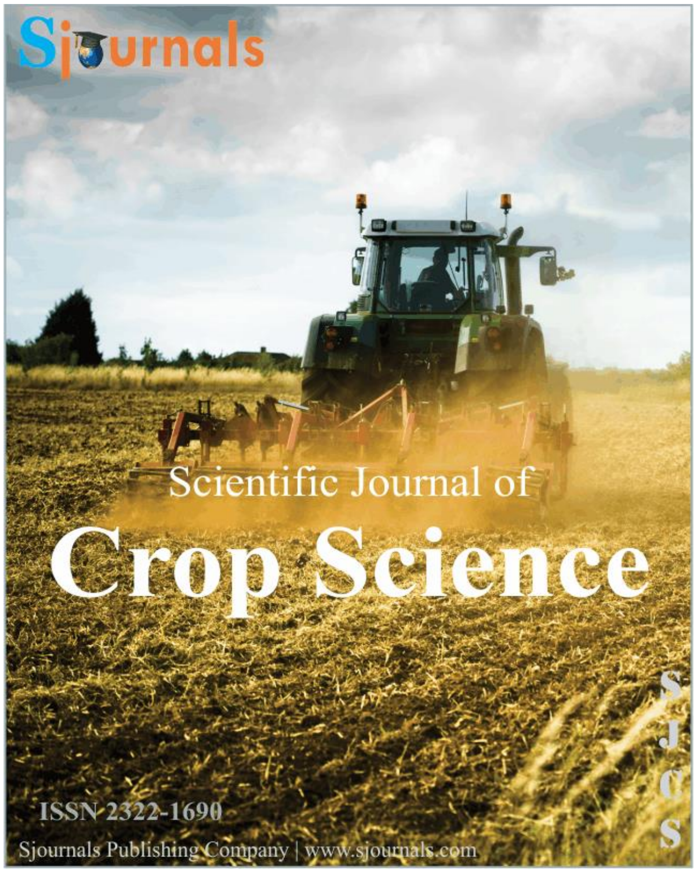
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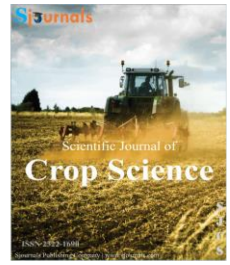

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Original article

Efficacy of foliar fungicide application for the management of wheat yellow rust (*Puccinia striiformis* f.sp. *tritici*) disease on bread wheat (*Triticum aestivum* L.) in the highlands of Bale, Southeastern Ethiopia

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ABSTRACT

Bread wheat (*Triticum aestivum* L.) is one of the most important widely cultivated cereal crops in Ethiopia. However, the production and productivity of wheat are constrained by various biotic and a biotic factors. Among these, wheat yellow rust is one of the most important fungal diseases of wheat in the country. The field experiment was conducted at three hot-spot areas (Sinana on-station, Selka, and Agarfa) during the 2019/20 cropping season to evaluate the effectiveness of foliar fungicides for the management of yellow rust disease on bread wheat. Bread wheat variety Kubsa (HAR 1685) was used for this study, which is highly susceptible to wheat rust diseases. The experiment was laid out in non-replicated plots at three hot-spot locations with two replications. Three different fungicides including the standard check (Rex®Duo) and untreated plot (control) were used as a treatment. The analysis of variance showed that fungicide treatments significantly ($P \leq 0.05$) reduced yellow rust severity compared to the untreated plot. The test fungicides provided that better efficacy in reducing yellow rust severity comparable with the standard check (Rex®Duo). Results revealed that the test and check fungicides reduced yellow rust severity by about 48% and 46%, respectively as compared to an untreated check. The application of Nexicor EC, Priaxor EC, and Rex®Duo 22, 17.8, and 26 qt ha^{-1} yield advantage over the untreated check, respectively. The highest net benefit was obtained from the application of

Rex®Duo, Nexicor EC followed by Priaxor EC fungicides as compared to the untreated plot. The application of Nexicor EC and Priaxor EC fungicides gave maximum economic profitability with an acceptable marginal rate of return to control the yellow rust of wheat. A one- times spray of Nexicor EC and Priaxor EC fungicides at the rate of 0.6 and 0.7 litre ha^{-1} are effective in reducing yellow rust of wheat if apply at early rust development.

