

Epidemiological Estimation of Foliar Rust Diseases of Wheat and Pathological Assessment of Different Rust Pathogens Isolated from Rainfed Areas of Punjab, Pakistan

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Abstract-Foliar rust diseases of wheat are major constraints to agriculture system of Pakistan. Wheat is consumed by 99% people of this country and also a source of economic growth. But due to epidemic of foliar rust diseases in various regions of the state quality as well as quantity of wheat varieties cannot be meet up to international standards. A couple of surveys were conducted to assess foliar rust disease severity in rainfed areas of upper, middle and lower pothohar region of Punjab, Pakistan. From four districts 21 locations were selected and wheat growing fields were surveyed. Questionnaires were filled by farmers to gather information about their crop management practices. During second survey infected leaves were collected to get inoculums of yellow, brown rust and powdery mildew. These inoculums were multiplied on universal susceptible wheat variety Morocco. Increased inoculum was collected and preserved for race identification and virulence behavior. The survey study concluded that powdery mildew was present only in one location of district Attock while stem rust was absent in all locations of four districts. Prevalence, incidence and severity of yellow and brown rust varied from one location to another. Yield attributes data of each wheat growing field covered number of tillers m^{-1} length, number of grains spike $^{-1}$, harvest index and grain and straw yields. Information extracted from surveys of wheat growing fields during 2013-2014 will help to formulate policies according to changing environmental conditions and crop management systems will be modified to meet international standards.

Keywords- Epidemiology, Pathological assessment, Germplasm, rust pathogens.

1 INTRODUCTION

WHEAT is staple food crop not only for Pakistan but in many other parts of the world. In Pakistan it occupies more farmland than any other crop grown in this country. Among total crop area cultivated in Pakistan wheat occupies 37% and 70% of total production. It is mainly grown in irrigated conditions having 20-22 acre feet water requirements. The Indus plains provide suitable topography, soil enriched with nutrients and favourable agricultural practices which give advantage of greater area for wheat cultivation [1].

Cultivation area of 8.033 million hectares is growing wheat crop in Pakistan and gives 19 million tons annual production. But this yield is very low among other wheat growing countries of the world [12]. Asian countries are at the top of list in wheat producing as well as consuming countries in the world.

Among Asian countries Pakistan gets 6th position for wheat production and wheat industry is third largest industry of the country. According to Food and Agriculture organisation (FAO) wheat production was 697.798 million tons in Pakistan during 2012-2013. There was 6.8% increase in production than previous year. According to economic survey of Pakistan, wheat crop adds value of 13.1% to agriculture and 2.8% to Gross domestic product (GDP). In 1990-2000 wheat production in Punjab province was 16.48 million tons (2667kg) per hectare which decreased to 15.41 million tons in 2000-2001. The reduction was 6.5% in total wheat production while 8% in average yield per hectare. Production of wheat further dropped to 14.59 million tons per hectare in 2001-2002. The gap of production was recovered in 2005-2006 hitting 16.8 million tons average yield per hectare. In

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2010-2012 wheat average yield was higher than previous years but unfortunately population of Pakistan is increasing 2.5% per annum but wheat production is stagnant since 2-3 years [14].

Pakistan country is divided into three main regions according to wheat productions i.e. areas having abundant production, moderate production and least production. Amongst five provinces of Pakistan only Punjab province produces 50% of wheat. Abundant productive areas are districts of Sialkot, Rahim Yar Khan, Kasur and Sargodha. Irrigation is done through canals in these areas. Moderate productive areas are located in eastern Punjab particularly districts of Bahawalpur, Bahawalnager, Gujrat, Muzaffargarh, Leiah and Attock also. Rawalpindi division comes under least productive area of wheat crop, most part of Baluchistan, Dera Ismail Khan and Hanza in NWFP are included in it. Production of wheat crop depends upon economic and physical factors. Physical factors include temperature, rainfall and soil while economic factors are cheap labour, escalating prices of good quality seeds, poor transportation means, lapse of storage capacity, gap between farmers and market values etc [11].

