Plant Protection, 06 (03) 2022. 225-231 DOI: 10.33804/pp.006.03.4347

Available Online at EScience Press
Plant Protection
ISSN: 2617-1287 (Online), 2617-1279 (Print)
http://esciencepress.net/journals/PP

EVALUATION OF INCIDENCE, SOME WHEAT LINES AND FUNGICIDES FOR THEIR PERFORMANCE AGAINST LEAF RUST OF WHEAT IN SINDH PROVINCE OF PAKISTAN

[a]Sajjad Ali, [b]Javed Asghar Tariq, [a]Manzoor Ali Abro, [a,c]Ghulam Hussain Jatoi, [a]Naeem Muhammad, [b]Imran Rauf, [b]Raza Muhammad Memon

[a] Department of Plant Pathology, Faculty of crop protection, Sindh Agricultural University, Tandojam, Sindh, Pakistan
[b] Nuclear Institute of Agriculture (NIA) TandoJam, Sindh, Pakistan.
[c] Department of Agriculture, Mir Chakar Khan Rind University Sibi, Pakistan.

ARTICLE INFO

Article history
Received: 18th August, 2022
Revised: 27th September, 2022
Accepted: 10th October, 2022

Keywords
Wheat
Screening
Resistant
Susceptibility
Rusts

ABSTRACT

Rusts cause considerable qualitative and quantitative losses to the wheat crop. However, their severity and losses can be minimized through the deployment of resistant cultivars. Current investigations were made to conduct surveys for leaf rust in Sindh province to scrutinize wheat germplasm against the disease and to check the efficacy of potential fungicides in controlling leaf rust of wheat. Experiments were conducted under artificial conditions at Nuclear Institute for Agriculture, Tandojam. Cobb's scale was used for disease ratings. Among screened wheat lines, one was rated as resistant, two were found moderately resistant, six showed moderately resistant and moderately susceptible type reactions, and one line exhibited moderately susceptible reaction. Moreover, the correlation between severity ratings (area under disease progress curve (AUDPC) and yield traits unveiled that there was a negative correlation between AUDPC and spike length, awn length, plants/sq.ft., and grain yield while a positive correlation for remaining traits. Among fungicides, Tilt and Bloom were found to be the most effective in controlling leaf rust. It is, therefore, recommended that the resistant genotypes should be used in future breeding programs to evolve resistant materials against leaf rusts of wheat and the most effective fungicides be used for the management of the disease to minimize yield losses.

Corresponding Author: J. A. Tariq
Email: jatariq_1411@yahoo.com

INTRODUCTION

The severe fungal infection in wheat could cause a 20% reduction in crop. These fungal infections reduce plant photosynthetic rate and may cause crop leaves to become necrotic, which reduces nutrient uptake and causes only partial filling of grains. Food insecurity in the area may result from the significant yield losses. The biggest threat to food security comes from rust entities, which have numerous reproductive rates, have ability to evolve new races and spread quickly (Duveiller et al., 2007). It is very important to protect crops from the devastations caused by wheat rusts, particularly leaf rust, to ensure the availability of wheat on a global scale. In wheat breeding programmes, disease-resistant wheat cultivars are a key component. Finding new sources of resistance is a good strategy for permanently reducing the threat posed by rust races. Recent efforts by agricultural experts believe on the application of breeding techniques, but these processes take time. On the other side, chemical control can be used to prevent diseases from spreading too quickly and to minimise yield losses. The majority of the primary diseases that affect growing crops have been successfully controlled by various types of fungicides. Among them, leaf spots, late blight, downy mildew, fruit rots, powdery mildews, cereal seed-borne diseases, rusts, and smuts are among the commercially significant diseases.

Despite being a relatively old method, the use of pesticides in disease management is still important for maintaining food supply globally. Many publications, especially those utilizing Azoles and strobilurin chemicals, claimed that disease control for the majority of the yield improvement brought on by the use of fungicides. According to Weinert and Wolf (1999), when fungicides were administered to wheat during the blooming stage, head blight in the crop was reduced by up to 80%. Gerhard (2001) investigated the physiological mechanisms involved in yield increase in winter wheat cultivars sprayed with strobilurin fungicides. According to his findings, the use of strobilurin fungicides increased absorption intensity preventing the side effects of fungal attack. Transpiration was also enhanced, and the plants displayed improved water use efficiency as well as longer green leaf life. Fungicide applications between the full elongation of the flag leaves and anthesis typically result in the greater reductions in disease severity and increases in wheat output or grain quality. To picture the prevalence of leaf rust, to explore resistant germplasm against rusts and to evaluate the efficacy of fungicides, current studies were designed.

