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ASSESSMENT OF STEM RUST SEVERITY OF DIFFERENT WHEAT VARIETIES

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ABSTRACT

Wheat (*Triticum aestivum* L.) is the most important cereal crop. It belongs to genus *Triticum* of the family *Poaceae*. The most prevalent pathogens on wheat are the three rusts viz., black/stem rust (*Puccinia graminis* Pers. *tritici* Erikss. and Henn.), leaf/brown rust (*Puccinia recondita* Rob. Ex. Desm. f. sp. *tritici*) and yellow/stripe rust (*Puccinia striiformis* West), which pose serious threat on its production. For assessment of disease severity the inoculation of uredospores in the infector lines at boot leaf stage by syringe inoculation method. The fungicide propiconazole 25 EC @ 1 ml/l was applied three times with an interval of 15 days in sprayed plot. The disease severity was recorded in fungicide sprayed plot and unsprayed plot. The unsprayed plot recorded the maximum disease severity ranged from 2.74 to 47.48 per cent and 2.74 to 46.55 per cent during 2021-22 and 2022-23, respectively.

Key words : Disease, Fungicides, Inoculation, Propiconazole, Severity.

Introduction

Wheat (*Triticum aestivum* L.) is the most important cereal crop for the majority of world's population. Wheat belongs to genus *Triticum* of the family *Poaceae*. It is the third largest cereal produced in the world after corn and rice and is most widely consumed as staple food in the world. In India, wheat is the second most important crop next to rice exclusively in the *Rabi* season.

Three species of wheat namely, *T. aestivum* L. (Bread wheat), *T. durum* (Macroni or Durum wheat) and *T. dicoccum* Schrank. (Emmer wheat) are commonly cultivated in India. Wheat is a major ingredient in foods such as bread, porridge, crackers, biscuits, muesli, pancakes, pies, pastries, cakes, cookies, muffins, rolls, doughnuts, gravy, beer, vodka, boza (a fermented beverage) and breakfast cereals. Besides staple food for human being and wheat straw is a good source of feed for large population cattle in our country, in manufacturing of straw board, paper, adhesives and various cosmetics and pharmaceutical products.

Wheat has been labeled “king of cereals”. The major wheat producing countries are China, India, USA, France, Russia, Canada, Australia, Pakistan, Turkey, UK, Argentina, Iran and Italy. These contribute about 76 per cent of the total world wheat production. The total area of wheat in the world was 220.94 million hectares with the production of 790.20 million metric tons and yields 3.58 metric tons per hectare (USDA, 2022).

Despite enormous economic and dietary values of the crop, the average yield of wheat in India is comparatively low as compared to other wheat producing countries. This has been attributed to multifaceted biotic and abiotic factors including insufficient/excess and erratic rainfall, poor agronomic practices, poor soil fertility, diseases and insect pests. Wheat is susceptible to many diseases including the highly destructive ones like rusts (*Puccinia* spp.), Septoria leaf blotches (*Septoria tritici*), Fusarium head blight (*Fusarium graminearum*), Tan spot (*Pyrenophora tritici repentis*), Smut (*Ustilago tritici*) and Powdery mildew (*Erysiphe graminis* f. sp. *tritici*)

(Prescott *et al.*, 1986). Of these, fungal diseases like rusts (stem, stripe and leaf rust), Fusarium head blight (FHB), Septoria blotch, *Helmenthosporium* spp. and Tan spot are the dominant ones that were reported over time (Badebo, 2002; CIMMYT, 2005).

Among all three rusts, black or stem rust caused by *Puccinia graminis tritici* is a significant disease of wheat worldwide which can cause yield losses of up to 100 per cent in susceptible varieties under conducive environment (Roelfs, 1985). Wheat rust race evolution is a threat to

Table 1 : Modified Cobb's scale (Peterson *et al.*, 1948) for scoring stem rust.