1. Introduction

Wheat (*Triticum aestivum* L.) is the most widely grown crop in the world. It provides 21% of the food calories and 20% of the protein to the tune of more than 4.5 billion people across 94 developing countries (Braithwaite et al., 1998). Wheat ranks fourth next to rice, maize, and sorghum in the world. Wheat is one of the most important widely cultivated cereal crops in Ethiopia. It is the main staple food for about 36% of the Ethiopian population (CSA, 2004; CIMMYT, 1988). Wheat ranks fourth in area coverage and total production after maize and tef (CSA, 2019). Ethiopia is the largest wheat-producing in Sub-Saharan Africa with more than 1.7 million hectares and more than 4.8 million households relying on rain-fed wheat (CSA, 2019). Wheat cultivation accounts for 13.91% and 15.86% in terms of area coverage and production compared to the total cultivated area and production of cereals (CSA, 2019). Bale and Arsi zones are one of the major wheat-producing areas in Ethiopia and they are recognized as one of the wheat belts in eastern Africa. The national average yield of wheat in the country is very low(2.9 t ha^{-1}) (CSA, 2019), which is far below the world's average yield (3.47 t ha^{-1}) (FAO, IFAD, UNICEF, WFP, WHO, 2018; USDA, 2018). The low productivity is mainly due to crop diseases globally. Among all wheat diseases, fungal rusts (stem, stripe, and leaf rust) are the most important (Saari and Prescott, 1985). Wheat rusts pose one of the key biotic constraints to production in Ethiopia (Bekele, 1986). Recurrent wheat stem and stripe rust epidemics have reduced wheat yield in Ethiopia. In 2010, a major stripe rust epidemic occurred, affecting approximately 600,000 hectares (Singh, 2015). The highlands of Ethiopia have long been known as hot spots for wheat rusts (Saari and Prescott, 1985). Conducive climatic conditions plus near-continual wheat production are key factors. In the core wheat-growing areas of Bale and Arsi, bimodal rainfall patterns permit two wheat seasons per year. This results in a green bridge allowing the disease to bulk up locally transferring inoculums from one wheat season to the next and therefore increasing the occurrence of rust epidemics (Zadoks and Bouwman, 1985; Bekele, 2003). Yield loss of up to 71% was recorded in bread wheat due to yellow rust in Bale highlands (Bekele, 2003; Dereje, 2003). However, in severe cases, stripe rust can cause 100% yield losses if infection occurs very early and the disease continues developing during the growing season, particularly on a highly susceptible wheat line (Chen, 2005). Efforts made so far towards resistant variety development to major wheat diseases were successful. However, most of them succumb to either yellow rust or stem rust soon after their release due to either the introduction of exotic races or the evolvement of new local races and changes in environmental factors (Wubishet and Tamene, 2016). To combat these fungal diseases screening programs become routine work in Ethiopia due to rust pathogens, evolution, and challenges from new races evolved resistance. The development of host genetic resistance is considered the most effective and low-cost management strategy for rust diseases, particularly in developing countries (Ellis et al., 2014). However, in the absence of effective resistance, fungicides are used to control the spread of rust disease. Fungicide use in Ethiopia is low compared with the intensive agriculture system in Western Europe (Singh et al., 2016). However, increases in on-farm wheat yield the availability of more affordable fungicides and increasing farmer awareness of wheat rusts are contributing to the increasing use of fungicide in Ethiopia. Hence, the objective of this study was to evaluate the effectiveness of foliar fungicides for the management of yellow rust disease on bread wheat.

2. Materials and methods

2.1. Description of the study areas

The experiment was conducted at three locations (Sinana on-station, Selka, and Agarfa) in the highlands of Bale during the 2019/20 cropping season. The locations were purposively selected based on hot-spot for wheat rust epidemics. Sinana Agricultural Research Center (SARC) is located in the highlands of Bale Southeastern Ethiopia. It is located at 07° 07' N latitude and 40° 10'E longitude at 2400 meters above sea level. SARC is characterized by bi-modal rainfall patterns forming two wheat-growing seasons in a year. The two seasons are locally named after the time of crop harvest. The short rainy season locally called '*Ganna*', extends from March to July. Whereas the main season locally called '*Bonaa*', extends from August to December. The Selka has located 33km from SARC in the Southwest direction. Agarfa has located 63km from SARC and 30km from Robe in the Northeast direction.

