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Management of Brown Rust (*Puccinia recondita*) of Wheat and its Impact on Yield under Jammu Sub-tropics of India

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Wheat cultivars PBW-343, PBW-550 and Agra local were used for testing seven fungicides viz., Propiconazole (Tilt 25EC), Tebuconazole (Folicur 250EC), Triadimefon (Bayleton 25%WP), Tebuconazole DS (Raxil 2%WP), Azoxystrobin 23% (Quadris 25SC) at 0.1 per cent while as Mancozeb (Dithane M-45) and Mancozeb + Carbendazim (Saaf) at 0.2 per cent concentration, respectively and three sowing dates viz., 15 Nov, 30 Nov. and 15 Dec. at University farm Chatha SKUAST-K during *Rabi* 2009-10. Sowing date (15th Nov.) significantly reduced the disease severity (36.42%) followed by late (30 Nov.) and very late sowing (15 Dec.), respectively. Different cultivars showed different levels of infection and yield at different sowing dates. Under field conditions, Raxil (0.1%) as seed treatment and Quadris (foliar spray @ 0.1%) were found most effective against brown rust followed by Raxil (ST) + Folicur (FS), and Raxil (ST) + Tilt (FS), respectively, at same concentration. Foliar application of chemicals singly or along with Raxil (ST) exhibited significant increase in yield of wheat cultivars. Seed treatment by Raxil (0.1%) was found to be least effective in reducing the disease severity.

Key words: Wheat, brown rust, disease severity, AURPC, yield.

The major constraints in increasing wheat production are biotic diseases that influence the crop yield by 10-12 per cent (Pal, 1966). The important fungal diseases that affect wheat are three rusts (stem, brown and stripe rust), Karnal bunt, leaf blights, powdery mildew, flag smut and hill bunt. However rust diseases cause significant damage world over. Leaf (brown) rust caused by *Puccinia recondita* Rob. ex. Desm. f. sp. *tritici* is recognized as an important disease of wheat worldwide, causing significant yield losses over large geographical areas (Kolmer, 2005). Yield losses ranging from 38.6 to 50.5 per cent and 8.7 per cent for early and late epidemics of brown rust, respectively, have been reported by Galich and Galich (1996). In most wheat growing areas, yield losses caused by brown rust have varied from 5 to 40 per cent, influenced by varietal susceptibility, nature of attack, rate of disease development and duration of disease (Roelfs and Bunshell, 1985.). Monoculturing of wheat cultivars, broad adaptation of the pathogenic fungus to diverse climatic conditions and emergence of new biotypes, brown rust has become a matter of great concern in recent past (Kolmer, 2005). The best option for management of the disease is to grow resistant cultivars. (Line and Chen, 1995). However, application of systemic fungicides as foliar spray is the only choice once the disease appears in the standing crop (Dalal and Singh, 1984). Fungicides viz., Tilt (propiconazole), Quadris (azoxystrobin), Stratego (propiconazole + trifloxystrobin),

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Headline (strobilurin), and Quilt (azoxystrobin + propiconazole) were used successfully to control wheat rust by Chen (2005). High virulence variability of the pathogen and the introduction of high yielding varieties coupled with high input technology, the disease has gained importance and has potential to change its status from minor to major disease in subtropics and intermediate zones of Jammu and Kashmir.

MATERIALS AND METHODS

Effect of date of sowing on leaf rust development

To study the effect of different sowing dates cultivars*viz*. Agra local, PBW-343, PBW-550, RSP-561, HD-2687 and DBW-17 were sown at three different dates i.e., timely sowing (15th November), late sowing (30th November) and very late sowing (15th December) and the effect on final rust severity (FRS) and yield was ascertained.Similarly, the test weight of 1000 seeds of each plot was measured by using electronics balance. Data was statistically analyzed by using OP Stat software. Observations regarding disease severity in each treatment and yield/plot were recorded.