Reaction type	Response value	Visible symptoms
O	0.0	No visible infection
R	0.2	Necrotic areas with or without uredia
MR	0.4	Necrotic areas with small uredia
X	0.6	Variable sized uredia with necrosis or chlorosis and fully susceptible
MS	0.8	Medium sized uredia with no necrosis but some chlorosis
S	1.0	Large sized uredia with no necrosis and chlorosis

Table 2 : Experimental details of assessment of losses in yield of wheat due to stem rust.

Experimental site	: Agronomy Instructional Farm, S.D.A.U, Sardarkrushinagar	
Year	: Rabi 2021-22 and 2022-23	
Design of experiment	: Split Plot Design	
Main plot	: Two	
Sub plot	: Four	
Replication	: 3 (Three)	
Plot size	: Gross : 4 m x 2.25 m	
	: Net : 3 m x 1.35 m	
Spacing	: 22.5 x 10 cm	
Fertilizer	: 120:60:40 NPK kg/ha	
Date of sowing	: 22/11/2021 and 22/11/2022	
Date of harvesting	: 09/03/2021 and 10/03/2022	
Treatment	Main- plot treatment	Sub – plot treatment
	S ₁ : Sprayed plot	V ₁ : GW-451
	S ₂ : Unsprayed plot	V ₂ : Lok-1
		V ₃ : GDW-1255
		V ₄ : A-9-30-1

global wheat production, for instance, a new stem rust race Ug99 (TTKSK), identified in Uganda in 1999 (Pretorius *et al.*, 2000), is of great concern because it has broad virulence to most stem rust (Sr) genes (Jin *et al.*, 2007).

Stem rust occurs mainly on stems, but can also be found on leaves, sheaths, glumes and awns. Initial symptoms appear as oval to elongate lesions with reddish-brown in colour. Stem rust pustules on leaves develop mostly on the dorsal side, but may penetrate and make limited sporulation on the frontal side. The initial macroscopic symptom is typically a small chlorotic fleck, which appears a few days after infection. As infected plants mature, uredinia change into telia, altering colour from red to dark brown to black, hence the disease is also called as black rust. Teliospores are attached tightly to plant tissue. The pathogen on the alternate host barberry produces basidiospores with raised yellow-orange lesions on leaves, petioles, blossoms and fruits (Singh *et al.*, 2012). Severe infection of stems interrupts nutrient flow to the developing heads, resulting in shriveled grains and stems weakened by rust infection are prone to lodging. Stem rust is favoured by humid conditions and warmer temperatures of 15 to 35°C. It is the most devastating of the rust diseases and can cause losses of 50 per cent in one month when conditions for its development are favourable. Losses of 100 per cent can occur with susceptible cultivars (Roelfs *et al.*, 1992).

Materials and Methods

The experiment was conducted at Agronomy Instructional Farm, S. D. Agricultural University, Sardarkrushinagar in two successive growing season 2021-22 and 2022-23.

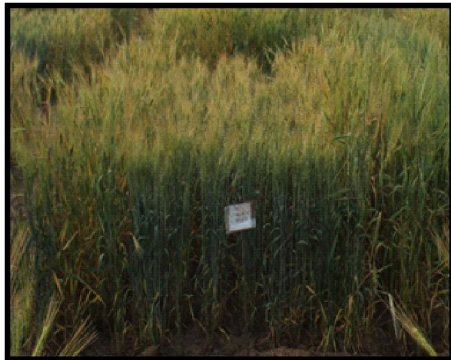
Experiment was laid out in split plot design (SPD). Each plot contains ten rows. Out of these six rows of respective variety and two border rows of both side of plot sown with susceptible infectors. The infector rows were inoculated with freshly collected uredospore at boot leaf stage by syringe inoculation method for uniform spread of inoculum. The fungicide propiconazole 25 EC @ 1 ml/l was applied three times with an interval of 15 days starting from disease appearance. During fungicide sprays, plastic sheets were used to separate the plot being sprayed from unsprayed plots, of each variety were also included. The effect of



