious issues (Khan, 2000). Farming of sugarcane does not require excessive use of insecticides and fungicides. However, the excess use of pesticides in Pakistan is one of the major challenge in sugarcane production (Gul *et al.,* 2015), which often lack the sufficient institutional conditions to ensure that these chemicals are used securely, without endangering human health and polluting the environment (Butler-dawson *et al.,* 2018). Excess uses of pesticides are causing environmental and health problems among sugarcane workers (Atreya, 2006). Sugarcane workers are exposed to chemicals in the field of sugarcane during chemical mixtures preparation and cultivation (Kasambala and martin, 2018). Common symptoms found in sugarcane workers are skin burning, skin infection, nausea, chest pain, diarrhea, respiratory problems, hypertension, convulsion, bleeding, cramping, nausea, asthma, fever, dizziness and vomiting. In turn, long-term exposure may increase the risk of cancer, weaken the immune system or cause neurological symptoms, endocrine disruptors, genetic mutations, and behavioral changes (Murray *et al.,* 2002). Pesticides residues pollutant the surface water, groundwater and decrease soil fertility. Pesticides also affects the natural enemies of sugarcane, physical structure of soil, climatic condition, increase resistant in sugarcane pests and cause environmental pollution (Ahad *et al.,* 2000). In such a critical situation, several agricultural research organizations in Pakistan recommend the development of Integrated Pest Management (Anwar *et al.,* 2005; Raza *et al.,* 2019). Therefore, alternative method of IPM is the best strategy against sugarcane pest without damaging the natural environment and human health (Cheesman *et al.,* 2005). Cultural control is one of the safest measures, as it usually requires changes to normal production practices. It requires long-term planning and is generally not a quick way to control pests. The major advantage of this method is that it does not even require extra labour. Cultural practices included plant density and spacing, trash mulching, time of seed planting and earthing up, frequently light irrigation, removal of infected plants, trap crops management, de-trashing, resistant varieties, intercropping (onion and garlic etc.) in addition to provide more income and reduce the population of sugarcane pests, sex pheromones trap and removal of water shoots (ICRISAT-WWF, 2009; Cheesman, 2005).

Biological agents are specific to pests and prefer to feed only on the target organism, which causes an adverse impact on sugarcane crop. In this method trichogramma card is used for controlling the population of sugarcane insect pests. The egg of trichogramma are stuck to the cards and released in sugarcane field. The egg hatch in 24 hours and the larvae are ready in 7 to 8 days. Start search for food for their pests and parasitize the egg of other pests resulted minimizing the pests of sugarcane crop. It can be released in the sugarcane field at the rate of 20,000 per acre at ten days interval at six times. Fungus Metarhizium is another biological control method, which tend to use to control population of sugarcane pest (Butler-dawson *et al.,* 2018; Leite *et al.,* 2005; Vian et al., 2006), and Entopathogenic nematodes used to control termite and root grabs in sugarcane. Cotesia savipes and trichogramma spp. are used to control sugarcane stem borer and moth borers (Bothelo *et al.,* 1999) while Sturmiopsis inferens is a parasitoid used to control the borer (Guo et al., 2001; Yang, 2003). Furthermore, awareness campaigns regarding IPM through mass and print media in collaboration with public and private sector can be a strategy to protect human health and environment from residual impacts of pesticides (Chaudry, 2004).

Additionally, extension agents should inform sugarcane farmers about biological control to reduce the excess use of pesticides to safe environment and human health. As well as the availability of Trichogramma cards, bio pesticides, bio fertilizers and resistant varieties must be ensured and their benefits must be explained to the sugarcane farmers for the sustainable sugarcane production (Galt, 2008). In addition, identification of symptoms and treatment of infected sugarcane workers at early stages could be other strategy to control affected people in Pakistan (Ahmad*et al.,* 2002).

MATERIALS AND METHODS

Ahad K, Anwar T, Ahmad I, Mohammad A, Tahir S, Aziz S, et al. Determination of insecticide residues in groundwater of Mardan Division, NWFP, Pakistan: a case study. Water SA 2000; 26: 409–12. District Rahim Yar Khan was taken randomly as a universe of the study from the province of Punjab. Tehsil Sadiqabd was selected randomly from District Rahim Yar Khan. Out of twenty-nine rural Union Councils (RUCs) of Tehsil Sadiqabad, two RUCs were selected purposively due to high production of sugarcane. From each selected Union Council, two villages were selected into account to investigate the health-related issues of sugarcane growers and its holistic effects on environment. The list of sugarcane farmers (who had been facing different problems regarding to their health) was prepared in the selected villages with the help of key informants of respective villages (key informants were Numberdar and progressive farmers of respective rural areas). After making the list, to ensure accessibility, 140 sugarcane farmers were selected through purposive sampling procedure. A well-structured interview schedule was developed for data collection. Validity of interview schedule was tested by using SPSS. Cronbach's

