Evaluation of efficacy of fungicides against *Puccinia sorghi,* incitant of Maize rust under *invivo* conditions in the mid hill region of Jammu, India

Abstract

Maize (*Zea mays* L.) occupies the first rank in terms of production and productivity whereas the third important cereal crop of world after rice and wheat with wide adaptability to diverse agro- climatic condition of world and considered as climate resilient crop. The present study is mainly focussed on testing the field efficacy of some new fungicides as foliar sprays for the effective management of maize rust. he trial for testing the efficacy of different fungicides *viz*., Propiconazole 25 EC, Chlorothalonil 75 WP, Azoxystrobin 25 EC and Hexaconazole 5 EC at different concentrations were carried out. Among the five treatments, treatment with strobilurin group of fungicide *i.e*. Azoxystrobin 25 EC @ 0.2 percent dosage proved to be effective overall the treatments with lowest disease severity of 9.88 per cent, followed by azole group of fungicides like Propiconazole 25 EC @ 0.2% with disease severity of 11.14 per cent and Hexaconazole 5 EC @0.1 % dosage with disease severity of 13.66 per cent. disease severity was recorded to be in the range from 9.88 to 24.22 per cent. Among all the treatments highest disease severity of 24.22 per cent was recorded in treatment with Chlorothalonil 75 WP @ 0.2 % dosage. Results revealed that strobilurin group of fungicides are more site specific, protective and curative properties and are less prone to resistance development and also translaminar and systemic nature helps this group of fungicide to be most effective against azole group of fungicides..

Key words: Fungicides, Fungitoxicants, Strobilurins, Azole, Translaminar

1. Introduction

Cereals belongs to graminaceae family and members of the monocotyledon, or monocot, family – one of two major groups of angiosperms (flowering plants) that are traditionally recognised. Among the cereals, Maize (*Zea mays* L.) is an important staple food crop and provides raw materials for the livestock and many agro-allied industries in the world (Randjelovic et al., 2011). It is a staple food for several million people in the developing world where they aquire their majority of protein and calorie requirements.

Maize (*Zea mays* L.) occupies the first rank in terms of production and productivity whereas the third important cereal crop of world after rice and wheat with wide adaptability to diverse agro- climatic condition of world and considered as climate resilient crop (Muiru et al., 2010; Keya and Rubaihayo, 2013). The crop produces a high yield per unit of land, making it an important crop for ensuring consumer food availability and security (Mboya et al., 2011).

The cultivation of maize around the world with an area of 193.7 million ha with annual production of about 1147.7 million MT and average productivity of 5.75 tons per ha (FAOSTAT, 2020). In India maize is cultivated over an area of about 9.2 million ha with annual production of 27.8 million MT and average productivity of 3.2 tons per ha (DACNET, 2020).

Amidst being the climate resilient crop, Maize crop is affected by different biotic and abiotic stresses. Some serious pests like Fall army worm, Shoot fly etc., are most prevalent and also different foliar diseases infects the maize which causes huge loss. Among the 18 foliar diseases of Maize, Rust is one of the most important disease which infects during the early stages of crop growth thereby reducing the yield upto 12 to 61 per cent.

Yellowing and early desiccation of maize leaves, leaf necrosis, and full destruction of photosynthetic regions are all symptoms of maize rust. Heavy rust infestation can cause stunting, partial ear tip fill, and pustules on the ear husk, lowering production and marketability. Rust symptoms on leaves include round to elongate dark brown pustules (Uredinia) distributed across both leaf surfaces, giving the leaf a rusty appearance (Hooker, 1985). Host plant resistance is the most efficient and cost effective strategy for the control of many plant diseases. Development of novel varieties using available 20 hypersensitive resistance (Rp) genes have been identified against maize rust in corn germplasm, partial or hypersensitive resistance can be used to manage it (Hooker, 1969, Ribeiro et al., 2016). It is feasible to find numerous candidate genes and Quantitative Trait Loci (QTL) that are strongly related with resistance to maize rust (Zheng et al., 2018).

