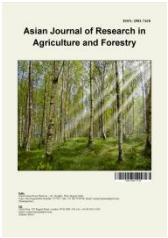

Asian Journal of Research in Agriculture and Forestry

Volume 10, Issue 4, Page 482-488, 2024; Article no.AJRAF.127144
ISSN: 2581-7418

Evaluation of Fungicides Efficacy for the Control of Yellow Rust *(Puccinia striiformis f.s.tritici)* Disease on Bread Wheat, Arsi Highlands of Ethiopia

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Authors' contributions

This work was carried out in collaboration between both authors. Author AAZ organized and compiled the data, conducted the analysis, wrote the paper, and reviewed and edited the manuscript. Author GMA managed the fieldwork, scored and organized the data, and contributed to editing and reviewing the manuscript. Both authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/ajraf/2024/v10i4350

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/127144

Original Research Article

Received: 23/09/2024
Accepted: 25/11/2024
Published: 13/12/2024

ABSTRACT

Two new verification test fungicides namely Cayunis EC 325 (Bixafen 75g/L +Spiroxamine 150g/L + Trifloxystrobin 100g/L), and Tridium 70 WG (Mancozeb59.7%+Azoxystrobin 4.7%+Tebuconazole 5.6%WG and evaluated with standard checks called Nativo SC 300(trifloxystrobin 100 gm/lt + tebuconazol 200 gm/lt) were evaluated the efficacies in controlling the yellow (stripe) rust. The objective of the study was to evaluate and verify the efficacy of new fungicides against yellow rust

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Cite as: *Zerihun, Alemu Ayele, and Getnet Muche Abebele. 2024. "Evaluation of Fungicides Efficacy for the Control of Yellow Rust (Puccinia Striiformis f.s.Tritici) Disease on Bread Wheat, Arsi Highlands of Ethiopia". Asian Journal of Research in Agriculture and Forestry 10 (4):482-88. https://doi.org/10.9734/ajraf/2024/v10i4350.*

disease control and recommend for registration. The trial was conducted in non-replicated with replication of sites at Meraro substation and Kulumsa agricultural research center, and Boru Chilalo farmers' field. The test fungicides of Cayunis 325 EC and Tridium 70WG had decreased the disease severity to the lowest level of 20% at all locations but 60% to 90% disease severity was recoded on the unsprayed treatment. The highest grain yield was recorded from cayunis 325 EC treatment was recorded 5861, 6428, 5398kgha^{-1} whereas Tridium 70 WG was recorded 2878, 6035 and 3224kgha-1at Kulumsa, Meraro and Boru chilalo respectively. Although the differences of test fungicides were not statistically significant, treated plots consistently produced higher yields, thousand kernel weights, and hectolitre weights than untreated plots. The result revealed that Bixafen 75g/L +Spiroxamine 150g/L + Trifloxystrobin 100g/L), and Mancozeb59.7%+Azoxystrobin 4.7%+Tebuconazole 5.6%WG fungicides were effective in controlling yellow rust disease and improving high grain yield than trifloxystrobin 100 gm/lt + tebuconazol 200 gm/lt and unsprayed control treatments in all tested experimental sites and recommended for registration

Keywords: Fungicide efficacy; yellow rust; disease severity; grain yield.

1. INTRODUCTION

Yellow rust (*Puccinia striiformisf.sp. tritici*) is one of the most important fungal diseases of wheat and the major production bottleneck in the major wheat growing regions of Ethiopia [1]. It is a serious wheat production problem at early growth stages and continue to develop during the developmental stage of the crop in highly prevalent cool and wet weather conditions in all continents where wheat is grown [2]. Currently, wheat yellow rust is the most economically important fungal disease caused with 100% yield loss in susceptible varieties and quality degradation particularly in susceptible cultivars [3,4]. Newly, recurrent aggressive Pst races are adapted to higher temperature climate and have spread to wheat producing areas of the world that were perversely less affected by wheat stripe rust disease [5].