MATERIALS AND METHODS

Leaf rust surveillance and monitoring

In three districts i.e. Hyderabad, Tando-Muhammed-Khan, and Thatta, surveys for the wheat leaf rust disease were carried out during the growing seasons of 2020 - 2021. Samples were collected from each ten kilometers of surveying areas. Random samples were collected from farms and farmers' fields. Between February and March 2021, survey sites were visited three to four times. Following formulae were used to display information on disease incidence and severity as described by (Figlan et al., 2020; Omara., 2021).

$$\text{Disease incidence} = \frac{\text{Numbers of rust infected plants}}{\text{Total numbers of plants examined}} \times 100$$

$$\text{Disease severity} = \frac{\text{Total lesion length (cm)}}{\text{Total leave length(cm)}} \times 100$$

Plant material

Ten genotypes were acquired from the NIA wheat breeder to test for resistance and susceptibility to leaf rust. In December, the material was planted. For sowing, a hand drill was used. Each entry's length was kept at 1 metre. There were four replicates of the experiment. All agronomic inputs were given to the crop.

Artificial inoculation of *Puccinia triticina*

Crop was artificially infected by llurediospore suspension of leaf rust using a hand sprayer. With help of hemocytometer, spores were counted. A rough adjustment was made to the final concentration of 10^6 spores/ml). Tween-20 (0.05%) was also added to the suspension to improve the sticking power of rust spores. Up until the onset of rust symptoms, inoculations were repeated.

Disease assessment

The Field was frequently visited. Data were collected at every 10 days until the crop reached maturity. A modified Cobb's scale was used to measure the severity of the leaf rust disease (Peterson et al., 1948), and a 0–1 scale was used to measure host response as shown in Table 1.

Area under disease progress curve (AUDPC) was calculated by using following formula.

$AUDPC = D1/2(Y_1+Y_k) + Y_2+Y_3+\ldots\ldots\ldots\cdots Y_{k-1.}$

Where: D = days between reading; Y_1 = first disease recording; Y_k = last disease recording.

Yield parameters

Plant growth and yield metrics such as plant height, spike length, awn length, number of spikes per plant, number of spikes per spike, and 100 grain weight were measured at crop maturity.

Effectiveness of fungicides for the management of leaf rust

Five fungicides viz. Boom, Tilt, Mancozeb, Sulfur and Topsin-M were evaluated for their effectiveness against leaf rust. The fungicides were sprayed on wheat at recommended doses. Distilled water served as control and data regarding efficacy fo fungicides were recorded as described by Iqbal and Mukhtar (2020).

Statistical analysis

Using Statistix 8.1 software, the data were statistically analyzed by (ANOVA). RCBD design was employed. Additionally, the least significant difference at (p 0.05) was employed to compare treatment averages.

Table 1. Scale for host plant response to leaf rust infection.

S. No.	Host Response	Host reaction value
1	Immune (I)	0.0
2	Traces (T)	0.1
3	Resistant (R)	0.2
4	Resistant to moderately resistant (RMR)	0.3
5	Moderately resistant (MR)	0.4
6	Moderately resistant to moderately susceptible (M)	0.6
7	Moderately susceptible (MS)	0.8
8	Moderately susceptible to susceptible (MSS)	0.9
9	Susceptible (S)	1.0

RESULTS AND DISCUSSION

Survey results

In three lower Sindh districts, different survey locations revealed a wide variation in the frequency of leaf rust. In diverse fields, the disease incidence of leaf rust ranged from 28.40% to 85.40%. Usman Pahwar Farm (85.40%) and Yusuf Naik Farm (75.67%) and farmer field (75.60%) displayed the highest prevalence of disease. These three fields are located in district Thatta. The Junejo farm (28.40%), Khadim farm (39.2%), and Latif farm SAU (40.45%), Tandojam showed the lowest disease incidence rates. These three fields are all situated in Hyderabad district. On a district-wide basis, Thatta district had the greatest mean incidence of leaf rust disease (85.40%), followed by T.M.K. (51.5%) and Hyderabad (28.40%) (Figure 1).