2.2. Treatments and experimental design

The experiment was laid out in non-replicated plots at hot-spot locations, where locations were considered as the replica. Bread wheat variety Kubsa (HAR 1685) which is highly susceptible to yellow rust (*Puccinia striiformis* f.sp. *tritici*) disease was used. The plots were 5m x 5m in size, spaced 2 m apart, and 1.5 m between plots. Recommended seed rate of 150 kg ha^{-1} and fertilizer rate of N/P_2O_5 41/46 kg ha^{-1} for wheat was used. Land preparation and weeding were done manually as recommended for wheat. Fungicide treatments, Nexicor EC (Fluxapyroxad 30 gm/L + Pyraclostrobin 200gm/L + Propiconazole 125 gm/L) and Priaxor EC (Fluxapyroxad 75 gm/L + Pyraclostrobin 150 gm/L) obtained from BASF TRO Chemical Company was sprayed with rates of 0.6 and 0.7 litre ha^{-1}, respectively. Widely used fungicide Rex®Duo (Epoxiconazole 187 g/L + Thiophanate-methyl 310 g/L SC) was included as a standard check along with an untreated check (control) for comparison. The detailed descriptions of the fungicides used are presented in Table 1. Fungicide treatments were applied at a 5% severity level of yellow rust. All the fungicide treatments were applied manually using a knapsack sprayer delivering 250 liters of water ha^{-1}.

Table 1
Detailed description of fungicides used in the study.

Fungicide (Trade name)	Active ingredient	Product formulation	Mode of action	Rate lit/ha
Nexicor EC	Fluxapyroxad+Pyraclostrobin+Propiconazole	Emulsifiable concentrate	Systemic	0.6
Priaxor EC	Fluxapyroxad+Pyraclostrobin	Emulsifiable concentrate	Systemic	0.7
Rex®Duo	Epoxiconazole+Thiophanate-methyl	Soluble concentrate	Systemic	0.5

2.3. Disease assessment

Wheat yellow rust (*Puccinia striiformis*) severity was assessed in percentage by estimating the approximate percentage of the whole plant affected by using a modified Cobb scale (Peterson et al., 1948) on a plot basis.

2.4. Yield and yield components

Data on the yield components were recorded on basis of crops harvested from 5m x 5m harvestable plot area and converted to hectare base. The average height of ten random plants from each plot was measured from the ground level including the ear at maturity in cm. After harvesting, the grain yield was adjusted to a moisture content of 12.5% and the weight of thousand kernel weight was measured in (g).

2.5. Fungicide efficacy

The fungicide efficacy (EF) was calculated using Abbott's formula (1925) as the following:

$EF (\%) = \frac{X-Y}{X} \times 100$ Where,

X – Disease severity in control
Y – Disease severity in treated plots

2.6. Partial budget analysis

Based on the pooled data obtained from the three locations, partial budget analysis was applied following the procedure developed by International Maize and Wheat Improvement Center (CIMMYT, 1988). A partial budget analysis was done based on the cost of current fungicides, labor, and the market price of wheat grain. Gross benefit, the total variable cost, net benefit (NB), and marginal rate of return (MRR) are some of the attributes used in the partial budget analysis. Gross benefit was incurred as the products of market price and grain yield of wheat. Total variable cost bears on the sum of all variable costs of inputs (like fungicides, knapsack sprayer, and labor (spraying and weeding), whereas the NB is the difference between the gross benefit and the total variable costs. The MRR was obtained through the ratio of the difference in NB and total input costs.

2.7. Data analysis

Data on disease and yield parameters were subjected to analysis of variance (ANOVA) by using R software. Means comparisons for the significantly different variables were made among the treatments using the least significant differences (LSD) test at 0.05 levels of significance.

3. Results and discussion

3.1. Epidemic onset and severity level

The onset of wheat yellow rust (*Puccinia striirfomis*) disease was early in the crop growing season at three locations (Sinana on-station, Selka, and Agarfa) resulting in a severe infection of 60% in the untreated plot (Table 2). The study conducted by Braun et al. (2010) indicates that the time of stripe rust onset is the most critical factor in defining the time of fungicide application rather than the phonological stage.

3.2. Effect of fungicides on wheat yellow rust severity

The fungicide treatments (Nexicor EC, Priaxor EC, and the check fungicide Rex®Duo) significantly ($P \le 0.05$) reduced yellow rust severity compared to the untreated check (Table 2). This work is in line with the findings of (Goel et al., 1975; Woods et al., 1983) reported that propiconazole effectively reduced the stripe rust when applied as a foliar spray. Similarly, Basandrai et al. (2020) also reported that all the treatments showed significantly less mean disease severity as compared with no spray check. Fungicide applications at the early stages of stripe rust are much more effective and can stop subsequent re-infections (Burkow et al., 2014). There was no significant difference observed among fungicide treatments in reducing yellow rust severity at three locations. The test fungicides provided that better efficacy in controlling yellow rust severity as compared to the standard check (Rex®Duo). The test and check fungicides reduced yellow rust severity by about 48% and 46%, respectively as compared to an untreated check. The test and check fungicides revealed that 80% and 76.7% efficacy in controlling yellow rust, respectively (Table 2). This work is in line with the findings of (Basandrai et al., 2013) reported that propiconazole was effective against powdery mildew, leaf rust, and yellow rust. reported that a one-time spray of Rex®Duo reduced yellow rust severity by 33% on susceptible variety Kubsa (Alemu et al., 2019).