In Ethiopia, the rapid emergence of virulent pathotypes of Pst 11, 16 and 17 have overcome most of recently released cultivars which are best resistant previous manner and known yellow rust resistant differential lines. The countries wheat belt areas of Arsi and Bale highlands are the known hotspots for the epidemics of wheat stripe rust disease [6]. Even though there is seasonal variability in the occurrence of stripe rust in Arsi and Bale highlands that the main and long rainy season is ideal for stripe rust development [7].

When yellow rust infection occurs very early in the crop development stage and the disease continues to develop during the growing season that can cause yield losses up to 96.7 to 100% on susceptible cultivars. In Ethiopia, grain yield losses of 22.9 to 39.7 %, 48.7 to 56.5 %, 43.3 to 57.5%, 48.7 to 56.5 % and 91.5 to 96.7% was recorded grain yield losses on resistant, moderately resistant, moderately susceptible and susceptible varieties respectively with shrivelled and reduced germination ability and kernel weight by 65.7 and 15.4% respectively [4].

Application of fungicides is the main strategy to control wheat rusts in Western Europe although efforts are in progress to reduce reliance on these compounds. Fungicides can be an important control option when rust epidemics are severe, however, their use results in significantly increased production costs for the farmers [8]. In developed countries of Europe, Australia and the Americas, fungicides, at times used on a large scale as a key part of the national food security strategy [9]. In Canada, use of fungicides for disease management is employed by farmers [10].

Foliar fungicides have been widely used to control stripe rust which prevented multimillion dollar losses and significantly reducing crop loss. Cooper and Dobson [11] testified, proper and frequent application of fungicides upon the disease onset gives benefits in the effort to increase crop productivity and quality of the grain. Hailu and Fininsa [12] also reported a relatively better yield for sprayed plots as compared to unsprayed plots under experimental condition and the spray interval is reported to be a significant factor in the disease severity and rate of epidemic development.

In Ethiopia, Ayele et al. [4] reported grain yield increment on susceptible varieties had increased 823.8 to 1863% and 1086.8 to 2883% with proper application of Tilt and Rex® Duo sprayed fungicides which improves yield increment and disease control respectively. So, the objective of the present study was to evaluate the efficacy of Cayunis 325 EC (Bixafen 75g/L +Spiroxamine

150g/L + Trifloxystrobin 100g/L), and Tridium 70 WG (Mancozeb59.7% +Azoxystrobin 4.7%+ Tebuconazole 5.6%WG fungicides against yellow rust disease control and recommend for registration.

2. MATERIALS AND METHODS

2.1 Description of Experimental Site

The trial was implemented at kulumsa agricultural research center sub-stations of Bekoji which is located at 7º 32' 27" North (N), 39º, 15', 21" East (E) with altitude range of 2780 meters above sea level while Meraro is located 7º 24' 27" North, 39º, 14', 56" East (E) with altitude range of 2990 meters above sea level. Monthly maximum and minimum temperature of the Meraro and Bekoji experimental sites have received 5.7 and 18.1℃, and 7.9 and 18.6℃ with annual rainfall of 1196 and 102 millimetres respectively. Both locations represent best screening and hotspot areas to yellow rust and characterized in receiving extended rainfall and bimodal cropping systems for major wheat production potential agro ecologies.

Cayunis EC 325 (Bixafen 75g/L +Spiroxamine 150g/L + Trifloxystrobin 100g/L) and Tridium (Mancozeb 59.7%+Azoxystrobin 4.7%+ Tebuconazole 5.6%WG) were verified with 0.9lit/ha and 2kg/ha recommended rate and standard checks Nativo 300SC (trifloxystrobin 100 gm/lt + tebuconazol 200 gm/lt and Rex® Duo (187g/lEpoxiconazole + 310g/l Thiophanate-methyl) with 0.75 lit/ha and 0.5 lit/ha with 250lit/ha water using knapsack spray as sole or integrated disease management options on wheat respectively (Table 1).