Epidemiology refers to distribution and determinants of health related issues including diseases. This study is also applied to control diseases by using different methods. Diseases are investigated in terms of severity, prevalence and incidence. Epidemiology includes both qualitative and quantitative analysis of diseases. Epidemiological data provides information about how often disease occurs in a region and at which severity scale [12]. The present study was conducted to assess epidemiology of foliar rust diseases in rainfed region of Punjab. A number of studies have been carried out to assess disease prevalence, incidence and severity of wheat crop. During epidemiological survey pathogen is collected and studied for its virulence behavior by making differential sets [17].

As wheat crop is third largest industry of Pakistan and contributes major value in GDP and agriculture growth sector. Besides, wheat is staple crop for 98% population and adds essential nutrients in diet. Keeping in view the importance of wheat crop it is necessary to manage it in best suitable ways. For management of this crop, health of the crop, pest management, nutrients availability, soil fertility, weeds control

and bacterial and fungal diseases control are of prime importance [3]. On wheat crop about 200 diseases are reported in which 100 diseases are caused by pathogens and others are due to weeds and different parasites. These diseases can be transmitted from one plant to another plant [16]. In Pakistan there are about 50 diseases reported on wheat crop which have economic affect also [3]. In all diseases fungal pathogens play significant role in yield loss and grain quality. The most frequent fungi causing diseases are rusts and smuts. Three diseases rusts, smuts and powdery mildew are serious constraint to wheat crop in Pakistan. Almost all wheat growing areas have been reported infected with these diseases. The survey reports revealed that there have been severe attacks of black stem rust, yellow rust and leaf rust in wheat growing areas of Pakistan during 1978, 1906, 1908 and 2009. Disease control is most essential control for high yield and better quality of wheat grains. Diseases can be controlled effectively if they are monitored timely starting from initial conditions till end [9].

Diseases of wheat crop can be categorised according to infection causing on different parts of plant. First category falls in infection of head and grains and diseases include common, bunt, *Fusarium* head blight, loose smut, sooty head molds, stagonospora nodorum blotch. Leaves infecting diseases are bacterial streak caused by bacteria, barley yellow dwarf, leaf rust, powdery mildew, septoria tritici blotch, stagonospora nodorum blotch, stem rust, stripe rust, tan spot, wheat soil borne mosaic, wheat spindle streak mosaic, wheat streak mosaic. Foliar rust diseases; yellow/stripe rust, brown/leaf rust, powdery mildew and tan spot infect different parts of plants thus taking high toll of crop yield [18]. They are most important diseases of cereals and cause 60-100% loss when an epidemic breaks out in the country [8].

Yield attributes of wheat growing fields are important characteristics of wheat crop which give information about its yield and quality. These attributes include number of tillers per meter length, number of tillers per meter square, number of grains per spike, harvest index, grain yield and straw yield etc. All these attributes are directly related with rate of seeds used per acre, nutrients availability and attack of diseases because these factors reduce place for development of more grains on spike and hence

badly affect their quality according to international standard. Wheat variety is also of considerable importance in regard of yield attributes. Different varieties show different behaviour and give varying yields of wheat crop.

2 MATERIALS AND METHODS

2.1 First Survey

First survey was conducted during October-November 2013 in wheat growing fields of pathohar region. Questionnaires were filled out by farmers to get their information about crop

There is need of systematic approach to study wheat cultivars relationship with its attributes. Weight of wheat grains is also related with genetic makeup of wheat cultivars [7].

management and occurrence of rust and other diseases.

2.2 Epidemiological Assessment of Foliar Rust Diseases in Wheat Growing Fields

Second survey was conducted to assess prevalence, incidence and severity from wheat growing fields by making diagonal transect in each field. Severity in each field was visually observed with the help of severity scale. Prevalence and disease incidence were calculated by using following formulae.

$$(\%) \text{ Prevalence} = \frac{\text{Locations showing foliar symptoms}}{\text{Total locations}} \times 100$$

$$\text{D.I.} = \frac{(\text{Foliar in class 1} + \text{class 2} + \text{class 3} + \text{class 4} + \text{class 5}) \times 100}{\text{Total foliar in sample} \quad 5}$$

2.3 Pathological Assessment of Foliar Rust Pathogens

2.3.1 Collection of Foliar Rust Pathogens

Foliar rust pathogens were collected from infected wheat crops by adopting diagonal pattern. Leaves were cut from infected plants and preserved at 5°C until further process was done. Samples of leaf rust, yellow rust and powdery mildew were stored separately.