Varietal Screening

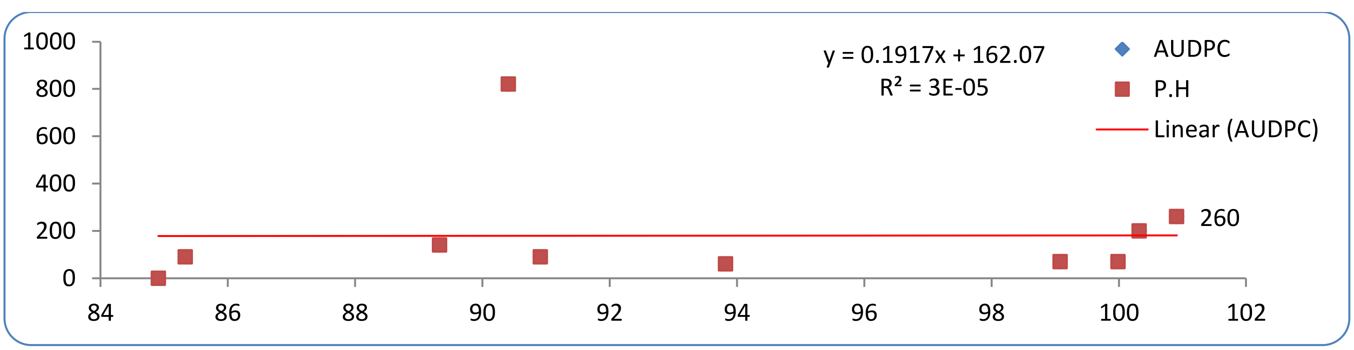
One of the screened wheat lines was evaluated to be resistant to leaf rust, two were shown to be moderately resistant, six displayed MRMS-type reactions, and one displayed a moderately susceptible response. Our results are consistent with those of other researchers (Channa et al., 2022; Hussain et al., 2011). Wheat that is resistant may have a stable gene set that is resistant. The genotypic behavior of advance wheat lines may be the cause of their variable pathogenicity attribute (Hussain et al., 2011; Iqra et al., 2020; Islam et al., 2017). To avoid severe yield losses, wheat can be given these new sources of Lr resistance.

Yield parameters of wheat plants

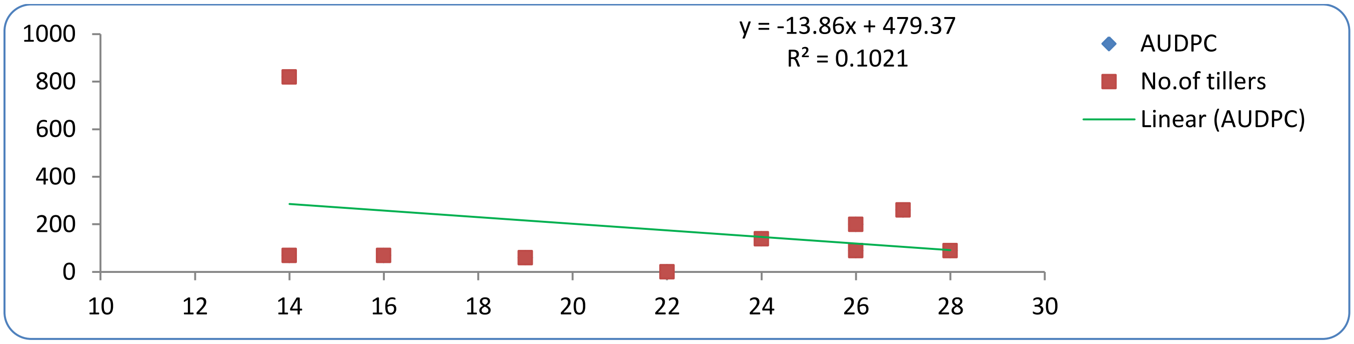
All cultivars' parameters for plant growth and yield were retrieved at the time of harvest. Regression analysis was used to examine that how the development of leaf rust affected these characteristics. When AUDPC and other yield characteristics were correlated, it was discovered that the remaining features had positive correlations whereas the number of tillers, number of pants/sq^2, and 100 grain weights had negative correlations.