2.2 Experimental Design and Management

The experiment was laid out in simple non replicated plot design at three experimental sites. The plot size used was 10m x 10m consisting of 50 rows. All other agronomic practices, such as weeding, fertilizer application and cultivation were implemented as per recommendation for bread wheat production.

2.3 Disease Assessment

Wheat yellow rust incidence and severity was assessed on weekly basis by counting the number of plants visibly diseased (for incidence), and by estimating the percentage of leaf area affected (for severity) from the plot based plants. The disease severity was scored two times before and after treatments application at three sites at fourteen days interval, starting of 20% disease severity by modified cob scale [13,14].

Disease incidence was assessed when symptoms appear for the first time and calculated with the following formula;

> Disease incidence = No. of infected plants from the samples taken/total No. of plants assessed (100)

3. RESULTS AND DISCUSSION

3.1 Disease Severity

Fungicide application of new test treatments and standard check significantly reduced yellow rust disease severity over the nil application. Under natural epidemics and without artificial inoculation of the pathogen on check treatment, the terminal yellow rust severities of about 90%, 70% and 60% for Cayunis 325 EC treatments and 80%, 60% and 50% with susceptible type of disease reaction for Tridium 70WG tested treatments were recorded on unsprayed plots at Meraro, Kulumsa and Boru Chilalo respectively (Table 2).

The terminal yellow rust severity after once spray of Nativo was recorded by 20s, 20s and 20s at Meraro, Kulumsa and Boru Chilalo while Cayuins 323EC was scored respectively. However, the terminal yellow rust severity at Meraro, Kulumsa and Boru Chilalo recorded uniform 20% was recorded on Cayunis EC 325 fungicide sprayed plots (Table 1). The highest disease severity (90 and 70%) was recorded in unsprayed plots at Meraro and Kulumsa on the unsprayed check plots and the lowest yellow rust disease severity 20mr were recorded on Cayunis EC 325 and Nativo sprayed plots at Kulumsa, Boru Chilalo and Meraro sprayed plots on respectively.

Among the foliar applications fungicides, Tridium 70WG, Cayunis EC 325 and Nativo 300SC were found most effective against rust and it gave the highest disease control over the untreated control (Table 2).

Conversely, there were no statically significant differences between the tests and standard check fungicides in reducing yellow rust disease severity (Table 1). However, from visual field observation the test fungicides, Tridium 70WG and Cayunis EC 325 showed comparable level of

efficacy in controlling yellow rust disease with the standard check, Nativo and Rex® Duo. Therefore, Cayunis EC 325 and Tridium 70WG can be recommended for the control of wheat yellow rust disease (Table 2).

3.2 Grain Yield and Yield Components

At Kulumsa grain yield were 6031 kgha^{-1}, 5861 kgha-1 and, 1861 kgha^{-1} on Nativo, Cayunis EC 325 and unsprayed check plots respectively (Table 3). At Boru chilalo Grain yield were recorded 5822 kgha^{-1}, 5398 kgha^{-1} and, 4013 kgha^{-1} on Nativo, Cayunis EC 325 sprayed and unsprayed check plots, whereas at Meraro grain yield were not harvested due to favourable environment to the yellow rust in the cropping season and spike of the treatments was infected on Nativo, Cayunis EC 325 and unsprayed check plots due to high yellow rust pressure and long moisture duration that needs additional fungicide application to reduce late coming rust appearance.

At Kulumsa thousand seed weight was 35.32g 34.3g and, 31.37g on Nativo, Cayunis EC 325 and unsprayed check plots whereas at Boru chilalo Grain yield were recorded 36.28 g, 36.06 g and, 34.56 g on Nativo, Cayunis EC 325 sprayed and unsprayed check plots respectively (Table 2).