Disease severity was recorded on the basis of Modified Cobb's Scale (Peterson *et al*., 1948):

1 = No infection
2 = <5 per cent leaf area infected
3 = 5-10 per cent leaf area infected
4 = 11-25 per cent leaf area infected
5 = 26-40 per cent leaf area infected
6 = 41-65 per cent leaf area infected
7 = 66-100 per cent leaf area infected

The area under rust progress curve was estimated by using the formula adapted by Pandey *et al*. (1989)

AURPC = D (1/2 (Y1+ Yk) + (Y 2+Y3+…….. Yk), where Y1, Y2…… Yk are K disease scorings at a constant interval of D- days.

Fungicidal management of brown rust

Tebuconazole DS (Raxil 2% WP) (0.1%) was used as seed treatment and six fungicides *viz*. tebuconazole 250 EC, propiconazole 25 EC, triadimefon 25WP and azoxystrobin 25SC @ 0.1 per cent and mancozeb+carbendazim and mancozeb @ 0.2 per cent concentration were used as foliar spray on three wheat cultivars PBW-343, PBW-550 and Agra local under randomized block design with four replications. Single foliar spray of respective fungicides was done after spray inoculation of urediospores suspension at boot leaf stage and seed treatment was made at the time of sowing. Tebuconazole DS (Raxil 2% WP) (0.1%) was used for seed treatment. Seeds treated with tebuconazole (Raxil 2 DS) @ 0.1 per cent were sown in field and fungicides *viz*. propiconazole (Tilt 25 EC), tebuconazole (Folicur 250 EC), triadimefon (Bayleton 25 WP), azoxystrobin 23% (Quadris 2.08 SC) at 0.1 per cent and mancozeb+ carbendazim (Saaf) and mancozeb (Dithane M 45) applied as foliar spray (0.2%) at boot leaf stage to assess the impact against brown rust. Observation regarding final rust severity (FRS) was recorded in each treatments and yield per plot was measured after harvest.

The plants in different plots were harvested, threshed and cleaned. Seeds were weighed on per plot basis and the data converted to qha^{-1}. The per cent increase in yield was ascertained as follows

$$\text{Per cent increase in yield} = \frac{b - c}{c} \times 100$$

Where,

b = estimate of yield obtained in treated plot
c = estimate of yield obtained in untreated plot

Fungicides used in the experiment

Common name	Commercial name	Manufacturer
Tebuconazole DS	Raxil 2 WP	Bayer India Ltd.
Propiconazole	Tilt 25 EC	Hindustan CIBA Geigy Ltd.
Tebuconazole	Folicur 250 EC	Bayer India Ltd.
Azoxystrobin 23%	Quadris 25 SC	Syngenta India Ltd.
Triadimefon	Bayleton 25 WP	Bayer India Ltd.
Saaf	Mancozeb+ carbendazim	United Phosphorus Ltd.
Mancozeb	Dithane M-45	Dow Agro Sciences India Pvt. Ltd.

RESULTS AND DISCUSSION

The effect of sowing dates showed significant differences in the brown rust severity (Table I). Among three sowing times the normal sown crop (15th November) exhibited minimum FRS (36.42%) and higher yield 38.51 qha^{-1} than late (30th November) and very late sown crop (15th Dec.) with FRS of (43.74%), (39.35%) and yield of (34.67qha^{-1}) and (31.28qha^{-1}), respectively. Among six tested wheat cultivars, Agra local showed highest FRS (80.76) and lowest yield (15.71) whereas DBW-17 shows a minimum FRS (12.18) and highest yield (42.78) for all the three sowing dates. The three sowing dates also significantly influenced the test weight of different varieties. Maximum test weight of 39.2 g was recorded from normal sowing date (15th November) followed by late (30th November) and very late (15th December) with an average test weight of 38.37 g and 37.02 g respectively. Vijaya and Balasubramanian (2002) found significant difference among the dates of sowing for per cent blast disease incidence and grain yield of rice. Similar findings have been reported by Getaneh and Agu (2008) who stated that the loss in test weight increased with the delay in the planting dates and was found to be maximum in fourth planting date.