2.3.2 Isolation and Multiplication of Fungal Pathogens

To isolate fungal pathogens from field collected infected leaves; the leaves were cut into pieces and put in petriplates containing blotter papers. Before putting infected samples petriplates were

watered to provide moisture. Petriplates were locked with parafilm, properly labelled and placed in diffused light overnight. After 24 hours spores were appeared on infected leaves pieces. These spores were inoculated on universal susceptible variety morocco for multiplication of pathogen. For inoculation leaves of morocco plants were moisture with tap water and sporulated leaves were rubbed with leaves. All pots of plants were tagged with proper labels. Inoculated plants were incubated in humidity chamber having 90-99% humidity for 22-24 hours at 18°C. After 24 hours plants were incubated in green house in clean room at 18°C for 7 days. When spores started to appear on leaves they were shifted to growth room and packed in polythene bags for 7 days. On 15th day inoculum was collected in powder form in capsules and properly labelled and preserved in refrigerator for race identification and virulence behavior.

2.4 Collection of Yield Attributes

All selected fields were observed in general protocol of diagonal pattern. Yield attributes were collected by measuring number of productive tillers per meter length and per meter area as well. About 80-100 plants were selected

to count number of grains per spike and mean values were calculated for thorough fields. Grains were collected from each field and 1000 grains were weighed for assessment of productivity of wheat crop. Grain yields and straw yields were estimated for measurement of harvest indexes.

3 Results and Discussions

Epidemiological and Pathological Assessment of Foliar Rust Diseases in Rainfed Wheat Growing Fields

Epidemiological studies explain how much disease has occurred in an area and in what intensity. Epidemiological survey of four districts showed a clear picture of foliar rust diseases in wheat growing fields. In district Jhelum yellow rust disease was most prevalent and severe in Harril Dina; incidence was high in field of Ch. Akram 100 % followed by Kotli Allayar which is 80%. Leaf rust was absent in Tehsil Jhelum while selected fields of Tehsil Dina were infected with leaf rust showing high prevalence and incidence in Boora jungle fields but severity of disease did not exceed 1-2 severity scale in range of less severe disease. None of the locations in district Jhelum were infected with powdery mildew and stem rust diseases.

In district Rawalpindi, yellow disease was prevalent in Sanghori but incidence was high on wheat crop of Kallar Syedan. It might be due to near in distance with locations of Dina which were also infected with yellow and leaf rust. Wind direction can cause an epidemic over larger areas. Wheat crops grown in Sherzaman colony, Daroya and Mori Rajgaan were free of infections of four foliar diseases i.e. stripe rust, leaf rust, stem rust and powdery mildew. During survey it was noted that wheat crop was 100% infected with yellow rust spores in Mori Rajgaan and whole field was put on fire to eradicate yellow rust disease. In Sanghori leaf rust infection was also noted with prevalence of 45% and incidence was 14 with moderate severity.

Among four districts leaf and yellow rust were most prevalent in district Attock. Almost all selected fields were infected with leaf and yellow rust but Ghari boota showed highest prevalence of yellow and leaf rust with highest incidence values. The severity of leaf and yellow rust diseases was 1-3 and 1-4 respectively. All selected wheat growing fields were free of stem rust disease but 100 % prevalence of powdery mildew in combination with yellow rust was noted on wheat crop grown in Jafar, District Attock. No other field under study was infected with powdery mildew.

In district Chakwal most of the fields were not infected with a single pore of yellow stem and leaf rusts. Powdery mildew was absent in all wheat growing fields. Only in one location of Mulhaal Mughlaan yellow and leaf rust diseases were prevalent with moderate severity.

There are a number of factors which are responsible for foliar rust disease development. These factors encompass environmental conditions including wind direction and speed, temperature, humidity, pattern of rainfall and growth stages of wheat crop. Powdery mildew was noted only in one location out of 23 selected locations. The condition required for development of powdery mildew disease is cool and moist place where air environment is reduced. The infected fields of powdery mildew were located on roadside and they were covered with Eucalyptus trees. These trees might have reduced air movement for wheat plants and provided dense cool places for development of powdery mildew spores. All other fields were open spaced that's why did not show infection of powdery mildew. The infection was more severe in plants nearby eucalyptus trees as compared to far away plants. Eucalyptus trees are not definite cause of powdery mildew disease development but they had provided suitable conditions for it [6].

