



Screening of Wheat Different Varieties against stripe rust (*Puccinia striiformis* f. sp. *tritici*) in Baghlan Province-Afghanistan

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ABSTRACT: Wheat strip rust is the most devastating fungal disease in the north Provinces of Afghanistan, causes heavy losses on this staple food crop for the last two years. Therefore, the experiment was carried out under field conditions in 2023, to screen the most growing wheat varieties against stripe rust disease. A total of 18 different varieties were used for this study to find out the resistant varieties. The study revealed that, among all tested varieties no one was found with complete resistance reaction against stripe rust (yellow leaf rust). 12 varieties such as Pat wheat, Hazardana lalmi, Zardana, Jawzjan, Kabali, Lalmi 17, Darulaman, Sarkha, Suleh, Wahdat, Chonta and Mazar-99 expressed moderately resistance reaction, while the other 6 varieties viz., Lalmi 4, Hazardana Abi, safidak, roshan, Kabul 013, Lalmi 15 showed moderately susceptible response to disease, a visible effects on wheat yield and plant height were also exposed by rust in some varieties compared to others, however the 15.00 gr/plot), whereas the lowest yield collected from zardana (1213.33 gr/plot) and safidak uppermost yield harvested from pat wheat (2128.33 gr/plot), Kabali (1970 gr/plot) and chonta (17 (1248.33 gr/plot), in respect to height, the highest wheat varieties were Sarkha 135.73 cm and Pat wheat 121.00 cm; while the lowest height recorded in Choonta 92.20 cm and Suleh 92.73 cm.

KEY WORDS: Wheat varieties, Resistance sources, leaf rust, Disease severity, moderately resistant.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the major staple food crop and main source of dietary energy in Afghanistan (1). Whole-meal or flour made from wheat is used to make a diversity of eating materials, including noodles, pancakes, chapattis, cereal, bread, and many more, A major contributor to Afghanistan's economy, constituting more than 30% of the country's Gross Domestic Product (GDP). This high contribution to the GDP indicates the economic significance of wheat cultivation and production in the country. Wheat accounts for a substantial portion of Afghanistan's agricultural harvest, making up approximately 60% of the total. The heavy reliance on wheat means that its availability and affordability directly impact the food security of the population. (2). Above than 781 million metric tons of wheat were harvest worldwide in the 2022–2023 marketing year, it showed escalation of 779.33 million metric tons, (3) The scattering of wheat fields including irrigated and rain fed was created using visual (S2) and SAR (S1) data and photos from planting to harvest in 2017. The maps illustrated that the northern region of the country is full occupied with rain-fed wheat, and concentration of rain-fed wheat detected there. The mentioned area interrelated to the (the Hindu Kush range) mountains sequence and obtains adequate volume of rainfall and snowfall during the winter. More than 80% of the country's wheat production (both irrigated and rain-fed) come out from sixteen provinces included Badghis, Takhar, Balkh, Kunduz, Herat, Helmand, and Kandahar, which produce about 50% of the homeland's wheat production, two rain-fed varieties (Diana 96 and Lalmi 04) were tested in three different zones and locations of Afghanistan, both were resistant in rain-fed condition and were resistant to Ug99 (4). Wheat (*Triticum aestivum* L.) suffered from three different types of rust diseases; stripe, leaf and stem rust. Among them, the most common and extensively dispersed wheat rusts is stripe rust which has become more severe problem causing great losses of wheat grain yield in rainy or humid and cool weather conditions (5). On average, 21.5% of wheat yield is lost due to stripe rust worldwide. Stripe rust can cause yield losses from 10 to 100% in China (6).