The use of fungicides has emerged as a practical alternative as part of modern and efficient maize production since disease control techniques like host plant resistance or cultural practices are inadequate for managing outbreaks of maize rust (Diaz et al., 2012). Due to the growing economic significance of the increased yield losses caused by maize rust disease, researchers have directed most of their attention into fungicide-based rust disease control (Mueller et al., 2005). Some non-systemic fungicides have been used for the control of disease but complete control is still lacking..

Maize rust is a limiting factor for maize cultivation under intermediate to temperate condition in mid hill region of Jammu. The present study is mainly focussed on testing the field efficacy of some new fungicides as foliar sprays for the effective management of maize rust. Less work has so far been carried out on maize rust and the disease has persisted with varying degree of crop damage.

2. Materials and methods:

The trial for testing the efficacy of different fungicides *viz.*, Propiconazole 25 EC, Chlorothalonil 75 WP, Azoxystrobin 25 EC and Hexaconazole 5 EC at different concentrations were carried out at Regional Agricultural Research Station, Rajouri during *Kharif* 2020. The data of each treatment is collected by tagging the randomly selected 50 plants.

The abovementioned fungicides were applied through foliar spray at 50 and 65 DAS. The effects of various fungicides at different concentrations applied as a foliar spray on maize rust were studied individually. The randomized block design is used in the field experiment and data *viz.*, disease severity (%), 100 grain weight, yield (q/ha), Percent increase in 100 grain weight and percent increase in yield is also recorded at the silking stage. The data on per cent disease severity was recorded using a specific scale/formula, and then a percent disease index was calculated according to Singh (1998).

$$\textbf{Percent disease index} = \frac{\text{PDI in untreated check} - \text{PDI in treated}}{\text{PDI in control}} \times 100$$

Table 1. The treatment details of fungicides used are furnished here under

S.No.	Chemical Name	Concentration (%)		
1.	Propiconazole 25% EC	0.05	0.1	0.2
2.	Chlorothalonil 75% WP	0.2	0.25	**0.3**
3.	Azoxystrobin 25% EC	0.05	0.1	0.2
4.	Hexaconazole 5% EC	0.03	0.05	0.1
5.	Control	-	-	-

3.Results:

The experiment to evaluate the efficacy of four fungitoxicants using foliar spray with three different concentrations was carried out using a Randomised block design at Regional Agricultural Research Station, Rajouri during *Kharif* 2020 under *invivo* conditions.

Four fungitoxicants were used for foliar sprays (Propiconazole 25% EC, Hexaconazole 5% EC, Azoxystrobin 25% EC and Chlorothalonil 75% WP at three different concentrations mentioned in (Table 1) along with control or untreated check.

The data retrieved from the present investigation on effect of various foliar sprays on severity of maize rust under fields condition revealed that all the foliar sprays were superior over the control in reducing the disease severity (Table 2 and Plate 1). The data pertaining to the disease severity was recorded to be in the range from 9.88 to 24.22 per cent. The strobilurin group of fungicide *i.e*. Azoxystrobin 25% EC @ 0.2 percent dosage proved to be effective among all the treatments with lowest disease severity of 9.88 per cent, followed by azole group of fungicides like Propiconazole 25% EC @ 0.2% with disease severity of 11.14 per cent and Hexaconazole 5% EC @0.1 % dosage with disease severity of 13.66 per cent. Among all the treatments highest disease severity of 24.22 per cent was recorded in treatment with Chlorothalonil 75% WP @ 0.2 % dosage as mentioned in table 2,3,4.

The data related to the fungicides and disease severity, yield has been dep

The data recorded with three different concentrations produced effective results. The per cent increase in yield was found maximum in the treatment sprayed with Azoxystrobin 25% EC at all dosages (0.05%, 0.1% and 0.2%) with an percent increase yield of 20.64, 27.86,31.49 respectively. On the contrary the minimum per cent increase in yield of 17.84 percent was recorded when sprayed with Chlorothalonil 75% WP @ 0.2% dose.