During 2013- 2014 the rainfall patterns provided suitable conditions for foliar rust disease development. Prolonged periods of rainfall are conducive for foliar rust pathogens to land on leaf surfaces and cause serious

infections. In district Chakwal most of sites were not infected with foliar rust pathogens because precipitation was absent in this area as compare to rainy days in district Rawalpindi, Jhelum and Attock. In district Chakwal wheat variety might have resisted disease development. Bux and his colleagues have worked on resistance of stripe rust in wheat germplasm. Their study favoured the aspect of disease prevention through cultivation of resistance varieties. Resistance at seedling and adult plant stages provides long term and reliable resistance [5].

Not only rainfall suitable temperature is pre requisite for disease development by foliar rust pathogens. Growth stages of wheat crop are also critical for severity of disease occurrence. In district Attock disease severity and prevalence was more in Ghari boota, it might have occurred due to early attack of pathogens on wheat plants. Temperature is related with sowing dates of wheat crop. In Pakistan sowing dates extends from 15th October to 25th November. The sowing

dates of wheat crop depend on cultivation and harvesting of previous crops. In Pakistan different cropping patterns are adopted according to area and water availability and economic factor is also considerable in this context. In 2010 a consolidated study was carried out to assess wheat crop in yield in response to sowing dates and different treatments of fertilizers at early and adult plant stages. The results proved that early sowings of wheat gave high yields and fulfilment of water requirements at initial stages provided better grains instead of depending upon rain water. They also concluded that yield was high in fine textured soils rather than coarse grained soils. The reason is that fine grains of soil provide more nutrients and have high water holding capacity than coarse particles which sometime make clumps and prevent nutrients availability. Silty loam soil was considered preferable soil for wheat crop cultivation as compared to loamy sandy soil [4].

Table: 1.6 Epidemiological data of foliar rust diseases of wheat in locations of district Rawalpindi

Diseases	Locations of District Rawalpindi	Incidence	Severity	Prevalence (%)
Stripe/ Yellow Rust	Sherzaman Colony	0	0	0
	Sanghori	13.78	1-3	80
	Kallar Syedan	28.66	1-2	65
	Daroya	0	0	0
	Mori Rajgaan	0	0	0
Leaf/Brown Rust	Sherzaman Colony	0	0	0
	Sanghori	14	0-1	45
	Kallar Syedan	0	0	0
	Daroya	0	0	0
	Mori Rajgaan	0	0	0

Stem/ Black Rust	Sherzaman Colony	0	0	0
	Sanghori	0	0	0
	Kallar Syedan	0	0	0
	Daroya	0	0	0
	Mori Rajgaan	0	0	0
Powdery Mildew	Sherzaman Colony	0	0	0
	Sanghori	0	0	0
	Kallar Syedan	0	0	0
	Daroya	0	0	0
	Mori Rajgaan	0	0	0

Note: A total of 15 fields from district Rawalpindi were surveyed to collect epidemiological data.

Severity Scale: 0-1 Very less , 1-2 Less sever, 1-3 Somehow, 1-4 Severe, 1-5 Very Severe

Table: 1.7 Epidemiological data of foliar rust diseases of wheat in locations of district Chakwal

Diseases	Locations of District Chakwal	Incidence	Severity	Prevalence (%)
Stripe/ Yellow Rust	Tharpaal	0	0	0
	Sehgalabaad	0	0	0
	Mulhaal Mughlaan	38.33	1-4	55
Leaf/Brown Rust	Tharpaal	0	0	0
	Sehgalabaad	0	0	0
	Mulhaal Mughlaan	26.33	1-4	40
Stem/ Black Rust	Tharpaal	0	0	0
	Sehgalabaad	0	0	0
	Mulhaal Mughlaan	0	0	0

Powdery Mildew	Tharpaal	0	0	0
	Sehgalabaad	0	0	0
	Mulhaal Mughlaan	0	0	0

Note: A total of 9 fields from district Chakwal were surveyed to collect epidemiological data.

Table: 1.8. Epidemiological results of foliar rust diseases of wheat in locations of district Jhelum.