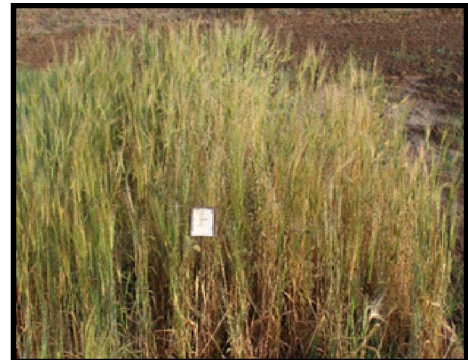
S_1V_1
 S_1 : Sprayed Plot
 V_1 : GW 451



S_1V_2
 S_1 : Sprayed Plot
 V_2 : Lok 1



S_1V_3
 S_1 : Sprayed Plot
 V_3 : GDW 1255



S_1V_4
 S_1 : Sprayed Plot
 V_4 : A-9-30-1



S_2V_1
 S_2 : Unsprayed Plot
 V_1 : GW 451



S_2V_2
 S_2 : Unsprayed Plot
 V_2 : Lok 1

S_2V_3
 S_2 : Unsprayed Plot
 V_3 : GDW 1255



S_2V_4
 S_2 : Unsprayed Plot
 V_4 : A-9-30-1

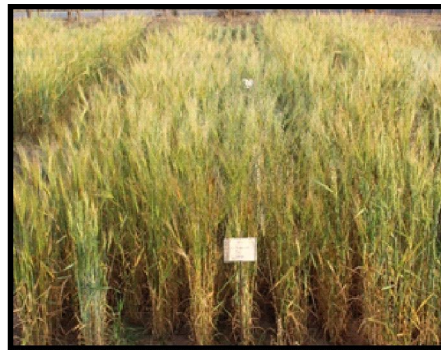


Plate 1 : Assessment of stem rust severity of different wheat varieties under field condition.

fungicide sprayed at different disease levels, plant reached to maturity was also studied. Stem rust severity for each plot was recorded every seven days from disease appearance using the modified Cobb's scale as described in Table 1.

Results and Discussion

Rust disease severity

Observations on stem rust after the first emergence of symptoms were made in each variety by recording the stem rust severity as per cent infection according to modified Cobb's scale (Peterson *et al.*, 1948) at weekly intervals.

During the growing season, two varieties (GW 451 & GDW 1255) showed resistance response, while other two varieties (Lok 1 & A-9-30-1) showed susceptible response against stem rust of wheat.

Effect of fungicide on disease severity

As per described in the material and methods an experiment was laid out in split plot design (SPD) to measure the effect of fungicide sprayed plot compare to unsprayed plot and the data presented in Table 3 revealed that the unsprayed plot recorded the maximum disease severity ranged from 2.74 to 47.48 per cent with 48.22 per cent final rust severity and sprayed plot recorded the minimum disease severity ranging from 2.93 to 26.30 per cent with 27.42 per cent final rust severity during the growing season 2021-22.

The data pertaining to the different wheat varieties presented in Table 4 revealed that the unsprayed plot recorded the maximum disease severity ranged from 2.74 to 46.55 per cent with 49.22 per cent final rust severity and sprayed plot recorded the minimum disease severity ranged from 2.95 to 26.30 per cent with 27.78 per cent

Table 3 : Disease severity of different wheat genotypes during 2021-22.