4. Discussion

Chemical control is one of the important disease management strategy for many foliar diseases and also inescapable means of controlling many plant diseases since, in addition to eradicative activity, they also offer a chemical toxic barrier against pathogens. Under severe maize rust infections, fungicides have been employed to lower disease severity and increase maize yields (Dillard and Seem, 1990). The current study mainly focussed on the *in vivo* evaluation of the efficacy of fungicides at different dosages in the field, found that all treatments considerably reduced disease severity when compared to control or untreated check. However the magnitude of reduction varied from treatment to treatment. Results revealed that Azoxystrobin 25% EC @ 0.2% proved most effective over all other treatments, followed by Propiconazole 25EC @0.25% in controlling the maize rust as the strobilurin group of fungicides are more site specific, protective and curative properties than azole group of fungicides. Strobilurin group of fungicides are less prone to resistance development and also translaminar and systemic nature helps this group of fungicide to be most effective against azole group. The studies of various workers have also reported the efficacy of these fungitoxicants in efficiently controlling maize rust (Shah and Dillard, 2003; Khan and Ilyas, 1996; Dey et al., 2013 and Wright et al., 2014).

5. Conclusion

Studies were conducted to control maize rust under fields conditions with different dosages of foliar sprays. It was observed that all the treatments restrained disease severity to a level significantly lower than that of control and enhanced yields. Azoxystrobin 25% EC proved to be the best with least disease severity of 9.88 per cent and also with the maximum yield followed by Propiconazole 25% EC with disease severity of 11. 14 per cent.

Table 2: Evaluation of different fungicides against maize rust under field conditions different dosages (Phase 1)

Treatment No.	Chemical Name	Disease Severity (%)	100 grain weight (g)	Yield (q/ha)	Percent increase in 100 grain weight	Percent increase in yield (%)
T_1	Propiconazole 25 EC at 50 and 65 DAS @0.05%	17.43	29.32	68.80	29.73	20.11
T_2	Chlorothalonil 75 WP at 50 and 65 DAS@0.2%	24.22	28.38	67.50	25.58	17.84
T_3	Azoxystrobin 25 EC at 50 and 65 DAS @0.05%	15.32	29.68	69.10	31.33	20.64
T_4	Hexaconazole 5 EC at 50 and 65 DAS@0.03%	20.10	28.90	68.05	27.88	18.80
T_5	CONTROL or Untreated check	37.34	22.60	57.28	--	---