As wheat stripe rust has become the most biotic limitation to wheat cultivation and production and threatens global food supply. As reported that, 88% of the world's wheat cultivars are susceptible to wheat stripe rust, leading to global losses of over 5 million tons of wheat with an estimated market value of \$USD one billion annually (7). The stripe rust disease is also known as yellow rust caused by the obligate biotrophic fungus *Puccinia striiformis* f. sp. *tritici*. The threat of this fungus to agriculture is rooted in its



tremendous genetic diversity as a result of sexual recombination occurring predominantly in the Himalayan region (Pakistan, Nepal and China) its long distance dispersal across continents by natural and human means, and its rapid local adaptation via stepwise evolution, overcoming a single resistance gene at a time (8). The pathogen biological capabilities compound the complexity of the management, windborne and rapid transmission of the spores, high reproductive potential and sexual recombination on the alternate hosts make timely cost effective decisions in the field. Using the genetic resistant wheat varieties, the wheat stem rust has been effectively controlled since the 1970s; but the wheat stripe and leaf rusts are still problem in the wheat production in China due to lack of effective management strategies and agricultural regulations (9). Planting rust-resistant wheat cultivars has been considered as an effective, economical, and green strategy to control wheat rust diseases (10). Currently, because of severe epidemics, the wheat stripe rust is also the most destructive disease amongst the three wheat rust diseases in most of the growing regions especially in Northern provinces of Afghanistan. As stripe rust disease epidemics has been occurred every year in the wheat growing regions in Afghanistan, had serious effects on yield losses and the other hand, some of the released resistant varieties against rust are still not cleared known, Hence, so this study was conducted to identify resistant or moderately resistant varieties growing in some regions in Afghanistan.

MATERIAL AND METHODS

Experimental Site and Screening of Wheat Varieties for Wheat Yellow Rust Disease

This research carried out at Research farm of Agriculture faculty, Baghlan University during the year (2022 /11/15 to 2023/5/15). Experimental site located at 36 degree and 5 minute Latitude and 68 degree and 38 minute Longitude, 566 meter above the sea level in open area under natural and field conditions. The soil was sandy loam type, irrigation and fertilization were performed based on crop's requirement. The first fertilization at the time of land preparation was Urea 8.3 gr/m² and 25 gr/m² DAP per plot, second time during the stem elongation stage 8.3 gr/m²/Plot, third time at the flowering stage 8.3 gr/m²/plot. The trails were contained (18) (treatments) local varieties and 3 blocks (replications), every plot (replication) comprise 120 wheat plants, sown in 6 lines, every line contained 20 plants. Space between rows and lines were 25 cm and 5 cm respectively, each plot concealed 3m² (2m×1.5m) area. The passageway between plots and blocks was 60 cm to facilitate agronomic practices recording of data and normal irrigation. 18 Varieties were selected for screening. The seeds were attained from diverse districts and scientific research station of Baghlan Province.

Table 1. Wheat Varieties screened against Yellow rust diseases.

1- Wheat pat,	10 Sarkha,
2- Hazar dana lalmi,	11- Safidak,
3- Zardana,	12- Suleh,
4- Lalmi 4,	13- Wahdat,
5- Hazardana Abi,	14- Choonta,
6- Jawzjan,	15- Mazar 99
7- Kabali,	16- Roshan,
8- Lalmi 17,	17- Lalmi 15,
9- Darulaman ,	18- Kabul 013,

Calculating of Wheat Rust Incidence and Severity:

The rust incidence was recorded, three times at ten days interval, including the percentage of plants affected from the earliest signs to the full development of leaf strip rust through the below (11)

$$DI \% = (\text{Number of disease leaves}) / (\text{Number of total leaves}) \times 100$$

The scale used for rust severity recording is a modified version of the Cobb scale, the Cobb scale typically ranges from 0-9 where 0 indicate no symptoms or resistance and 9 representing complete infection or susceptibility.



Table 2: Scale for recording disease severity (12)

Category	Grade/Scale	Plants % infected	Reaction	Abbreviations
0	0	0	No infection	HR
1	1	1-10	Visible chlorosis, necrosis and no uredia	R
2	3	11-30	Small uredia with chlorotic and necrotic area	MR
3	5	31-50	Variable sized uredia with chlorosis, necrosis or both	MS
4	7	51-75	Medium sized uredia with chlorotic areas	S
5	9	76-100	Large uredia covered the leaf	HS

Disease severity calculated rendering to the following formula (13).

$$DS\% = (\text{Sum of diseases rating}) / (\text{Total no. of Plants} \times \text{Maximum disease grade}) \times 100$$

Statistical analysis:

Statistical analysis done through OPSTAT- HAU- Hisar software system, the software performs one-way and two-way ANOVA to analyze the effect of one or more factors on a continuous response variable.