3.3. Effect of fungicides on wheat crops growth

There was no phytotoxic effect observed on wheat crop growth during the growing season due to the application of test fungicides to control yellow rust epidemics.

3.4. Effect of fungicide on plant height

The statistical analysis revealed that there was no significant difference between the fungicide treatments and untreated check in plant height (Table 2).

3.5. Effect of fungicides on grain yield

The analysis of variance revealed that there was a significant *($P \le 0.05$)* difference observed between fungicide treatments and untreated plots in grain yield (Table 2). There was no statistically significant difference observed between test and check fungicides in grain yield relatively higher grain yield was obtained from Rex Duo sprayed plot, but the difference is insignificant to differentiate the effect of the chemicals. The test fungicides (Nexicor EC and Priaxor EC) revealed that 2200 kg ha^{-1} (22 qt ha^{-1}) and 1780 kg ha^{-1} (17.8 qt ha^{-1}) and the check (Rex Duo) showed 2600 kg ha^{-1} (26 qt ha^{-1}) yield advantage over the untreated check, respectively (Table 2). This work is in line with the findings of (Sharma Ram et al., 2016) reported that an average grain yield increase of 44 & 48% with a single or two fungicide applications. Also, Ahanger et al. (2014) reported an average yield increase of 44 & 29.8% in stripe rust susceptible and resistant wheat varieties. Similarly, the work done by Singh et al. (2016), also reported a 44.29% yield increment of grain yield when treated with fungicide as compared to the untreated plot. The study conducted by Basandrai et al. (2020) also indicated that mean grain yield increased ranges from 6.72-14.58 q/ha over the unsprayed check.

3.6. Effect of fungicides on thousand kernel weight

There was a significant difference between fungicide treatments and untreated plots in thousand kernel weight (Table 2). However, there was a non-significant difference observed among the fungicide treatments in thousand kernel weight. This work is in agreement with Wubishet and Tamene (2016) reported that a non-significant difference observed among fungicide treatments in thousand kernel weight of wheat infected by rust disease. The plots sprayed by fungicide treatments increased thousand kernel weight ranges from 10.4 -15.2% over the unsprayed plot. This work is in agreement with (Xi et al., 2015; Reid and Swart, 2004) reported that the application of fungicides increased thousand kernel weight ranges from 8-10%.

Table 2

Combined mean effect of different foliar fungicide application on wheat yellow rust severity, yield, and yield-related traits at Sinana, Selka, and Agarfa during 2019/20 cropping season.

Treatment	Rate (l/ha)	Yellow rust Severity (%)	PH (cm)	Grain yield (kg/ha)	TKW (gm)
Priaxor EC	0.7	12.00[b]	86.5[a]	2980[a]	33.9[a]
Nexicor EC	0.6	12.00[b]	84.00[a]	3400[a]	37.9[a]
Rex Duo (standard)	0.5	14.00[b]	82.5[a]	3800[a]	38.7[a]
Untreated (Control)	-	60.00[a]	73.5[a]	1200[b]	23.5[b]
Mean		18.5	82.64	3057.14	35.08
CV (%)		21.28	6.91	15.35	8.20
LSD (0.05)		9.63	13.97	1148.3	7.04

PH= Plant Height, TKW = Thousand Kernel Weight, HLW = Hectoliter Weight, LSD = Least significant difference among treatment means (P≤ 0.05), CV = Coefficient of variation, Means with the same letter within a column are not significantly different.