	S.Em (±)	1.42	0.09	0.12	--	--
	CD (p=0.05)	3.23	0.36	0.35	--	--

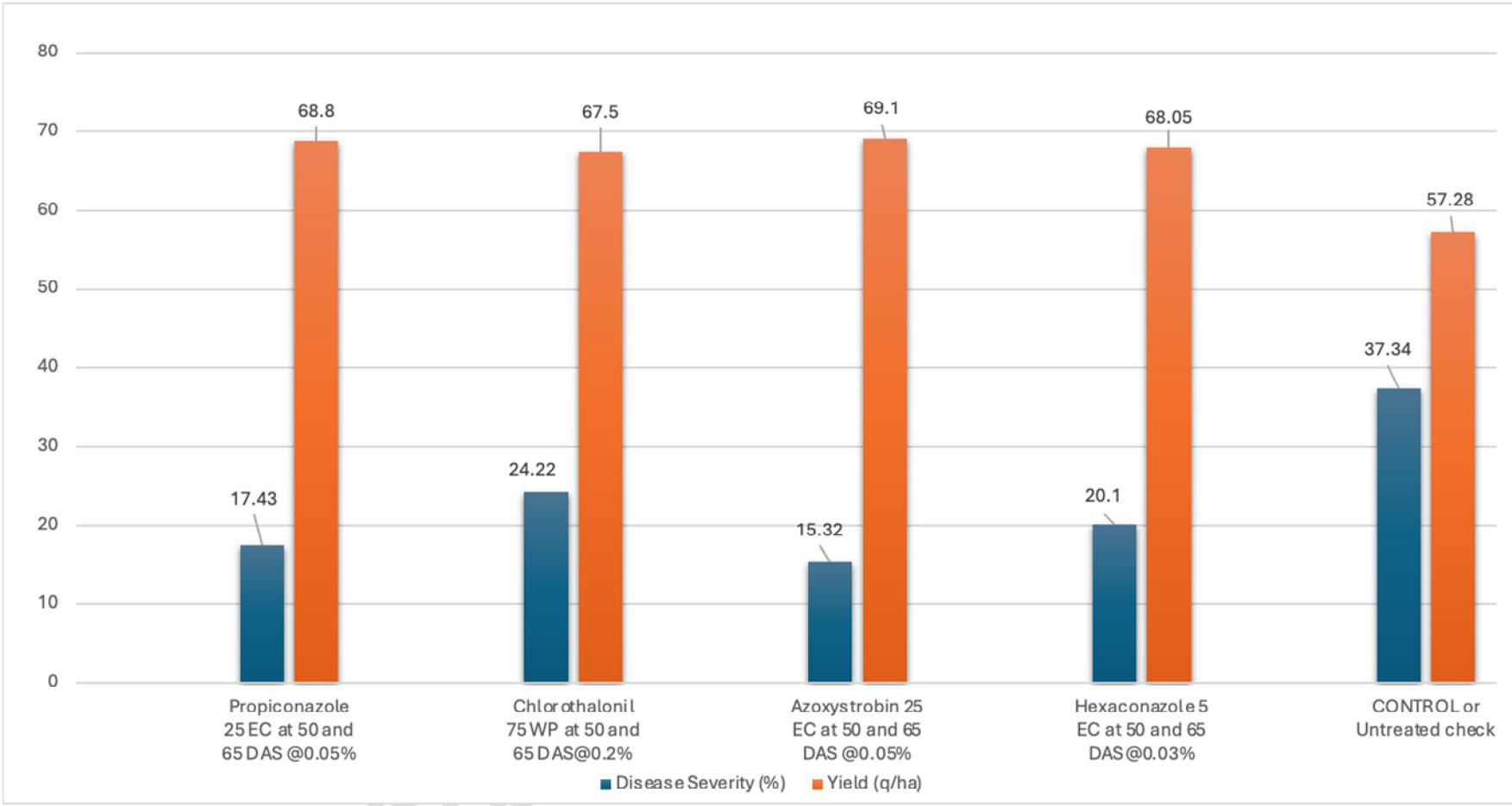

Fig. 1. Evaluation of different fungicides against maize rust under field conditions different dosages (Phase 1)

Table 3: Evaluation of different fungicides against maize rust under field conditions different dosages (Phase 2)

Treatment No.	Chemical Name	Disease Severity (%)	100 grain weight (g)	Yield (q/ha)	Percent increase in 100 grain weight	Percent increase in yield (%)
T_1	Propiconazole 25 EC at 50 and 65 DAS @0.1%	13.07	30.49	72.92	34.92	27.30
T_2	Chlorothalonil 75 WP at 50 and 65 DAS@0.25%	18.16	29.51	71.55	30.60	24.91
T_3	Azoxystrobin 25 EC at 50 and 65 DAS @0.1%	11.49	30.87	73.24	36.58	27.86
T_4	Hexaconazole 5 EC at 50 and 65 DAS@0.05%	15.07	30.05	72.13	32.99	25.93
T_5	CONTROL or Untreated check	37.65	22.60	57.28	--	---
	S.Em (±)	1.56	0.12	0.17	--	--
	CD (p=0.05)	4.10	0.48	0.54	--	--