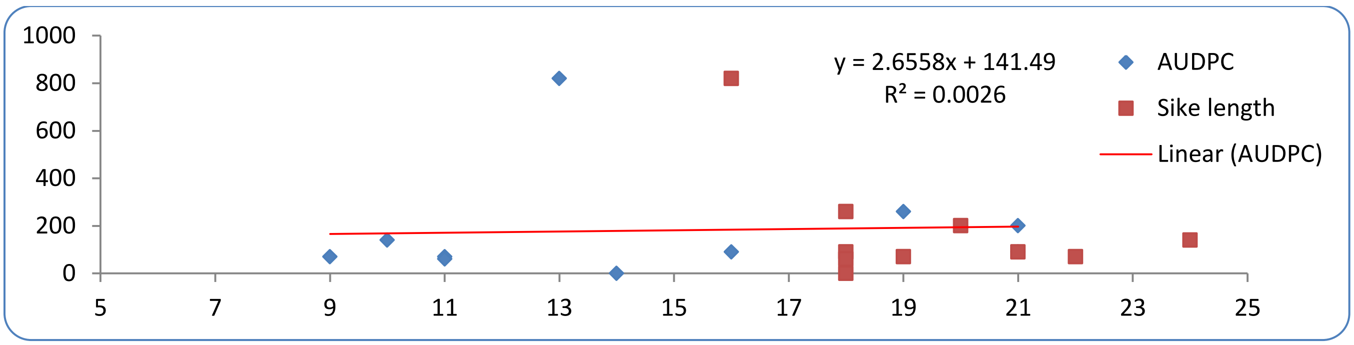
Efficacy of fungicides

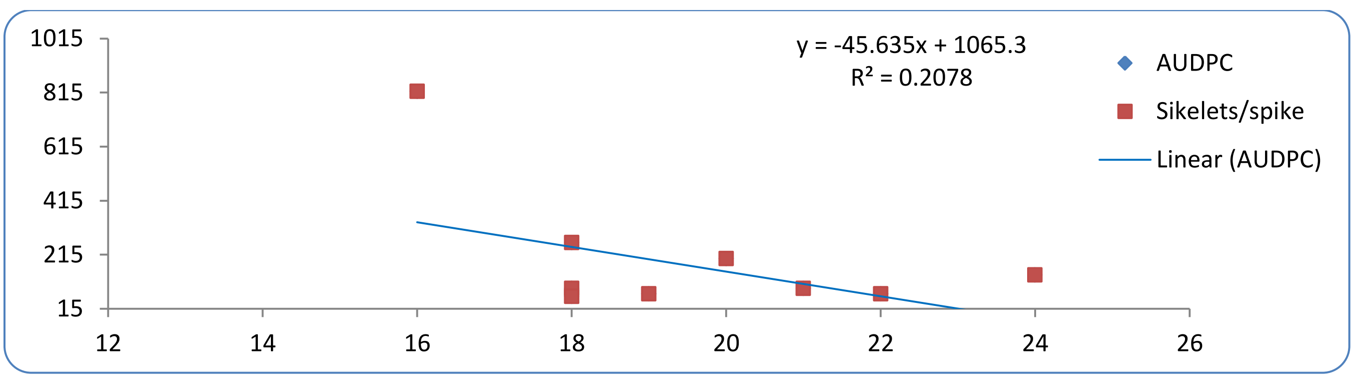
Among fungicides, Tilt and Bloom were found the most effective (Table 2) in controlling leaf rust which reduced rust severity up to 5% as compared to control (100% severity) (Figure 2). In every part of the world where wheat is grown, leaf rust poses a substantial threat to crop output, leading to significant yield losses (Rehman et al., 2013).