Diseases	Locations of District Jhelum	Incidence	Severity	Prevalence (%)
Stripe/ Yellow Rust	Kala Dev	43.33	1-3	60
	Mazhar Shah	63.66	1-2	40
	Kotli Allayar	38	0-1	80
	Ch. Akram	82	1-3	70
	Harril Dina	51	1-4	100
	Amjad Dina	24	1-3	90
	Boora Jungle	30	1-2	40
	Leaf/Brown Rust	Kala Dev	0	0
Mazhar Shah		0	0	0
Kotli Allayar		0	0	0
Ch. Akram		10	1-2	30
Harril Dina		21.5	0-1	22
Amjad Dina		14.66	1-2	16
Boora Jungle		34.33	0-1	38
Stem/ Black Rust		Kala Dev	0	0
	Mazhar Shah	0	0	0
	Kotli Allayar	0	0	0
	Ch. Akram	0	0	0
	Harril Dina	0	0	0
	Amjad Dina	0	0	0
	Boora Jungle	0	0	0

	Kala Dev	0	0	0
	Mazhar Shah	0	0	0
	Kotli Allayar	0	0	0
Powdery Mildew	Ch. Akram	0	0	0
	Harril Dina	0	0	0
	Amjad Dina	0	0	0
	Boora Jungle	0	0	0

Note: A total of 21 fields from district Jhelum were surveyed to collect epidemiological data.

Table: 1.9. Epidemiological data of foliar rust diseases of wheat in locations of district Attock.

Diseases	Locations of District Attock	Incidence	Severity	Prevalence (%)
Stripe/ Yellow Rust	Kharala Karan	89	1-3	92
	Jafar	16.66	1-2	40
	Gulyaal	22.33	1-2	45
	Ghari Boota	95	1-4	97
	Tremeela	10	0-1	14.33
	Chota Kamra	6.33	0-1	10
Leaf/Brown Rust	Kharala Karan	36	1-3	78
	Jafar	0	0	0
	Gulyaal	0	0	0
	Ghari Boota	86	1-3	100
	Tremeela	0	0	0
	Chota Kamra	0	0	0
Stem/ Black Rust	Kharala Karan	0	0	0
	Jafar	0	0	0
	Gulyaal	0	0	0
	Ghari Boota	0	0	0
	Tremeela	0	0	0
	Chota Kamra	0	0	0

	Kharala Karan	0	0	0
	Jafar	90	1-3	100
Powdery Mildew	Gulyaal	0	0	0
	Ghari Boota	0	0	0
	Tremeela	0	0	0
	Chota Kamra	0	0	0

Note: A total of 18 fields from district Attock were surveyed to collect epidemiological data.

Collection of Yield Attributes of Wheat Growing Fields Along with Cultural Practices Adopted by Farmers and their Knowledge Regarding Crop and Disease Management

Yield attributes of wheat growing fields give information about economic value of the crop. These attributes measure quality and quantity of crops in terms of yield production. The study area selected for present research showed different yield attributes according to their soil environment and other factors of wheat variety etc. In all four districts higher yield was noted in Sherzaman colony located in Rawalpindi. This crop was healthier than any other site due to no disease occurrence. In district Chakwal two locations did not show any foliar rust disease but due to wheat less productive variety number of grains and their weight was not satisfactory. While crop was drastically affected in Ghari boota, district Attock. The grain health is badly affected by rust pathogens because rust pathogens extract most of nutrients and deplete nutrient source for plants. But the loss of grain weight again depends upon wheat resistance towards disease. Sahar and Inqilaab has been identified as susceptible wheat variety but the survey of wheat growing fields opened this aspect that some farmers are still cultivating these susceptible varieties due to their native problems of seeds prices and availability [18].

The number of tillers per meter length and per meter square area varied from location to location and from one field to another field depending upon the cultivated area of fields. In combination with foliar rust diseases weeds were a serious constraint for wheat production in all four districts. In Daroya, district Rawalpindi

wheat growing fields were 60% occupied with weeds which really reduced their productive yields. Similar situation was prevailed in Boora Jungle, district Jhelum but weeds were less in district Chakwal and district Attock. Some farmers had used weed killers but without significant results. Most common weeds found in four districts were dumbi sitti, jungle jai, poli, kandyari, piazzi, dhodhak, shatra etc. All these factors combine to affect wheat production yields and hard work and investment is not harvested fruitfully [18].