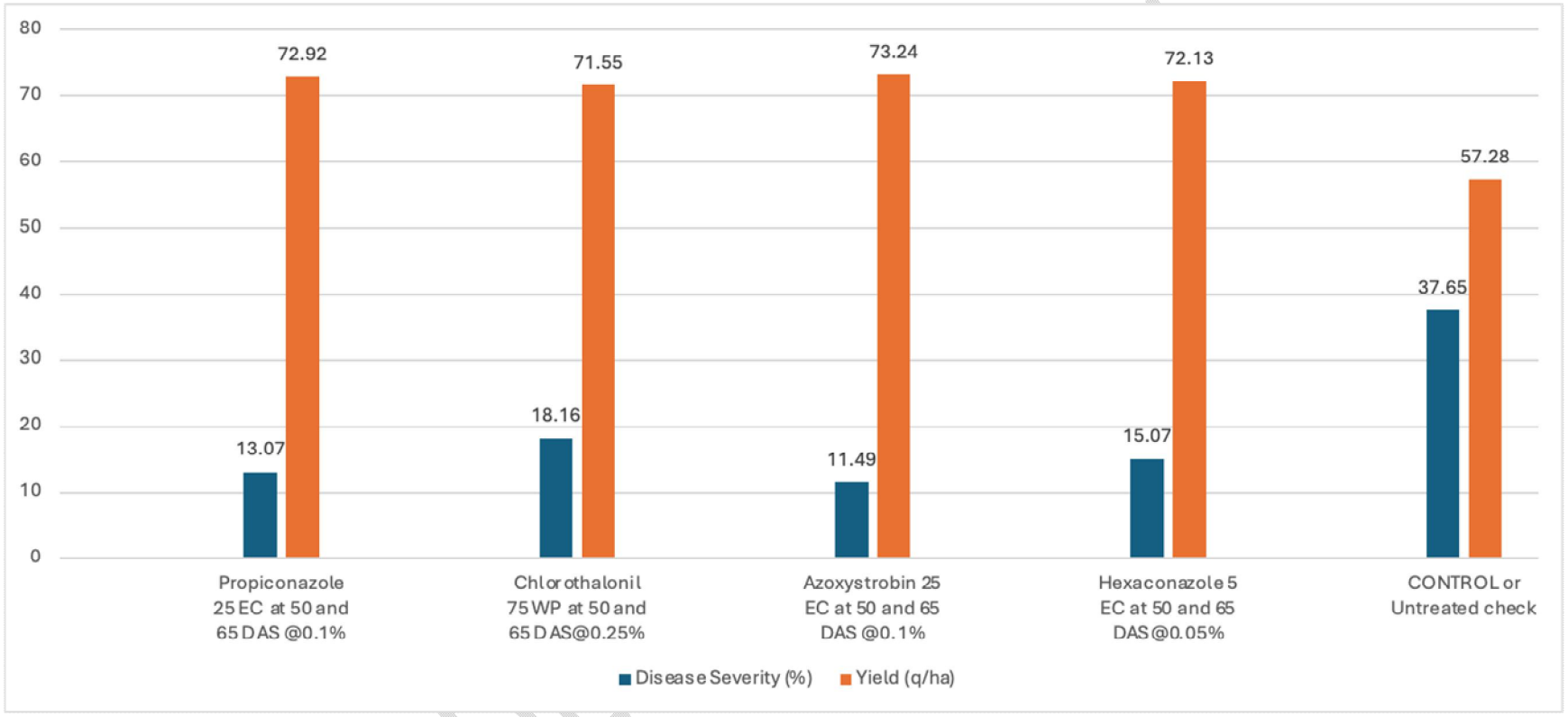

Fig 2.: Evaluation of different fungicides against maize rust under field conditions different dosages (Phase 2)

Table 4: Evaluation of different fungicides against maize rust under field conditions different dosages (Phase 3)

Treatment No.	Chemical Name	Disease Severity (%)	100 grain weight (g)	Yield (q/ha)	Percent increase in 100 grain weight	Percent increase in yield (%)
T_1	Propiconazole 25 EC at 50 and 65 DAS @0.2%	11.14	31.07	74.99	37.48	30.92
T_2	Chlorothalonil 75 WP at 50 and 65 DAS@0.3%	15.05	30.08	73.57	33.1	28.44
T_3	Azoxystrobin 25 EC at 50 and 65 DAS @0.2%	9.88	31.46	75.32	39.20	31.49
T_4	Hexaconazole 5 EC at 50 and 65 DAS@0.1%	13.66	30.63	74.17	35.53	29.49
T_5	CONTROL or Untreated check	37.65	22.60	57.28	--	---
	S.Em (±)	1.65	0.16	0.19	--	--
	CD (p=0.05)	3.23	0.53	0.62	--	--