Fungicidal management (Table II) revealed that the foliar spray of fungicides was more effective in reducing the disease severity and increase in yield of the what crop. Seed treatment with Raxil on PBW-343, PBW-550 and Agra local decreased Final Rust Severity (FRS) to 38.33, 28.67 and 58.66 per cent as compared to untreated check with Final Rust Severity (FRS) of 46.22, 35.50 and 75.00 per cent, respectively. Foliar application of fungicides revealed that Quadris was most effective in reducing the FRS in all the varieties followed by Folicur, Tilt and Bayleton. Seed treatment+foliar spray of fungicides significantly reduce the final rust severity in treated varieties over untreated checks. Raxil (ST) + Quadris (FS) @ 0.1 per cent exhibited maximum control of brown rust showing only 10.88, 6.31 and 17.67 per cent disease severity in PBW-343, PBW-550 and Agra local. The AURPC indicated a significant decrease in brown rust on different wheat varieties with fungicides than untreated check. Yusupov *et al*. (2008) reported that the seed treatment with (triticonazole + prochloraz)

Table 1. Effect of date of sowing on leaf rust development and yield in different wheat cultivars during *Rabi* 2009-10

Cultivars	Final rust severity (%) at different sowing				Yield (qha^{-1})				Test weight (g)			
	Normal (15 Nov.)	Late (30 Nov.)	Very late (15 Dec.)	Mean	Normal (15 Nov.)	Late (30 Nov.)	Very late (15 Dec.)	Mean	Normal (15 Nov.)	Late (30 Nov.)	Very late (15 Dec.)	Mean
Agra local	75.33	88.67	78.27	80.76	18.81	15.49	12.84	15.71	38.86	37.32	36.05	37.41
PBW 343	46.50	58.67	50.00	51.72	40.28	36.07	34.08	36.81	38.85	38.19	37.34	38.13
PBW 550	38.33	45.85	42.33	42.17	42.05	37.18	35.19	38.14	39.40	38.80	36.92	38.37
RSP561	11.22	15.50	14.00	13.57	41.38	38.51	35.41	38.43	40.91	40.32	38.68	39.97
HD2687	36.80	40.20	38.83	38.61	40.94	36.51	33.64	37.03	36.44	35.30	35.02	35.59
DBW17	10.33	13.53	12.67	12.18	47.58	44.26	36.51	42.78	41.20	40.31	38.10	39.87
Mean	36.42	43.74	39.35	-	38.51	34.67	31.28		39.28	38.37	37.02	-
	Cultivar (C)	Sowing dates (SD)	(C x SD)		Cultivar (C)	Sowing dates (SD)	(C x SD)		Cultivar (C)	Sowing dates (SD)	(C x SD)	
S.E.m±	0.76	0.54	1.31		0.90	0.54	1.44		0.27	0.19	0.47	
CD(p=0.05)	2.18	1.54	3.77		2.53	1.80	N.S.		0.78	0.55	N.S.	

Table 2. Effect of seed treatment, foliar spray and combination of fungicides on brown rust development on wheat cultivars during Rabi 2009-10