Alpha value for questions in the different objectives was varied from 0.82 to 0.95. Further to check reliability the data collection tool was also presented to the experts of Institute of Agri. Extension and necessary amendments were made. The interview schedule was further pre-tested on 20 respondents (that were other than the purposively selected 140 sugarcane growers). At last well-structured interview schedule was developed for data collection. The data were analyzed for logical interpretations through Statistical Package for Social Sciences (SPSS).

RESULTS AND DISCUSSION

Table 1 reveals that more than forty-five (45.7%) of the respondents had up to 2 acres, 34.3% of the respondents had 3 to 5 acres and 12.9% of the respondents had 6 to 10 acres of land. It also revealed that 111 of the respondents (79.3 %) were involved in agriculture and on the other hands, the more than fifty (57%) had income satisfaction for their social status was very low. The 39.3% percent of the respondents were illiterate and due to that, this narrow down their opportunities for proper awareness regarding Integrated Pest Management and they also do not have proper information regarding the uses of pesticides which ultimately leads to damage the environment as well as affect the human health.

Table 1. Demographic characteristics of the respondents (N = 140).

Variable	Frequency	Percentage
No. of children		
1-2	79	56.4
3-5	43	30.7
Above 5	18	12.9
Age (Year)		
20-30	54	38.6
31-40	64	45.7
Above 40	22	15.7
Land holding	Frequency	Percentage
Up to 2 acre	64	45.7
3 to 5 acre	48	34.3
6 to 10 acre	18	12.9
above 10 acre	10	7.1
Educational Attainment	Frequency	Percentage
Never	55	39.3
Primary	45	32.1
Matric	28	20.0
Secondary	12	8.6
Occupation	Frequency	Percentage
Agriculture	111	79.3
Labour	21	15.0
Government job	8	5.7
Private job	2	1.4
Family Size	Frequency	Percentage
Joint	129	92.1
Nuclear	11	7.9
Income	Frequency	Percentage
Up to 100000	57	40.7
10001- 200000	32	22.9
20001- 300000	28	20.0
Above 300000	23	16.4

Source: Field survey, 2018.

The results given in the Table 2 reveals that natural microbes of soil are affected was place at 1st position with mean 2.87 among residual impact of pesticides on environment. Pesticides also effects the beneficial insects of sugarcane (mean = 2.86±1.20), soil fertility (mean = 2.32±1.37), negative effect on sugarcane productivity, physical structure of soil and drinking water is contaminated due to excess use of pesticides were given 4th position and 5th position with mean value of 1.54, 1.39 and 1.40, respectively. Findings of current study is similar with the findings of Dung *et al. (*2007) and he indicated that the excess use of pesticides on sugarcane crop alter physical structure of soil and reduce the fertility of the soil. He further indicated that it also affects the natural microbes of the soil and increase the resistance of sugarcane pests against pesticides, which ultimately cause the reduction of sugarcane production.

Table 2. Residual impact of pesticides on environment with special reference to sugarcane cultivation.

Effects of pesticides on Environment	WS	Mean	SD	Rank
Natural microbes of soil are affected	402	2.87	1.24	1
Beneficial insects of sugarcane are affected due to excess use of pesticides	400	2.86	1.20	2
Soil fertility disturbed due to regular pesticide applications	325	2.32	1.37	3
Negative effect on sugarcane productivity due mishandling pesticides	281	2.01	1.54	4
Physical structure of soil is disturbed	263	1.88	1.39	5
Drinking water is contaminated due to excess use of pesticides	245	1.75	1.40	6
Quality and quantity of sugarcane changed due to spray of pesticides	240	1.71	1.31	7
Biological control is disturbed due to over use of pesticides	239	1.71	1.35	8
Residues of pesticides in air affect the environment	237	1.69	1.65	9
Climatic variation due to over use of pesticides	236	1.69	1.29	10
Increase resistant in sugarcane pests due to blind use of pesticides	215	1.54	1.35	11

The results given in the Table 3 indicated that excessive use of pesticides is causing different health problems among sugarcane workers. Among them skin disease was placed at 1st position with mean 3.91 because skin is more sensitive part of the body and pesticides effects rapidly on it. The other effects on health like chest pain (mean = 3.79±1.27),

hypertension (mean = 3.74±.97), genetic mutations (mean = 3.68±1.33), swelling of unprotected parts of body (mean = 3.66±.97) dryness of throats (mean = 3.64±1.56), stomach disturbance (mean = 3.59±.93), neurobehavioral disorder (mean = 3.56±.84), skin infection (mean = 3.55±1.23), diarrhea (mean = 3.50±.90), weaken the immune system (mean = 3.48±.72) and vomiting (mean = 3.47±1.10). These results are also concord with Masood *et al.* (2007) who reported that pesticides affect the health and cause different diseases like vomiting, respiratory problems, lungs problem, change in hormone system and cancer.