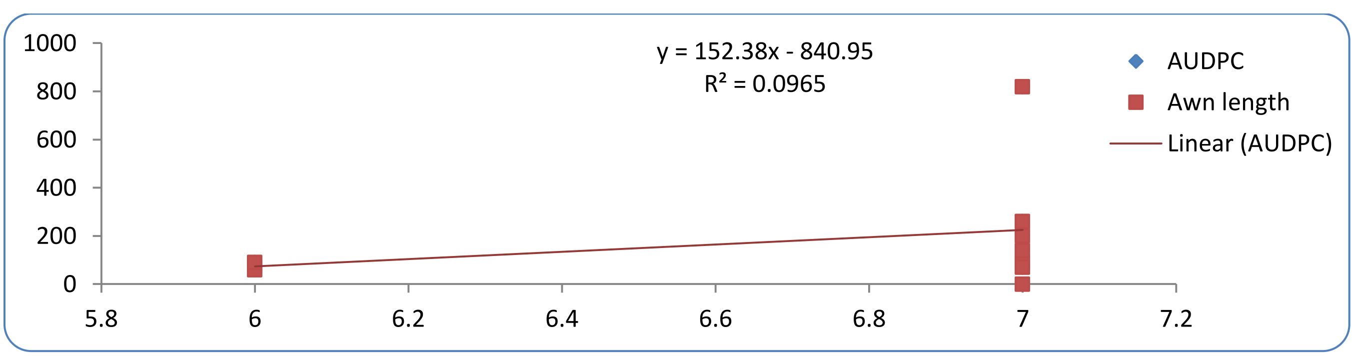


 DOI: 10.33804/pp.006.03.4347









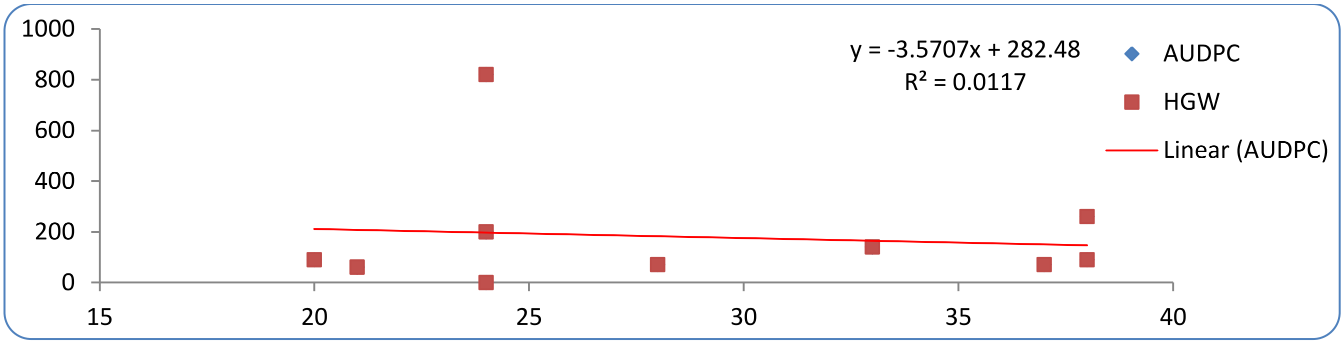


Figure 1. Relative among parameters of wheat AUDPC.

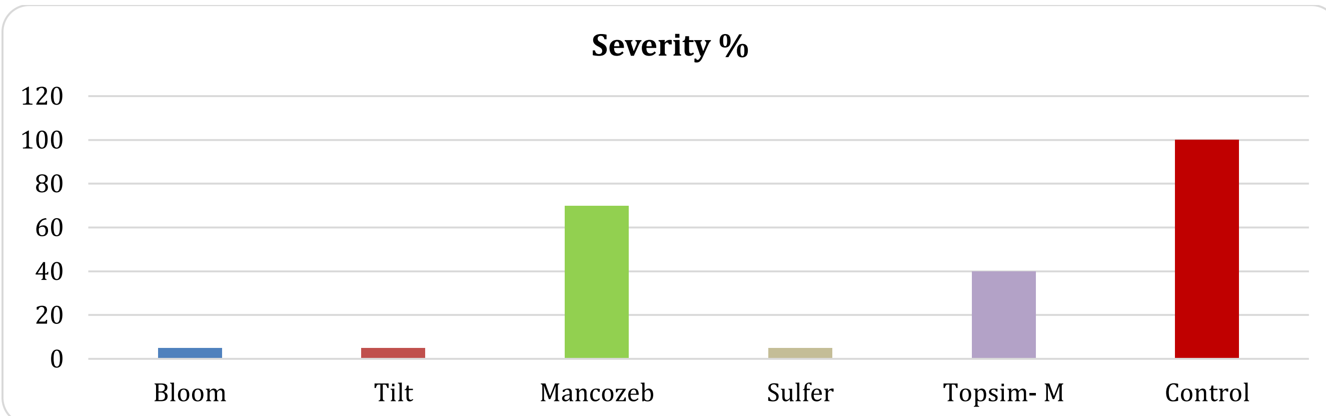


Figure 2. Effectiveness of fungicide reducing the severity of Wheat Rust.

Table: 2 Survey results of leaf rust of wheat in wheat growing of Sindh.