RESULT

Geographical and Meteorological conditions during the growing season:

Humidity and temperature are crucial epidemiological factors for developing of Rust diseases in wheat; therefore, for significance of study, the relative humidity percentage and temperature recorded during the growing season. Data of Relative humidity and temperature were recorded during the season at field level by temperature and humidity meter Showed in the (Table 3.)

Table 3. Geographical and Meteorological environments during the season:

Location	Latitude and longitude	Altitude	Temperature (0c)	Relative humidity (%)
Baghlan University Agriculture faculty research farm	36.089270	68.650708	25.85	56.57

Wheat Rust incidence recording and calculation:

Incidence of stripe rust recorded three times consistently with 10 days interval, the first observation recorded after 80 days of sowing (ADS) when the rust was in initial stage produced brown pustules on the leaves. The pustules were circular, slightly elliptical, and smaller than those of stem rust. Usually contain commonalities of orange to orange-brown uredospores. An average of three consecutive observations, the highest rust incidence was recorded on Kabul 013 (28.28%) and Kabul 15 (28.28%) followed by Roshan (26.00%), Lalmi 4 (25.84%), Mazar 99 (26.00%) and Hazardana Lalmi (22.52%), while. the lowest incidence of rust was recorded with Pat wheat (15.33%) followed by Jawzjan (16.00%), Zardana (16.96%), Wahdat (18.23%), Sarkha (17.00%), Hazardan Abi (20.67%), Kabali (22.33%), Lalmi 17 (23.37%) and safidak (24.00%). The varieties such as Darulaman (20.33%), Suleh (22.00%) and Choonta (23.00) showed mostly similar incidence with each other. The study revealed that, Disease incidence of treatments were significantly different with each other as presented in (Table 2).

Table 4. Stripe rust incidence in selected varieties.

Variety Name	1 st .Obseration	2d .Observation	3 rd .Observation	Means
Pat wheat	5.00	14.00	27.00	15.33
Hazardana lalmi	11.55	19.00	37.00	22.52
Zardana	8.88	17.00	25.00	16.96
Lalmi 4	15.83	23.00	38.70	25.84
Hazardana Abi	9.00	19.00	34.00	20.67



Jawzjan	7.00	15.00	26.00	16.00
Kabali	6.00	25.00	36.00	22.33
Lalmi 17	6.11	26.00	38.00	23.37
Darulaman	5.00	23.00	33.00	20.33
Sarkha	7.00	18.00	26.00	17.00
Safidak	10.00	23.00	39.00	24.00
Suleh	9.00	17.00	40.00	22.00
Wahdat	9.70	18.00	27.00	18.23
Choonta	7.00	21.00	41.00	23.00
Mazar 99	13.00	22.00	43.00	26.00
Roshan	14.00	26.00	38.00	26.00
Lalmi 15	14.00	28.00	42.00	28.00
Kabul 013	13.83	29.00	42.00	28.28
C.D				5.473
C.V				14.934

Severity of Stripe Rust in Wheat Varieties:

All varieties showed various retort against the disease, among 18 varieties, 12 varieties such as Pat wheat, Hazardana lalmi, Zardana, Jawzjan, Kabali, Lalmi 17, Darulaman, Sarkha, Suleh, Wahdat, Chonta and Mazar 99 detain less reaction (19.00, 28.33, 20.80, 16.33, 20.66, 21.00, 18.96, 16.00, 22.20, 18.33, 23.33 and 25.53) respectively and encompassed in moderately resistance, 6 varieties such as Lalmi 4, Hazardana Abi, Safidak, Roshan, Lalmi 15 and Kabul 013 reacted less than others and categorized in moderately susceptible. The highest reaction come out in Safidak and Roshan (32.300%) and (23.00%) respectively. The lowest disease severity was recorded on Sarkha, Jawzjan and Wahdat (16.00), (16.333) and (18.33) respectively. The analysis result of the percent disease severity was significantly different among the tested varieties. Pat wheat, Hazardana lalmi, Zardana, Jawzjan, Kabali, Lalmi 17, D,arulaman, Sarkha, Suleh, Wahdat, Chonta and Mazar 99, Lalmi 4, Hazardana Abi, Safidak, roshan, Kabul 013, Lalmi 15 were significantly reacted than each other (presented in Table 5 and Fig 1.)