Treatments	Disease severity (%)							
	18-01-2022	25-01-2022	01-02-2022	08-02-2022	15-02-2022	22-02-2022	01-03-2022	FRS
Main plot treatments (S)								
S ₁ : Sprayed plot	23.53* (2.93)**	25.71 (3.55)	32.96 (6.00)	36.82 (7.56)	49.38 (13.48)	59.95 (19.16)	72.37 (26.30)	74.32 (27.42)
S ₂ : Unsprayed plot	22.82 (2.74)	28.57 (4.50)	38.35 (8.18)	64.76 (21.90)	71.64 (25.87)	93.37 (37.80)	119.06 (47.48)	124.40 (48.22)
S. Em. ±	0.20	0.32	0.28	0.40	0.43	0.60	0.59	1.04
C.D. at 5%	1.20	1.94	1.68	2.46	2.63	3.66	3.62	6.36
C.V.%	8.84	12.19	8.05	8.29	7.44	8.16	6.46	10.93
Sub plot treatments: Varieties (V)								
V ₁ : GW 451	5.44 (0.10)	5.44 (0.10)	5.44 (0.10)	5.44 (0.10)	5.44 (0.10)	5.44 (0.10)	5.44 (0.10)	5.44 (0.10)
V ₂ : Lok 1	40.44 (5.45)	45.02 (6.72)	63.13 (12.98)	90.52 (26.22)	110.65 (36.68)	144.74 (55.12)	181.65 (72.13)	190.53 (74.62)
V ₃ : GDW 1255	5.44 (0.10)	5.44 (0.10)	5.44 (0.10)	5.44 (0.10)	5.44 (0.10)	5.44 (0.10)	5.44 (0.10)	5.44 (0.10)
V ₄ : A-9-30-1	41.40 (5.70)	52.66 (9.20)	68.63 (15.20)	101.76 (32.51)	120.52 (41.83)	151.03 (58.61)	190.33 (75.23)	196.04 (76.46)
S. Em. ±	0.23	0.23	0.32	0.48	0.41	0.82	0.83	1.43
C.D. at 5%	0.70	0.71	0.98	1.48	1.78	2.53	2.57	4.40
Interaction (S × V)								
S. Em. ±	0.32	0.32	0.45	0.68	0.82	1.16	1.18	2.02
C.D. at 5%	0.99	0.99	1.38	2.10	2.52	3.58	3.63	6.22
C.V.%	7.20	6.23	6.55	6.97	7.02	7.88	6.39	10.55

FRS = Final rust severity recorded at 08/03/2022

*Figures outside of parentheses are arc sin transformed values

**Figures in the parentheses are original values.

Table 4 : Disease severity of different wheat genotypes during 2022-23.

Treatments	Disease severity (%)							
	17-01-2023	24-01-2023	31-01-2023	07-02-2023	14-02-2023	21-02-2023	28-02-2023	FRS
Main plot treatments (S)								
S ₁ : Sprayed plot	23.60* (2.95)**	26.86 (3.90)	32.44 (5.81)	45.13 (11.31)	49.66 (13.63)	61.02 (19.76)	72.37 (26.30)	74.94 (27.78)
S ₂ : Unsprayed plot	22.83 (2.74)	29.06 (4.67)	38.50 (8.27)	63.00 (20.88)	72.46 (26.35)	94.22 (38.23)	115.28 (46.55)	128.73 (49.22)
S. Em. ±	0.15	0.18	0.22	0.57	0.49	0.61	0.64	0.76
C.D. at 5%	0.90	1.08	1.36	3.50	2.99	3.72	3.89	4.61
C.V.%	6.62	6.60	6.57	11.05	8.36	8.18	7.07	7.72
Sub plot treatments: Varieties (V)								
V ₁ : GW 451	5.44 (0.10)	5.44 (0.10)	5.44 (0.10)	5.44 (0.10)	5.44 (0.10)	5.44 (0.10)	5.44 (0.10)	5.44 (0.10)
V ₂ : Lok 1	40.58 (5.48)	46.65 (7.20)	61.69 (12.40)	98.72 (29.93)	111.74 (37.30)	146.82 (56.22)	182.78 (72.60)	197.27 (76.47)
V ₃ : GDW 1255	5.44 (0.10)	5.44 (0.10)	5.44 (0.10)	5.44 (0.10)	5.44 (0.10)	5.44 (0.10)	5.44 (0.10)	5.44 (0.10)
V ₄ : A-9-30-1	41.41 (5.70)	54.31 (9.73)	69.34 (15.57)	106.68 (34.27)	121.62 (42.47)	152.79 (59.57)	181.65 (72.90)	199.19 (77.33)
S. Em. ±	0.20	0.23	0.30	0.56	0.65	0.79	0.85	1.01
C.D. at 5%	0.61	0.72	0.91	1.72	1.99	2.45	2.62	3.19
Interaction (S × V)								
S. Em. ±	0.28	0.33	0.42	0.79	0.91	1.12	1.20	1.46
C.D. at 5%	0.87	1.02	1.29	2.43	2.82	3.46	3.70	4.51
C.V.%	6.30	6.18	6.13	7.57	7.79	7.53	6.66	7.46