Sr. No	Distt.	Locations	No: of fields	Samples taken field	Disease incidence (%)
		Juneju farm	1	10	28.40%
1	Hyderabad	Syed khadim Sha farm	1	10	39.42%
		Latif farm SAU	1	10	40.45%
2	TMK	Farmer Field	1	10	55.60%
		Sarhandi Farm	1	10	62.55%
		Nakargi Farm	1	10	68.60%
		Yousaf Naik Village	1	10	75.67%
3	Thatta	Local Field	1	10	75.60%
		Usman Pehwar Farm	1	10	85.40%
		Vegetable Farm	1	10	61.70%

Environmental factors that favor disease development as well as vulnerable cultivars play a role. The production of resistant cultivars is the only sustainable and effective strategy for averting disease epidemics. Low AUDPC scores in the current study indicated genotypes with high to moderate levels of resistance to leaf rust. These results agreed with those of Prabhu et al. (1993) and Pretorious (1983), who employed AUDPC to pinpoint the causes of leaf rust resistance. Similar to this, while evaluating leaf rust resistance, Ahmad et al. (2019), and Khan et al. (2017) reported the same infection results. Epidemiological factors have regularly shown to have a significant influence on the beginning of disease. The amount of urediniospores produced per unit area of infected leaves rose considerably with temperature (both lowest and maximum), increasing the number of spores produced each day (Milus et al., 2009; Geagea et al., 1997; Yamin et al., 2020). Under conditions of high relative humidity, fungus appressoria germination increased between 4 and 25 ^{0}C for maximum and minimum temperature.

Rainfall and wind speed are also positively connected with the emergence of leaf rust on the majority of treatments. At a rate of 5 to 10 millimeters per hour, the rain drops promote the release of fungal spores through splashing or direct impact. Much like how increasing wind speed and wind blast led to better spore dispersion (Rizwan et al., 2017).

Fungicides are the most reliable form of disease management in the absence of resistant cultivars Disease can be controlled by planting disease free seed as soon as possible after deep ploughing, practicing hygienic cultivation, eliminating weeds, and keeping a healthy population (Channa et al., 2021). Fungicides must be applied several times to infected crops in order to achieve a sufficient yield. Khan et al. (2017) evaluated three systemic fungicides viz. Thiophanate methyl, Carbendazim, and Ridomil MZ (Mancozeb 64% + Metalaxyl 8%) in the field at a concentration of 0.2% each. The only one of these, Ridomil MZ proved successful followed by the mixture of Carbendazim and Captan. The results of this inquiry are substantially supported by these findings. In our study, Tilt and Bloom were proven to be the most helpful. Additionally, according to Singh et al. (2014), three consecutive sprays of Mancozeb had the greatest impact in controlling the severity of Alternaria leaf blight followed by a schedule that included two consecutive sprays of Mancozeb (0.2%) and a third of Rodomil MZ (0.25).

AUTHORS' CONTRIBUTIONS

SA, JAT and GHJ conceived and designed the experiments. MAA and GHJ collected the data. SA, NM and IR TA performed the experiment. JAT and GHJ critically revised of the manuscript for intellectual content. All authors read and approved the final manuscript

CONFLICT OF INTEREST

No conflict of interest

REFERENCES

Ahmad, K., Wajid, K., Khan, Z. I., Ugulu, I., Memoona, H., Sana, M., & Sher, M. (2019). Evaluation of potential toxic metals accumulation in wheat irrigated with wastewater. *Bulletin of environmental contamination and toxicology*, *102*(6), 822-828.

Channa, A. W., Bux, H., Sial, M. A., Jatoi, G. H., & Kumar, R. (2021). Virulence Phenotyping of Leaf Rust (*Puccinia triticina*) Isolates from Southern Pakistan. *International Journal of Phytopathology*, *10*(2), 101-123.

Channa, A. W., Bux, H., Jatoi, G. H., Sial, M. A., Shah, S. M., Figari, I. M., & Koondhar, N. (2022). Evaluation of Seedling Resistance and Marker Assisted Selection for Leaf Rust (*Puccinia triticina*) Resistance in Pakistani Wheat Landraces, Cultivars and Advanced Lines. *International Journal of Phytopathology*, *11*(2), 155-169.

Duveiller, E., Singh, R. P., & Nicol, J. M. (2007). The challenges of maintaining wheat productivity: pests, diseases, and potential epidemics. *Euphytica*, *157*(3), 417-430.