Table 3. Residual impact of pesticides on human health with special reference to sugarcane workers.

Pesticides Effects on health	WS	Mean	SD	Rank
Skin diseases	548	3.91	0.95	1
Chest pain	531	3.79	1.27	2
Hypertension	523	3.74	0.97	3
Genetic mutations	515	3.68	1.33	4
Swelling of un protected parts of body	513	3.66	0.97	5
Dryness of throats	510	3.64	1.56	6
Stomach disturbance	503	3.59	0.93	7
Neurobehavioral disorder	498	3.56	0.84	8
Skin infection	497	3.55	1.23	9
Diarrhea	490	3.50	0.90	10
weaken the immune system	487	3.48	0.72	11
Vomiting	486	3.47	1.10	12
Respiratory problems	472	3.37	1.10	13
Lungs	464	3.31	0.62	14
Nausea	458	3.27	1.46	15
Tiredness	451	3.22	0.85	16
Eye irritation	433	3.09	1.68	17
Change in hormone system	432	3.09	1.44	18
Convulsion	431	3.08	1.61	19
Fever	414	2.96	0.71	20
Dizziness	293	2.09	1.45	21

Figure 1 indicated that only 5.0 percent respondents fully adopted and 8.6 percent partially adopted "information about biological method", whereas a large majority (86.4%) of the respondents never adopted this method. The 2.1 percent respondents fully adopted and 5.7 percent respondents partially adopted level of information about Trichogramma card whereas more than ninety (92.1%) of the respondents never adopted this method. Only 5.7 percent of the respondents fully adopted "level of information about bio pesticides", whereas as more than ninety (90.7%) of the respondents never adopted this method. Only 5.0 percent respondents were fully adopted and 9.3 percent respondents were partially adopted whereas vast majority (85.7%) of the respondents never adopted "level of information regarding natural enemies of sugarcane" Sugarcane farmers excess usage of pesticides which pollute the surface water, groundwater and decrease soil fertility. Pesticides affect the natural enemies of sugarcane, physical structure of soil, climatic condition, increase resistance in sugarcane pests and cause environmental pollution (Galt, 2008). In such a critical situation, one of the major challenges is the adoption of biological control method (Aslam *et al.*, 2007) because it is a suitable technique used to control insect pests and protect the environment for the better human health. Therefore, proper awareness regarding biological control and information about Trichogramma cards, bio pesticides, bio fertilizers and resistant varieties is the best strategy against sugarcane pests without damaging the natural environment and human health (Cheesman *et al.*, 2005).

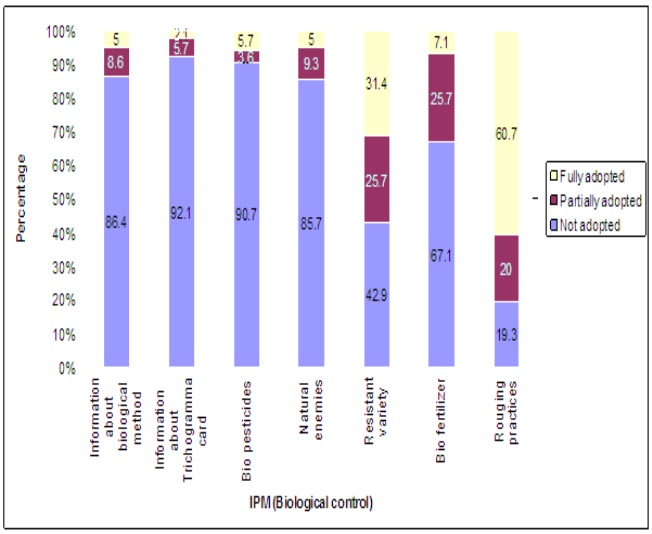

Figure 1. Adoption level of integrated pest management (biological control) among sugarcane farmers.