At Kulumsa hectolitre weight was 42, 39 and 33 kghl^{-1} on Nativo, Cayunis EC 325 and unsprayed check plots and at Boru chilalo hectolitre weight was recorded 52, 50 and, 42 kghl^{-1} on Nativo, Cayunis EC 325 sprayed and unsprayed check plots respectively whereas at Meraro hectolitre weight were not recorded on Nativo, Cayunis EC 325 and unsprayed check plots that shrivelling of wheat kernels and reduced flour yield which indicated that stripe rust affected grains resulted in lower dough strength which could affect baking quality. The statistical analysis showed that there was no significant difference between the test fungicides and the standard check fungicide in grain yield, thousand kernel weight and hectoliter weight (Table 3). Even though there was numerical significant difference in grain yield, thousand kernel weight and hectoliter weight between test fungicide Cayunis EC 325 and Nativo, relatively higher grain yield, thousand kernel weight and hectoliter weight was obtained from Cayunis EC 325 and Nativo sprayed treatments but the difference is insignificant to differentiate the effect of the test fungicide and standard check. Test and standard check fungicides revealed numerically significant yield advantage over unsprayed plot.

In 2020 main cropping season yellow (stripe) rust disease pressure was very high and excellent disease epidemics developed to the level of creating significant difference among treatments across all test locations in Arsi zone. Fungicide spray treatments (test and standard check fungicide) significantly reduced yellow rust diseases severity over the nil application. Under natural epidemics (no spray) on check treatment, the terminal yellow rust severities of about 90%, 60% and 50% was recorded on unsprayed plots at Meraro, Kulumsa and Boru Chilalo respectively.

The terminal yellow rust severity after once spray of Rex® Duo was recorded by 20%, 10% and 15% at Meraro, Kulumsa and Boru Chilalo respectively whereas, the terminal yellow rust severity at Meraro, Kulumsa and Boru Chilalo recorded 20%, 10% and 15% was recorded on Tridium fungicide sprayed plots respectively (Table 2).

The highest disease severity (90 and 60%) was recorded in unsprayed plots at Meraro and Kulumsa on the unsprayed check plots and the

Table 1. Common name, trade name, formulation and manufacturers of fungicides against yellow rust in wheat, 2021

Common Name	(Commercial Name)	(Active Compounds)	Recommended Dose
Bixafen+ Spiroxamine+Trifloxystrobin	Cayunis 325 EC	Bixafen 75g/L +Spiroxamine 150g/L + Trifloxystrobin 100g/L	0.9lit/ha
Mancozeb+Azoxystrobin+Tebuconazole	Tridium 70 WG	Mancozeb59.7%+Azoxystrobin 4.7%+Tebuconazole 5.6%WG	2kg/ha
trifloxystrobin+ tebuconazol	Nativo	trifloxystrobin 100 gm/lt + tebuconazol 200 gm/lt	0.75lit/ha
Epoxiconazole + Thiophanate-methyl	Rex® Duo	187g/lEpoxiconazole + 310g/l Thiophanate-methyl	0.5lit/ha
Nil	-	-	-

Source: Ministry of Agriculture in Ethiopia, 2022

Table 2. Effect of fungicides on yellow rust disease severity of bread wheat

Treatmemnts	Meraro		Kulumsa		Boru Chilalo	
	Before spraying	After spraying	Before spraying	After spraying	Before spraying	After spraying
Nativo	20s	20mr	25s	20mr	20s	20mr
Cayunis	20s	20mr	25s	20mr	20s	20mr
Untreated	20s	90s	25s	70s	20s	60s
Tridium	20s	20mr	10s	10mr	15s	15mr
Rex® Duo	20s	20mr	10s	10mr	15s	15mr
Untreated	20s	80s	10s	60s	15s	50s

Table 3. Effect of fungicides application on grain yield, tkw, hlw of bread wheat

Treatments	Grain yield (kgha^{-1})			HLW (kghl^{-1})			TKW (gram)		
	KU	MR	BC	KU	MR	BC	KU	MR	BC
Nativo 300 SC	6031	5983	5822	35.32	34.9	36.3	42	41	52
Cayunis 325 EC	5861	6428	5398	34.3	35.2	36.1	39	45	50
Untreated	1861	50	4013	31.37	15.3	33	34.6	11	42