Baloch and his co-workers had conducted a study on effect of planting time and seed rates on yield attributes of wheat crop. Their study concluded that high seed rate is directly proportional to higher number of tillers, number of grains per spike and high grain yields with maximum 1000 grains weight. Survey information of present study also revealed that there was higher yields and number of grains per spike with increase in seed rate per acre as in results of Sherzaman colony located in upper pothohar region showed higher production of wheat crop. The study proved that Punjab 2011 and Chakwal 50 gave high wheat yields as compared to Inqilaab and other varieties which are considered as susceptible varieties for foliar rust diseases [4].

Grain weight is important attribute for measurement of wheat production yield. There are number of factors which affect weight of wheat grains and its quality. Foliar rust

pathogens extract all essential nutrients from plants and leave deplete source of nutrients for wheat plants. Weeds are another burden on wheat quality and reduce weight grains. In present study the results had shown that grain weight is dependent on different aspects i.e. availability of NPK, chlorides Ca and Mg and absence of foliar diseases [20]. A similar study has been conducted in 2010 on stability

parameters for tillers, grain weight and yield of wheat cultivars in Pakistan. This study concluded that extra number of tillers per meter square also have effect on wheat quality regarding its number of grains per spike, spike length and grains weight. Not only are these parameters responsible for better crop yield but wheat variety plays an important role in yield attributes and yield production [19].

Table: 1.10 Yield attributes of wheat growing fields in district Rawalpindi.

Locations of District Rawalpindi	Variety of Wheat	Tillers per meter length	Tillers per meter square	No. of grains	Grain and straw yield (Mann per acre)	Weight of 1000 grains (g)	Harvest index (%)
Sherzaman							
*F1	Sahar	38	226	42-46	22	58	31
**F2	Sahar	40	210	30-35	21	52	
***F3	Sahar	37	206	32-36	20	53	
Sanghori							
F1	Chakwal 50	24	208	24-28	21	47	27
F2	Chakwal 50	26	212	22-24	19	51	
F3	Chakwal 50	25	220	18-20	20	34	
Kallar Syedan							
F1	Chakwal 50	32	220	30-32	16	40	32
F2	Chakwal 50	28	244	28-32	15	34	
F3	Sahar	30	221	22-26	16	42	
Daroya							
F1	Punjab 2011	36	213	32-34	10	28	17
F2	Punjab 2011	34	218	38-40	8	49	
F3	Punjab 2011	30	204	32-36	11	33	
Mori Rajgaan							
F1	Sahar	40	208	24-26	22	48	29.04
F2	Sahar	36	198	20-22	19	42	
F3	Sahar	35	188	24-26	18	43	

*F1 represents field 1 of each specific location.

**F2 represents field 2 of each specific location.

***F3 represents field 3 of each specific location.

Table: 1.11 Yield attributes of wheat growing fields of district Chakwal

Locations of District Chakwal	Variety of Wheat	Tillers per meter length	Tillers per meter square	No. of grains	Grain and straw yield (Mann per acre)	Weight of 1000 grains (g)	Harvest index (%)
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Locations of District	Variety of	Tillers per meter	Tillers per square	No. of grains	Grain and straw	Weight of 1000	Harvest index
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Tharpaal							
*F1	Uqaab13	38	213	22-26	21	48	
**F2	Inqilaab	40	200	20-25	22	52	32
***F3	Punjab 2011	37	198	28-30	20	43	
Sehgalabaad							
F1	Punjab 2011	24	208	24-28	21	47	31
F2	Punjab 2011	26	212	22-24	18	51	
F3	Punjab 2011	25	214	18-20	20	34	
Mulhaal Mughlaan							
F1	Punjab 2011	32	228	30-32	17	29	26
F2	Watan	28	204	28-32	18	34	
F3	Inqilaab	30	239	22-26	19	32	