Table 5. Rust disease Severity in Wheat varieties:

Name of variety	Means of Rust Severity%			Means	Reactions
	1 st Ob	2 nd Ob	3 rd Ob		
Pat wheat	5.00	21.00	31.00	19.00	MR
Hazardana lalmi	7.00	24.00	54.00	28.33	MR
Zardana	8.00	25.40	29.00	20.80	MR
Lalmi 4	11	34	49	31.33	MS
Hazardana Abi	12.8	35.8	45	31.20	MS
Jawzjan	6.00	18.00	25.00	16.33	MR
Kabali	7.00	26.00	29.00	20.66	MR
Lalmi 17	7.50	19.50	36.00	21.00	MR
Darulaman	8.90	17.00	31.00	18.96	MR
Sarkha	7.00	16.00	25.00	16.00	MR
Safidak	11.00	37.00	48.90	32.30	MS
Suleh	9.00	25.00	32.60	22.20	MR
Wahdat	10.00	19.00	26.00	18.33	MR
Choonta	13.00	27.00	30.00	23.33	MR
Mazar 99	7.60	27.00	42.00	25.53	MR
Roshan	11.00	32.00	53.00	32.00	MS



Lalmi 15	13.5	33.5	47.5	31.50	MS
Kabul 013	12.00	32.00	50.00	31.33	MS
C.D				8.989	
C.V				22.319	

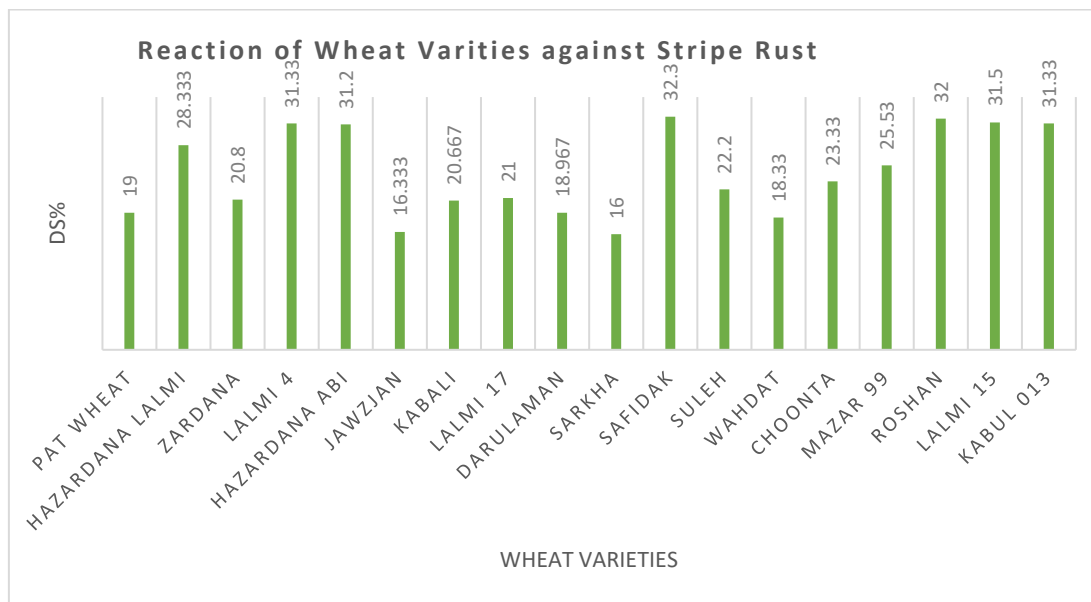


Fig. 1. Rust disease Severity of Wheat varieties.