3.7. Partial budget analysis

Partial budget analysis revealed that there was a significant variation observed among the tested fungicides in net benefit (NB) and marginal rate of return (MRR). The combined mean of the three locations showed that the highest net benefit recorded on plots sprayed by Rex®Duo (58,630.84 birrs/ha) followed by Nexicor EC (52,459.17 birrs/ha) and Priaxor EC (45, 979.1 birrs/ha) fungicides whereas the lowest net benefit obtained from the unsprayed plot (18,515 birrs/ha) (Table 3). Results revealed that the application of Nexicor EC and Priaxor EC fungicides gave a high profitable yield response with a positive MRR of 4,802.54 and 2,873.11, respectively (Table 3). Hence, the application of Nexicor EC and Priaxor EC is recommended as the best with the combination of resistant variety and also acceptable return to control wheat yellow rust in the highlands of Bale and similar agro-ecologies.

Table 3

Partial budget analysis of different foliar fungicide applications to control wheat yellow rust at Sinana, Selka, and Agarfa districts during 2019/20 cropping season.

Treatment	Total cost	Marginal cost	Net benefit	Marginal benefit	MRR
Untreated (control)	0	0	18,515	0	0
Priaxor EC	955.9	955.9	45,979.1	27,464.1	2,873.11
Nexicor EC	1090.83	134.93	52,459.17	6,480.07	4,802.54
Rex®Duo	1219.16	128.33	58,630.84	6,171.67	4,809.201

MRR=Marginal Rate of Return

4. Conclusion

The test fungicides (Nexicor EC and Priaxor EC) statistically did not differ from the standard check fungicide (Rex Duo) in controlling yellow rust disease of wheat and also provided comparable in grain yield and thousand kernel weight with check fungicide. Moreover, Nexicor EC and Priaxor EC fungicides significantly reduced yellow rust disease severity to the lowest level and also showed grain yield advantage better than the untreated check but comparable for the check fungicide (Rex Duo). Nexicor EC and Priaxor EC fungicides are found to be effective in controlling yellow rust disease of wheat with a rate of 0.6 and 0.7 lit/ha, respectively. Thus, Nexicor EC and Priaxor EC fungicides are recommended as alternative fungicides for the management of yellow rust of wheat.

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References

Abbott, W.S., 1925. A method of computing the effectiveness of an insecticide. J. Econ. Entomol., 18(2), 265-267.

Ahanger, R.A., Gupta, V.I.S.H.A.L., Bhat, H.A., Dar, N.A., 2014. Management of yellow rust (Puccinia striiformis West) of wheat and its impact on yield under Jammu sub-tropics of India. Bioscan., 9(1), 215-218.

Alemu, A., Alemayehu, C., Elfinesh, S., 2019. Effect of varieties, fungicides, and application frequencies to wheat yellow rust disease (*Puccinia striiformis* f. sp. *tritici*) management in Arsi Highlands of Ethiopia. Am. J. BioSci., 7(6), 113-122.

Basandrai, A.K., Mehta, A., Rathee, V.K., Basandrai, D., Sharma, B.K., 2020. Efficacy of fungicides in managing yellow rust of wheat. J. Cereal Res., 12(2), 103-108.

Basandrai, A.K., Sharma, B.K., Basandrai, D., 2013. Efficacy of triazole fungicides for the integrated management of yellow rust, leaf rust, and powdery mildew of wheat. Plant Dis. Res., 28, 135-139.

Bekele, E., 1986. Review of research on diseases of barley, tef, and wheat in Ethiopia. A review of crop protection research in Ethiopia proceeding. First Crop Protection Symp. (Addis Ababa, Ethiopia: IAR). 79-108p.

Bekele, H., 2003. A short report on stripe rust and stem rust Proc. Agronomy Workshop.ed GBedada (Addis Ababa, Ethiopia: Bale Agricultural Development Enterprise), BADE 2003. 67-78p.

Braithwaite, M., Cromey, M.G., Saville, D.J., Cookson, T., 1998. Effects of fungicide rates timing on control of stripe rust in wheat Arable crops. in Proc. 51st. N.Z. Plant Protection Conf, 66-70. https://www.researchgate.net/publication/266356024.

Braun, H.J., Atlin, G., Payne, T., 2010. Multi-location testing as a tool to identify plant response to global climate change. In: C.R.P. Reynolds (ed.), Climate change and crop production, CABI, London, UK.

Burkow, J., Singh, A., Valle, V., Velazquez, J., Padilla, D., Renova, J., Arriola, L., Bichara, D., 2014. A model for stripe rust growth with two fungicidal effects.

Chen, X.M., 2005. Epidemiology and control of stripe rust [Puccinia striiformis f. sp. tritici] on wheat. Can. J. Plant Pathol., 27(3), 314-337.