Jhelum	Wheat	length	meter		yield (Mann per acre)	grains (g)	(%)
Kala Dev							
*F1	Punjab 2011	30	196	22-26	20	50	33.9
**F2	Punjab 2011	28	210	20-25	21	54	
***F3	Punjab 95	27	216	28-30	19	45	
Kotli Allayar							
F1	Punjab 2011	24	208	24-28	22	48	28.6
F2	Faisalabad2008	26	212	22-24	21	52	
F3	Aas	25	220	18-20	20	43	
Mazhar							
Shah	Punjab 2011	32	234	30-32	21	47	27
F1	Punjab 2011	28	225	28-32	20	51	
F2	Punjab 2011	30	228	22-26	20	34	
F3							
Ch. Akram							
F1	Chakwal 50	34	230	32-34	23	50	31
F2	Chakwal 50	33	235	38-40	20	54	
F3	Chakwal 50	34	242	32-36	21	42	
Amjad Dina							
F1	Chakwal 50	40	210	34-36	22	58	32
F2	Inqilaab	36	214	40-42	18	49	
F3	Chakwal 50	35	209	34-36	20	53	
Harril Dina							
F1	Inqilaab	38	220	30-34	18	48	30.4
F2	Inqilaab	40	214	34-36	21	42	
F3	Inqilaab	37	203	38-40	17	43	
Boora							
Jungle	Punjab 95	36	228	30-34	14	47	19.8
F1	Inqilaab	34	233	20-24	19	51	
F2	Aas	30	224	28-30	18	34	
F3							

Table 1.12 Yield attributes of wheat growing fields in district Jhelum.

Table: 3.14 Yield attributes of wheat growing fields of district Attock

Locations of District Attock	Variety of Wheat	Tillers per meter length	Tillers per meter square	No. of grains	Grain and straw yield (Mann per acre)	Weight of 1000 grains (g)	Harvest index (%)
Kharala							
Karan							
*F1	Sahar	38	216	22-26	21	38	27
**F2	Sahar	40	210	20-25	18	30	
***F3	Sahar	37	196	28-30	16	33	
Jafar							
F1	Faisalabaad2008	34	208	24-28	13	47	18
F2	Faisalabaad2008	36	212	22-24	16	41	
F3	Faisalabaad2008	35	220	18-20	14	34	
Gulyaal							
F1	Bhakkar	32	220	30-32	26	50	29
F2	Bhakkar	28	244	28-32	21	54	
F3	Bhakkar	30	193	22-26	20	42	
Ghari							
Boota							
	Inqilaab	36	210	32-34	17	28	17
F1	Inqilaab	34	215	38-40	15	29	
F2	Inqilaab	30	220	32-36	18	33	
F3							
Tremeela							
F1							
F2	Chakwal 50	40	188	18-20	12	38	20
F3	Chakwal 50	36	153	16-18	16	34	
	Chakwal 50	35	164	20-22	14	35	
Chota Kamra							
F1	Bhakkar	32	170	24-28	20	38	18
F2	Bhakkar	28	185	22-24	18	32	
F3	Bhakkar	30	172	18-20	19	30	

4 CONCLUSIONS

The present study was conducted with basic purpose of survey of wheat growing fields in upper lower and middle pothohar regions. Two surveys were conducted at beginning of winter wheat growing season and other at maturation of wheat crop. Persisting cultural practices and ways of crop management were assessed with the help of questionnaires which were filled by farmers during survey of their wheat fields. Environmental conditions including prolonged rainfalls and temperature differences play an important role in disease development. Not only environmental conditions but management practices and sowing dates of wheat seeds are conducive for better yields and prevention of diseases. All selected locations were noted with foliar rust diseases prevalence with exceptions of

few fields in each location. Stem rust disease did not occur in pothohar region of Punjab during 2013-2104 wheat growing season.

Powdery mildew was noted only in three fields of district Attock. It was due to some unique reasons found in peripheral boundaries of those fields. High incidence and prevalence of both yellow and brown rust was found in two locations of middle pothohar region i.e. Ghari Boota and Kharala Karan and in a few locations of lower pothohar areas. In upper pothohar region most of wheat growing fields were free of yellow and brown rust. Wheat yields were high in district Rawalpindi while relatively lower in district Attock and disease prevalence, incidence and severity was relatively higher in this district. While in district Jhelum some fields were more productive but affected with foliar rust diseases.

According to survey of 2013-2014 in previously infected wheat growing fields it is concluded that farmer are not well aware of foliar rust diseases management. They did not show any knowledge regarding use of fungicides at particular growth stages of wheat crop. Along with different diseases weeds are a serious burden on better yields of wheat crop. Resistant varieties are

better options to prevent disease occurrence but farmers in far areas are unaware about use of resistant varieties and they use seeds of susceptible varieties to get higher productions.

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