Table 4 indicated that proper land preparation was ranked as 1st with mean 2.31 and standard deviation of 0.721. Late sowing of sugarcane was ranked as 2nd with (weighted score=295), timely sowing was ranked as 3rd with (weighted score=265). Removal of previous crop residues was ranked 4th, summer hoeing was ranked 5th, inter cropping was ranked 6th, recommended seed rate was ranked 7th, mulching was ranked 8th, crop rotation was ranked 9th, proper planting distance was ranked 10th and seed treatment was ranked 11th with weighted score 260, 249, 248, 245, 244, 238, 233 and 237, respectively.

Table 4. Information regarding cultural practices adopted by sugarcane farmers.

Information regarding cultural practices	WS	Mean	SD	Rank
Proper land preparation	324	2.31	0.721	1
Late sowing	295	2.11	0.631	2
Timely sowing	265	1.89	0.802	3
Removal of previous Crop residues	260	1.86	0.705	4
Summer hoeing	249	1.78	0.814	5
Inter cropping	248	1.77	0.743	6
Recommended seed rate	245	1.75	0.882	7
Mulching	244	1.74	0.743	8
crop rotation	238	1.69	0.839	9
Proper planting distance	223	1.59	0.881	10
Seed treatment	237	1.69	0.839	11

Table 5 indicates that lack of awareness regarding IPM was ranked as 1st with mean 3.57 and standard deviation 0.58. However, enforce of pesticides (mean = 3.47±.63), lack of technical knowledge (mean = 3.37±.78), non-availability of trichogramma card (mean = 3.10±.92), poor extension services regarding IPM (mean = 2.96±1.02) and slow process (mean = 2.10±.1.10) were ranked 2nd to 6th, respectively.

Table 5. Hinders to adopt IPM among sugarcane farmers.

Hinders to adopt IPM	WS	Mean	SD	Rank
Lack of awareness regarding IPM	494	3.53	0.58	1
Enforce of pesticides	486	3.47	0.63	2
Lack of technical knowledge	472	3.37	0.78	3
Non availability of trichogramma card	433	3.10	0.92	4
Poor extension services regarding IPM	414	2.96	1.02	5
Slow process	294	2.10	1.10	6

Dependent Variable:

***Adoption of IPM technology*:** The value of R-Square in the model summary is 0.361. From the 36% change in adoption of IPM technology was explained by the two variables such as effects of pesticides on environment and human health in the model (Table 6).

The overall model is statistically significant according to the findings. To judge the significance of the model F-test was applied. The F-value is 38.625, which is significant at less than 1% level of significant. The value obtained suggests that the model is highly significant. The impact of each individual variable is prescribed as:

Effects of pesticides on environment: The coefficient for this variable had a negative sign of 0.274 and is significant at 1%.It shows Integrated Pest Management is a source of reduction in pesticides' effect on environment. Therefore, the hypothesis "IMP will be helpful to reduce the effects of pesticides on environment" is accepted.

***Effects of pesticides on human health*:** The coefficient for this variable had a negative sign of 0.274 and is significant at the significance level of 1%. It shows that if the farmers adopt Integrated Pest Management then they were facing less effect of pesticides on human health. Therefore, the hypothesis "IMP will be helpful to reduce the effects of pesticides on human health" is accepted.

Table 6. Implication of IMP technology is an alternative strategy to overcome the residual impacts of pesticide on environment and human health.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.600[a]	0.361	0.351	0.622

a. Predictors: (Constant), Pesticides Effects on health, Effects of pesticides on Environment

ANOVA[a]

Model		Sum of Squares	d.f.	Mean Square	F	Sig.
1	Regression	29.916	2	14.958	38.625	0.000[b]
	Pesticides impact	53.055	137	0.387		
	Total	82.971	139			

a. Dependent Variable: IPM

b. Predictors: (Constant), Pesticides Effects on health, Effects of pesticides on Environment

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.059	0.206		14.827	0.000**
	Residual impact of pesticides on Environment	-0.274	0.084	-0.231	-3.281	0.001**
	Residual impact of pesticides on health	-0.534	0.061	-0.613	-8.707	0.000**

***Conclusion*:** Illiterate and lack of awareness had challenge of proper use of pesticides. Sugarcane farmers in tehsil Sadiqabad is facing different health and environmental problems. Furthermore, majority of the farmers are using over dose of pesticides, which is directly affecting the human health and increase the resistant among sugarcane pests. Moreover, sugarcane farmers were unaware about the Integrated Pest Management and few of them adopt the recommended biological control and cultural methods. However, limited factors hinders the IPM included Lack of awareness about biological control methods, technical knowledge, enforce of pesticides, poor agricultural extension services and low awareness of trichogramma, which ultimately resulted in low production and acceptance rate of IPM and high adoption of pesticides. It is dire need to create awareness campaigns regarding effectiveness of biological and cultural methods to sugarcane growers.

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