FRS = Final rust severity recorded at 07/03/2023

*Figures outside of parentheses are arc sin transformed values

**Figures in the parentheses are original values.

final rust severity during the growing season 2022-23.

Effect of different varieties on disease severity

The data pertaining to the different wheat varieties presented in Table 3 revealed that the two varieties (GW 451 & GDW 1255) were not record any disease symptoms because they were the resistance sources. The variety A-9-30-1 recorded the highest rust severity ranged from 5.70 to 75.23 per cent with 76.46 per cent of final rust severity followed by Lok 1 showed the disease severity ranged from 5.45 to 72.13 per cent with the final rust severity of 74.62 during the growing season 2021-22.

During the growing season 2022-23, the data pertaining to the different wheat varieties is presented in Table 4. The two resistance varieties (GW 451 & GDW 1255) were not record any disease symptoms. The highest rust severity observed in A-9-30-1 were ranging from

5.70 to 72.90 per cent with 77.33 per cent of final rust severity followed by Lok 1 was recorded 5.48 to 72.60 per cent disease severity with the final rust severity (76.47%).

The effect of fungicide sprayed and unsprayed on disease severity in wheat has been studied earlier by several research workers.

Ahmad *et al.* (2010) observed that maximum severity of 90 per cent of yellow rust resulted in 54 to 55 per cent calculated and predicted losses, respectively. While 40, 50, 60 and 70 per cent disease severity of yellow rust caused 35-34, 38-37, 42-40 and 46-47 per cent calculated and predicted losses, respectively. Hasan *et al.* (2012) reported that all tested cultivars showed different disease severity ranged from 5-80 per cent with susceptible infection types.

Asmmawy *et al.* (2013) recorded the disease

severity of all the tested genotypes ranged from 5 to 30 per cent. Thabet and Najeeb (2017) observed that all tested cultivars showed different final rust severity per cent ranged between 3.46 and 66.66 per cent. Disease severity was high for cvs. Gemmiza-7 (53.33%- 66.66%) and Sids-1 (33.30% - 56.66%). Whereas, the final rust severity per cent was the lowest on wheat cultivars showing the low levels of susceptibility Sakha 94 (4%) at 2014/2015 and Sids-13(3.46%) at 2015/2016.

Degete and Chala (2019) observed that terminal stem rust severity on untreated plots was 63.3 per cent on both susceptible varieties, 66.7 per cent on moderately susceptible variety. Terminal stem rust severity on treated plots varied between 10.7 and 20 per cent on susceptible varieties, 30 per cent on moderately susceptible variety suggesting a significant reduction in stem rust disease level as the result of fungicide sprays.

Summary and Conclusion

For assessment of losses in yield the inoculation of uredospore in the infector lines at boot leaf stage by syringe inoculation method. The fungicide propiconazole 25 EC @ 1 ml/liter was applied three times with an interval of 15 days in sprayed plot. The disease severity was recorded in fungicide sprayed plot and unsprayed plot. The unsprayed plot recorded the maximum disease severity ranged from 2.74 to 47.48 per cent and 2.74 to 46.55 per cent with comparison to sprayed plot (2.93 to 26.30% & 2.95 to 26.30%) during 2021-22 and 2022-23, respectively. The two varieties (GW 451 & GDW 1255) were not record any disease symptoms because they were the resistance sources. The variety A-9-30-1 recorded the highest rust severity ranged from 5.70 to 75.23 per cent and 5.70 to 72.90 per cent followed by Lok 1 recorded (5.45 to 72.13 & 5.48 to 72.60%) during 2021-22 and 2022-23, respectively.

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