Height, Weight of thousand Grains and Yield per Plot of Wheat Varieties Screened for Yellow Rust

Yield per plot, weight of 1000 grains and height were recorded once at the appropriate time, to identify the difference of stated characters of screened varieties, the utmost yield was obtained in pat wheat (2,128.33 gr/plot) , Lalmi 17 (1800.00 gr/plot) ,Kabali (1790 gr/plot) and Chonta (1715 gr/plot) trailed by Wahdat, Sarkah, Hazardana lalmi, Suleh, Darulaman with the yield (1671.66 gr/plot), (1663.33 gr/plot), (1661.66 gr/plot) , (1631.66 gr/plot) , (1608.33 gr/plot) respectively, while, the lowest yield collected from Zardana (1213.33 gr/plot), Safidak (1248.33), Hazardana Abi (1341.66 gr/plot), and Kabul 013(1371.66 gr/plot) followed by Lalmi 4 , Lalmi 15, Roshan, Jawzjan and Mazar 99 with yield (1398.33 gr/plot) , (1385.00 gr/plot), (1550.00 gr/plot), (1571.66 gr/plot) and (1593.33 gr/plot). The highest wheat varieties were Sarkha 135.73 cm and Pat wheat 121.00 cm the lowest height recorded in Choonta 92.20 cm and Suleh 92.73 cm showed in (Table 6).

Table 6. Height, Weight of thousand grains and yield per plot of wheat Varieties screened for yellow rust:

Varieties Name	Yield/Plot (gr)	Weight/1000 grain	Height (cm)
Pat wheat	2128.33	42.79	121.00
Hazardana lalmi	1661.66	43.09	97.13
Zardana	1213.33	42.28	96.93
Lalmi 4	1398.33	38.01	89.80
Hazardana Abi	1341.66	41.97	100.25
Jawzjan	1571.66	45.54	95.60
Kabali	1790.00	37.25	89.33
Lalmi 17	1650.00	41.68	96.60
Darulaman	1608.33	50.97	97.40
Sarkha	1663.33	56.35	135.73



Safidak	1248.33	37.79	96.20
Suleh	1631.66	38.22	92.73
Wahdat	1671.66	41.92	100.13
Choonta	1715.00	39.25	92.20
Mazar 99	1593.33	39.44	100.26
Roshan	1550.00	41.33	97.26
Lalmi 15	1385.00	43.07	96.80
Kabul 013	1371.66	40.48	95.66
C.D	303.530	4.915	7.851
C.V	11.567	6.972	4.735

DISCUSSION

Rust is the most devastating wheat disease in Afghanistan, different varieties are remained without resistant reaction, and most of the cultivating varieties are susceptible against it; so, it was necessary to identify resistant or at least medium resistant varieties among the locally growing varieties. Rust infections pose a significant danger to food security due to their high reproduction rate and capacity to spread swiftly and create novel path types (14).

The current study revealed that the high relative humidity and low or medium temperature had acceptable effect on development of Strip rust, the same result come out in a research (15) that high humidity, rainfall and low (18-25 c0) temperature increase the rust disease, out of 18 local varieties 6 cultivars (Lalmi 4, Hazardana Abi, Safidak, Roshan, Lalmi 15 and Kabul 013) showed moderately susceptible reaction with high incidence and severity of strip rust than other varieties, the result of similar work in Nepal screening of varieties Aditya (10MR), NL-971 (10MR), BL-3503 (20MS, MR), BL-3623 (TR, TMR), NL-1008 (10MR, R), NL-1064 (20MR), Becard#1 (10MR) and Chyakhura-1 (TMR) had low severity and resistant to moderately or trace resistant disease response against the yellow rust. Similarly in an experiment (16) bring out that Aditya (10MR), NL-971 (10MR), BL-3503 (20MS, MR), BL-3623 (TR, TMR), NL-1008 (10MR, R), NL-1064 (20MR), Becard#1 (10MR) and Chyakhura-1 (TMR) had low severity and resistant to moderately or trace resistant disease response against the yellow rust.

CONCLUSION

Wheat stripe rust is destructive fungal disease on wheat in Afghanistan especially in Northern regions. The spores of the causing pathogen can be widely transmitted a long distance by wind. Currently, the epidemics of the stripe rust disease frequently taken placed and have been resulted in economic losses for wheat production. The best management strategies for rust diseases are host resistance and production of resistant varieties, so the conventional breeding techniques such as selection and introduction of new varieties are essentially used the same as those for other agronomic characters. Therefore, the most common released local varieties were tested to find out the desirable varieties with less severity records. So, amongst all, the varieties viz., Sarkah, Jawzjan, Wahdat, Darulaman and Kabali expressed with moderately resistance in respect to less disease severity, meanwhile the highest yield was recorded by Sarkha, Pat wheat, Mazar-99, Hazardan Abi and Wahdat.

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