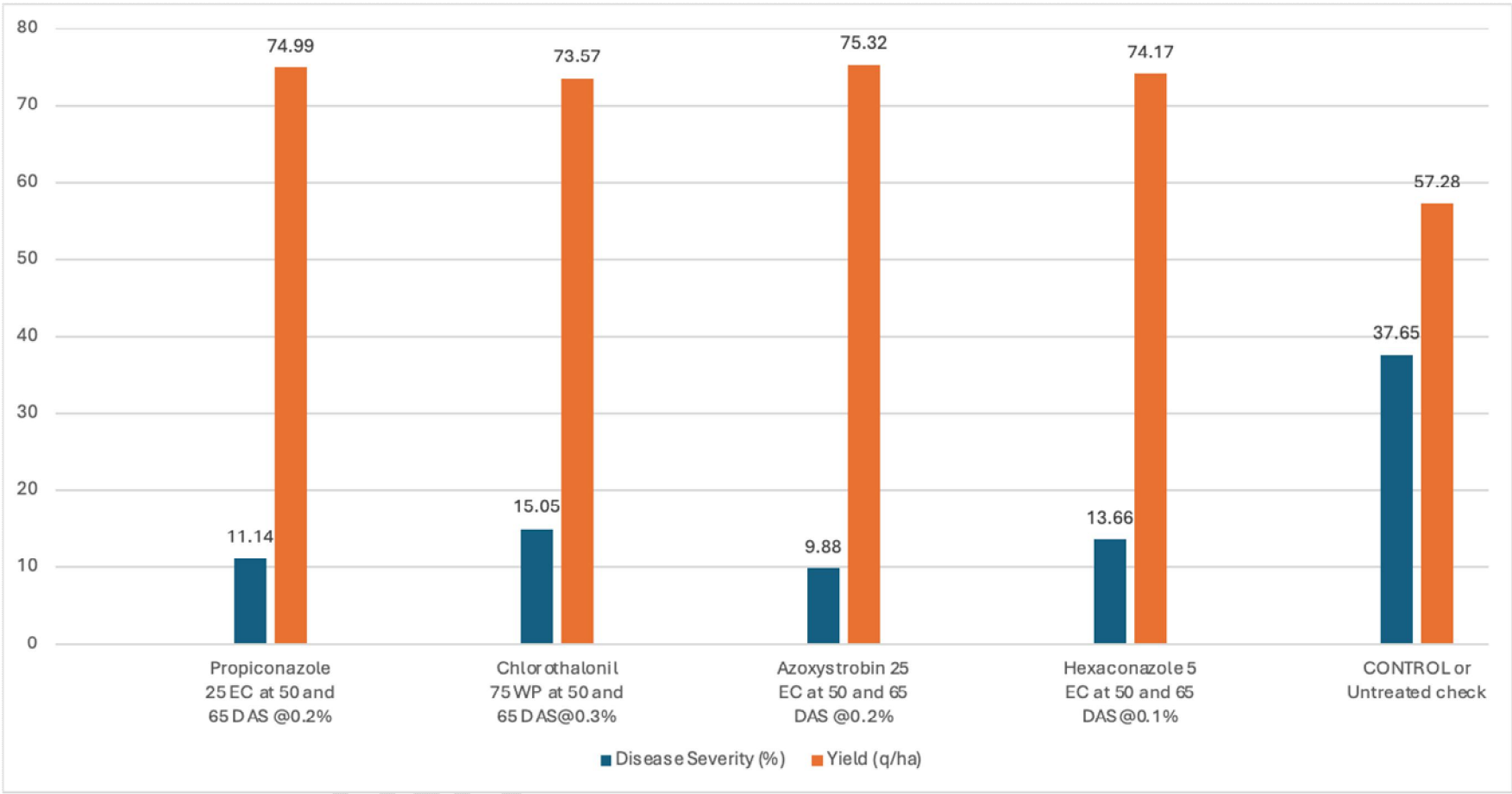

Fig 3: Evaluation of different fungicides against maize rust under field conditions different dosages (Phase 3)

Plate 1: Experimental Plot for Evaluation of efficacy of fungicides against Maize rust

Statements and Declarations

Data availability:

The data is available with the authors for further references

Disclaimer (Artificial intelligence)

Option 1:

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.

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1.
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3.

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