CIMMYT (International Center for Maize and Wheat Improvement), 2005. Sounding the alarm on global stem rust: An assessment of race Ug99 in Kenya and Ethiopia and the potential for impact in neighboring regions and beyond. Expert Panel Report. International Center for Maize and Wheat Improvement (CIMMYT), Mexico. 26p.

CIMMYT, 1988. From agronomic data to farmer recommendations: Economics training manual completely revised. Mexico, D.F.

CSA (Central Statistic Authority), 2019. Report on area and production of major crops by private peasant holdings in 2019/20 Meher cropping season. Statistical Bulletin. CSA, Addis Ababa, Ethiopia.

CSA (Central Statistical Authority), 2004. Agricultural survey sample. Report on area and production of crops (private peasant holdings, *meher* season). Statistical Bulletin No 33. Addis Ababa, Ethiopia.

Dereje, H., 2003. Effect of stripe rust (*Puccinia striiformis*) on yield and yield components and quality of improved bread wheat (*Triticum aestivum*) varieties. MSc Thesis. Alemaya University. 99p.

Ellis, J.G., Lagudah, E., Spielmeyer, W., Dodds, P., 2014. The past, present, and future of breeding rust-resistant wheat. Front Plant Sci., 5, 1-13.

FAO, IFAD, UNICEF, WFP, WHO, 2018. The state of food security and nutrition in the world 2018. (Building climate resilience for food security and nutrition) (202p). FAO. License: CC BY-NC-SA 3.0 IGO. ISBN 978-92-5-130571-3. https://creativecommons.org/ licenses/by-NC-sa/3.0/igo.

Goel, L.B., Singh, D.V., Srivastava, K.D., Joshi, L.M., 1975. Effectiveness of some new systemic fungicides against the yellow rust of wheat under glasshouse conditions. Indian J. Farm Sci., 3, 86-88.

Peterson, R.F., Campbell, A.B., Hannah, A.E., 1948. A diagrammatic scale for estimating rust intensity of leaves and stem of cereals. Can. J. Res. Sect. C., 26, 496-500.

Reid, D., Swart, J., 2004. Evaluation of foliar fungicides for the control of stripe rust (Puccinia striiformis) in SRWW in the Northern Texas Backlands. Department of Agricultural Sciences, Texas A & M University-Commerce.

Saari, E.E., Prescott, J.M., 1985. World distribution with economic losses. The Cereal Rusts. Diseases, Distribution, Epidemiology and Control ed AP Roelfs and WR Bushnell (Orlando: Academic). 2, 259-298.

Sharma Ram, C., Kumarse, N., Amir, A., Zafar, Z., Jalilov, U., 2016. Reduction of winter wheat yield losses caused by stripe rust through fungicide management. J. Phytopathol., 164, 671-677.

Singh, R.P., 2015. Emergence and spread of new races of wheat stem rust fungus: a continued threat to food security and prospects of genetic control. Phytopathol., 105(7), 872-884.

Singh, V.K., Mathuria, R.C., Gogoi, R., Agarwal, R., 2016. Impact of different fungicides and bioagents, and fungicidal spray timing on wheat stripe rust development and grain yield. Indian Phytopathol., 69, 357-362.

USDA (United State Department of Agriculture), 2018. Foreign agricultural service: World agricultural production global analysis (World agricultural supply and demand report). 31. Circular series WAP 11-18, DC 20250-1051. Foreign Agricultural Service/USDA.

Woods, S., Chen, K.C., Gaunt, R.E., 1983. Chemical control of leaf blotch and stripe rust in Kopara wheat. Proceedings of the 36th Weed and Pest Control Conference 233-36p, Palmerston North, New Zealand.

Wubishet, A., Chemeda, F., 2016. Effects of environment on wheat varieties' yellow rust resistance, yield and yield related traits in south-eastern Ethiopia. SciencePG. Plant, 4(3), 14-22.

Wubishet, A., Tamene, M., 2016. Verification and evaluation of fungicides efficacy against wheat rust diseases on bread wheat (Triticum aestivum L.) in the Highlands of Bale, Southeastern Ethiopia. Int. J. Res. Stud. Agr. Sci., 2(9), 35-40.

Xi, K., Kumar, K., Holtz, M.D., Turkington, T.K., Chapman, B., 2015. Understanding the development and management of stripe rust in central Alberta. Can. J. Plant Pathol., 37, 21-39.

Zadoks, J.C., Bouwman, J.J., 1985. Epidemiology in Europe. The Cereal Rusts: Disease, Distribution, Epidemiology and Control ed A P Roelfs andWR Bushnell (Orlando, FL: Academic), 2, 329-369.

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