Table 4. Effect of fungicides application on grain yield, TKW, HLW of bread wheat

Treatments	Grain yield (kgha^{-1})			HLW (kghl^{-1})			TKW (gram)		
	KU	MR	BC	KU	MR	BC	KU	MR	BC
Tridium 7WG	2832	5795	3221	35.10	36.8	35.8	26.5	24.5	25.7
Rex® Duo	2878	6035	3224	36.08	35.1	36.5	28.6	30	26.6
Untreated	1550	907	1986	34.08	20	35.9	12.9	12.5	22

lowest yellow rust disease severity 10% and 15% were recorded on Tridium and Rexiduo sprayed plots at Kulumsa and Boru Chilalo respectively as well as 20% at Meraro which the Rexiduo and Tridium sprayed plots. Among the fungicides foliar spray application of Rex® Duo and Tridium were found most effective against rust and it gave the highest disease control over the untreated control (Table 4).

However, there was no numerically significant difference between the test and standard check fungicide in reducing yellow rust disease severity (Table 4). However, from visual field observation the test fungicide, Tridium showed comparable level of efficacy in controlling yellow rust disease with the standard check, Rex Duo. It is evident from visual field observation and Table 1 data result is that the test fungicide, Tridium showed comparable level of efficacy on yellow rust disease severity reduction compared to the standard check. Therefore, Tridium can be recommended for the control of wheat yellow rust disease.

Such outcomes could be attributed to the fungicides' efficacy in combating wheat against stripe rust diseases on bread wheat [15]. Wegulo et al. [16] revealed that up to 42% yield loss was prevented by application of foliar fungicides to winter wheat. Similarly, Kelley [17] found that over a six-year period, the fungicide propiconazole significantly boosted winter wheat yield by 77%. Furthermore, Wanquan et al. [18] reported significant yield increases from fungicide application to control the disease complex of leaf rust, tan spot and Septoria tritici blotch in wheat. In general, the current study also clearly shows that in Ethiopia, it is impossible to grow susceptible to moderately susceptible wheat varieties without application fungicides in areas where wheat rust diseases are the major problems especially, in Arsi and Bale highlands [19,20].

4. CONCLUSION

Among the four fungicides, foliar application of Cayunis EC 325 and Tridium 70WG were found the most effective against yellow rust at Meraro which was highest disease pressure and gave the highest disease control. Moreover, the test fungicides reduced yellow rust disease severity to the lowest level disease management and revealed grain yield advantage better than the standard checks and untreated checks. Although the differences of test fungicides were not statistically significant, treated plots consistently produced higher yields, thousand kernel weights, and hectolitre weights than untreated plots. After all assessment and evaluation result, the newly verified fungicides are very effective in controlling yellow rust disease for improving wheat yield. Thus, Cayunis EC 325 (Bixafen 75g/L

+Spiroxamine 150g/L + Trifloxystrobin 100g/L) and Tridium (Mancozeb 59.7%+Azoxystrobin 4.7%+Tebuconazole 5.6%WG) are recommended for registration as an alternative fungicide for the control of wheat yellow rust disease at rate of 0.9lit/ha and 2kg/ha with 250lit/ha water using knapsack spray as sole or integrated disease management options on wheat.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