Figlan, S., Ntushelo, K., Mwadzingeni, L., Terefe, T., Tsilo, T. J., & Shimelis, H. (2020). Breeding wheat for durable leaf rust resistance in Southern Africa: variability, distribution, current control strategies, challenges and future prospects. *Frontiers in Plant Science*, *11*, 549.

Geagea, L., Huber, L., & Sache, I. (1997). Removal of urediniospores of brown (*Puccinia recondita* f. sp. *tritici*) and yellow (*P. striiformis*) rusts of wheat from infected leaves submitted to a mechanical stress. *European Journal of Plant Pathology*, *103*(9), 785-793.

Gerhard, M. Der Einfluss Strobilurinhaltiger Fungizide auf PhysiologischeAblaufe der Ertragsbildung an Winterweizensorten. Dissertation, Mu¨nchen, Germany, 2001. 13.

Hussain, M. I., González, L., Souto, C., & Reigosa, M. J. (2011). Ecophysiological responses of three native herbs to phytotoxic potential of invasive *Acacia melanoxylon* R. Br. *Agroforestry systems*, *83*(2), 149-166.

Iqbal, U., Mukhtar, T., 2020. Inhibitory effects of some fungicides against *Macrophomina phaseolina* causing charcoal rot. Pakistan Journal of Zoology 52(2), 709-715.

Iqra, L., Rashid, M. S., Ali, Q., Latif, I., & Malik, A. (2020). Evaluation of genetic variability for salt tolerance in wheat. *Biological and Clinical Sciences Research Journal*, *20*(1), 16-23.

Islam, M. S., Saito, J. A., Emdad, E. M., Ahmed, B., Islam, M. M., Halim, A., & Alam, M. (2017). Comparative genomics of two jute species and insight into fibre biogenesis. *Nature plants*, *3*(2), 1-7.

Khan, M. Z. H., Hasan, M. R., Khan, M., Aktar, S., & Fatema, K. (2017). Distribution of heavy metals in surface sediments of the Bay of Bengal Coast. *Journal of Toxicology*, *13*(2)*, 87-98*.

Milus, E. A., Kristensen, K., & Hovmøller, M. S. (2009). Evidence for increased aggressiveness in a recent widespread strain of *Puccinia striiformis* f. sp. *tritici* causing stripe rust of wheat. *Phytopathology*, *99*(1), 89-94.

Omara, R. I., Nehela, Y., Mabrouk, O. I., & Elsharkawy, M. M. (2021). The emergence of new aggressive leaf rust races with the potential to supplant the resistance of wheat cultivars. *Biology*, *10*(9), 925.

Prabhu, S. S., Runger, G. C., & Keats, J. B. (1993). X chart with adaptive sample sizes. *The International Journal of Production Research*, *31*(12), 2895-2909.

Pretorious, E. (1983). Erkenning van Vakverenigings in Suid-Afrika. *Indus. LJ*, *4*.

Rehman, A. U., Sajjad, M., Khan, S. H., & Ahmad, N. (2013). Prospects of Wheat Breeding for Durable Resistance against Brown, Yellow and Black Rust Fungi. *International journal of agriculture & biology*, *15*(6)*, 117-123*.

Rizwan, M., Ali, S., Hussain, A., Ali, Q., Shakoor, M. B., Zia-ur-Rehman, M., & Asma, M. (2017). Effect of zinc-lysine on growth, yield and cadmium uptake in wheat (*Triticum aestivum* L.) and health risk assessment. *Chemosphere*, *187*, 35-42.

Singh, R. P., Hodson, D. P., Huerta-Espino, J., Jin, Y., Njau, P., Wanyera, R., & Ward, R. W. (2008). Will stem rust destroy the world's wheat crop?. *Advances in agronomy*, *98*, 271-309.

Weinert, J.; Wolf, G. A. (1999). ErfahrungenzumAuftreten von Ahrenfusariosen und zurBeka mpfungsstrategieim Weizen schland. Dissertation, Gottingen, Germany.

Yamin, S. Y., Tariq, J. A., Memon, R. M., Bhutto, S. H. ., & Asif , M. U. . (2021). Screening of wheat genotypes against leaf rust under artificial and natural environmental condition. *Journal of Applied Research in Plant Sciences*, *2*(1), 117–122.