Treatment	FRS (%)			AURPC			Yield (qha^{-1})			Yield increase (%)		
	PBW	PBW	Agra	PBW	PBW	Agra	PBW	PBW	Agra	PBW	PBW	Agra
	343	550	local	343	550	local	343	550	local	343	550	local
Raxil (ST)	38.85	28.67	58.66	1689.98	1247.15	2489.50	40.72	41.83	20.14	5.74	5.02	15.09
Propiconazole (FS)	19.50	12.87	24.67	848.25	559.85	1073.15	49.13	49.79	25.23	27.58	25.01	44.17
Tebuconazole (FS)	17.22	11.22	22.33	749.07	488.07	971.36	50.90	50.68	25.67	32.17	27.24	46.69
Azoxystrobin (FS)	14.33	8.67	20.35	623.36	377.15	885.23	52.01	54.22	27.22	35.06	36.13	55.54
Triadimefon (FS)	23.66	15.33	35.00	1029.21	666.86	1522.50	46.03	46.03	23.02	19.53	15.57	31.54
Carbendazim+Mancozeb (FS)	27.50	20.11	42.20	1196.25	874.79	1835.70	42.49	43.37	21.69	10.33	8.89	23.94
Mancozeb (FS)	38.33	25.33	55.25	1667.36	1101.86	2403.38	41.20	42.89	20.93	6.99	7.68	19.60
Raxil (ST)+ Propiconazole (FS)	15.25	11.95	18.33	663.38	519.83	830.65	51.56	51.34	26.00	33.89	28.90	48.57
Raxil (ST)+ Tebuconazole (FS)	13.67	10.32	19.35	594.65	448.92	801.24	53.11	52.89	26.88	37.91	32.79	53.60
Raxil (ST)+Azoxystrobin (FS)	10.88	6.31	17.67	473.28	274.49	766.81	54.88	57.32	28.90	42.51	43.91	65.14
Raxil (ST)+Triadimefon (FS)	20.50	15.24	27.65	891.75	662.94	1178.36	47.80	46.95	24.75	24.12	17.87	41.43
Raxil (ST)+Carbendazim+Mancozeb (FS)	24.33	17.66	35.77	1070.11	725.67	1621.21	43.01	44.00	23.00	11.69	10.47	31.43
Raxil (ST)+ Mancozeb (FS)	34.33	23.85	45.33	1450.00	934.45	1974.34	41.83	43.15	21.40	8.62	8.34	22.29
Control	46.22	35.50	75.00	2010.57	1544.25	2853.49	38.51	39.83	17.50	-	-	-
Mean	24.61	17.36	35.54	1068.37	744.73	1514.78	46.66	47.38	23.74			
SEm±	1.73	1.78	1.71				2.32	2.18	1.97			
CD (p=0.05%)	5.06	5.20	4.99				6.77	6.37	5.75			

ST= Seed treatment (Raxil @ 0.1%),
FS= Single foliar spray (Propiconazole, Tebuconazole, Azoxystrobin and Triadimefon each @ 0.1%), (Carbendazim+Mancozeb and Mancozeb each @ 0.2%)

successfully controlled the infection of powdery mildew and brown rust. Covarelli and Orfei (2005) while evaluating the effect of seed dressing products and foliar sprays on brown rust concluded that Azoxystrobin alone or in combination with epoxiconazole significantly reduced the brown rust severity.

Appraisal of means indicated that maximum increase in yield (15.09%) was observed in case of Agra local and minimum in case of PBW-550 (5.02%) when treated with Raxil (seed treatment). The foliar application of fungicides revealed that Quadris proved more effective in increasing the yield on varieties Agra local (55.54%) and PBW-550 (36.13%) as compared to BW-343 (35.06 %). The yield of all the three varieties was also influenced by combination of seed treatment and one foliar spray of fungicides. Maximum per cent increase of yield was found in plots treated with foliar spray of Quadris in addition to seed treatment with Raxil 2% DS @ 0.1% concentration and was found to be 42.51, 43.91 and 65.14 per cent in PBW-343, PBW-550 and Agra local, respectively. Increase in the yield of wheat varieties in response to combined effect of seed treatment and foliar spray has also been reported by Covarelli and Orfei (2005). Singh (1999) reported that fungicides (mancozeb and propiconazole) were effective in controlling the leaf rust leading to an increase in grain yield to the extent of 25.8 to 11.1 per cent, with the higher increase in wheat cultivar HD 2329 than HD 2285. The results are in confirmation with Hamm and Eggers (2008) who reported that application of Quadris was most effective followed by Folicur and Tilt in increasing the seed yield. The effectiveness of Quadris could be because it causes hormonal change in wheat leading to increasing grain yield due to delayed senescence and water conserving effects.

CONCLUSION

The normal sown crop (15th November) showed minimum FRS, highest yield and test weight than other two sowing dates. Single foliar spray of Quadris, Folicur and Tilt (0.1%) reduced rust severity significantly than rest of fungicides and display significant increased in yield. Quadris, Folicur and Tilt (0.1%) as single foliar spray and in combination with Raxil (@ 0.1% seed treatment) were most effective in controlling the final rust severity and increasing the grain yield.

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