ACKNOWLEDGEMENT

The authors recognized, Ethiopian Institute of Agricultural Research (EIAR) is sincerely recognized for technical support and Kulumsa Agricultural Research center for facilitating the field research. Entirely round delivery by crop protection research team of the center is really appreciated.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Ayele B, Fehrmann H, Yahyaoui A. Status of wheat stripe rust (Pucciniastriiformis) races and their virulence in major wheat growing areas of Ethiopia. Pest Management Journal of Ethiopia. 2008a;12:1-7.
2. Chen W, Wellings C, Chen X, Kang Z, Liu T. Wheat stripe (yellow) rust caused by Puccinia striiformis f. sp. tritici. Molecular plant pathology. 2014;15(5):433-446.
3. Chen YE, Cui JM, Yang JC, Zhang ZW, Yuan M, Song C, et al., Biomonitoring heavy metal contaminations by moss visible parameters. J. Hazard. Mater. 2015;296:201–209.
DOI: 10.1016/j.jhazmat.2015.04.060
4. Alemu Ayele and Getnet Muche. Yield loss assessment in bread wheat varieties caused by yellow rust (Puccinia striiformis f. sp. tritici) in Arsi Highlands of South Eastern Ethiopia. American Journal of BioScience. 2019;7:104-112.
5. Ali S, Gladieux P, Leconte M, Gautier A, Justesen AF, et al. Origin, Migration Routes and Worldwide Population Genetic Structure of the Wheat Yellow Rust Pathogen Puccinia striiformis f.sp. tritici. PLoS Pathog. 2014;10(1): e1003903.
DOI:10.1371/journal.ppat.1003903
6. Worku Denbel. Epidemics of Puccinia striiformis f. sp. tritici in Arsi and West Arsi Zones of Ethiopia in 2010 and identification of effective resistance genes. J. Nat. Sci. Res. 2014;4:33-39.
7. Bekele Hundie, Shambel Kumbi and Dereje Hailu. Seasonal variations in the occurrence of wheat stripe rust in Bale highlands. Pest Management Journal of Ethiopia. 2002;6:65-72.
8. Hodson DP. Shifting boundaries: challenges for rust monitoring. Euphytica. 2011;179:93–104.
9. ICARDA. Strategies to reduce the emerging wheat stripe rust disease. Synthesis of a dialog between policy makers and scientists from 31 countries In: International wheat stripe rust symposium, Aleppo, Syria; 2011.
10. Poole NF, Arnaudin ME. The role of fungicides for effective disease management in cereal crops. Canadian Journal of Plant Pathology. 2014;36(1):1-11.
11. Cooper J, Dobson H. The benefits of pesticides to mankind and the environment. Crop prot. 2007;26:1337-1348.
12. Hailu D, Fininsa C. Epidemics of stripe rust (puccinia striiformis) on common wheat (*Triticum aestivum*) in the highlands of bale, southeastern Ethiopia. Crop Prot. 2007;26:1209-1218.
13. Peterson RF, Campbell AB, Hannah AE. A diagrammatic scale for estimating rust intensity on leaves and stems of cereals. Canadian journal of research. 1948;26:496-500.
14. Roelfs AP, Singh RP, Saari EE. Rust diseases of wheat: concepts and methods of disease management. Cimmyt; 1992.
15. Wubishet Alemu & Tamene Mideksa, International Journal of Research Studies in Agricultural Sciences (IJRSAS). 2016;2(9):35-40.
16. Wegulo SN, Breathnach JA, Baenziger PS. Effect of growth stage on the relationship between tan spot and spot blotch severity

and yield in winter wheat, Crop Prot. 2009;28:696–702.
17. Kelley KW. Planting date and foliar fungicide effects on yield components and grain; 2001.
18. Wanquan Chen, Colin Wellings, Xianming Chen, Zhengsheng Kang and Taiguo Liu, Wheat stripe (yellow) rust caused by Puccinia striiformis f. sp. Tritici. Molecular Plant Pathology. 2014;15(5):433–446. DOI: 10.1111/mpp.12116.
19. Ministry of Agriculture. List of pesticide registrants in Ethiopia, unpublished document; 2022.
20. Mogens S, Hovmøller, Amor H, Yahyaoui, Eugene A, Milus and Annemarie F, Justesen. Blackwell Publishing Ltd Rapid Global Spread of Two Aggressive Strains of a Wheat Rust Fungus. Molecular Ecology. 2008;17:3818–3826. DOI: 10.1111/j.1365-294X.2008.03886.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/127144