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Tracking of wheat black rust in Puccinia path

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Abstract

Wheat is the most important staple food of about two billion people (36% of the world population). India is the second largest producer of wheat after China. Under the biotic stresses wheat can be infected by three different rust species: *Puccinia triticina* (leaf rust), *Puccinia striiformis* f. sp. *tritici* (stripe rust), and *Puccinia graminis* f. sp. *tritici* (stem rust) fungi and these are widely distributed around the world and are considered the most harmful wheat pathogens globally. Among them stem rust is the most destructive. Wheat production may be adversely affected by this disease. Roving survey was carried out in Madhya Pradesh and Maharashtra adjoining Mahabaleshwar at different latitude, Longitude and Altitude. Survey findings are clearly indicating that irrespective of genetic makeup (Resistance and Susceptibility) of prevailing cultivars the disease occurrence was not there. For example Ajay 72, GW 496, Ajeet 102, Lok 1, Eagle Daphtari, Bombay super in Maharashtra and GW 273, HI 1500, GW 322, MP 3020, WH 147 and Lok-1 in Madhya Pradesh are now susceptible and varieties Phule Samadhan, Trimbak, NIAW 1415, MACS 6478, NIDW 15 MP 1558, in Peninsular area are resistant. Non of the varieties from Maharashtra and Madhya Pradesh region were found to be infected during both years (2020-21 & 2021-22).

Keywords: Surveillance, black rust, inoculum track, natural occurrence

Introduction

Wheat is an important cereal crop and one of the most important for the world's population. It is the most important staple food of about two billion people (36% of the world population). Wheat provides nearly 55% of the carbohydrates and 20% of the food calories consumed globally (Breiman and Graur, 1995)^[3]. It is the most important cereal crop after rice in India. Wheat production is adversely affected by several biotic/Phytopathogenic microbes (Fungal, Bacterial, Viral diseases and Insect) and abiotic (Heat, Drought, Cold and Salinity) stresses. Of all the biotic stresses stem rust is the most devastating disease of wheat.

A Historic account of wheat rust epidemics in India has been given by Nagarajan and Joshi 1(1975)^[11]. Epidemic occurred in Jabalpur in 1786 and later in 1805, 1827, 1828-29, 1831-32. Epidemics of rust in India have been observed around 1843 in Delhi and Allahabad, Banaras and Jhansi during 1884 and 1895. Later on in 1905 an epidemic of rust was reported to have occurred in Punjab and sub mountainous regions of Gorakhpur. Another report of epidemic in Indo-Gangetic plains is of 1910-11.

Joshi, *et al.* (1985)^[8] recorded stem rust affected large area of Narmada valley in Madhya Pradesh during 1978-79 and local varieties Pissi and Malwi local were heavily attacked.

Mishra and Singh (1969)^[9] reported heavy attack of stem rust of wheat especially on local varieties of wheat, Safad pisi, Bansi and Jalaliya from some villages of Khandwa, Khargone and Hoshangabad district during 1965-66. In 1967-68 it also reported on local and few improved wheat varieties in Sagar, Damoh, Datiya, Vidisha, Jabalpur, Narsinghpur, Khandwa, Mandasour, Dhar, Chhatarpur, Tikamgarh and Raisen districts of Madhya Pradesh. In Pipariya tehsil of Hoshangabad districts a heavy attack of rusts was observed on local wheat varieties, in Powarkheda severe attack of stem rust was recorded on varieties DL 34, NP 839, HY 65, C 330, Sonara 63, Sonara 64. Several occurrences of rust fungi spreading from one continent to another through the atmospheric route (Brown and Hovmøller 2002)^[4]. For instance, the Ug99 lineage races have by now spread over large areas from South Africa (Pretorius *et al.* 2012)^[13] to Iran (Singh *et al.* 2015)^[15] and Russia (Sibikeev *et al.* 2016)^[14], although have not reached India (Nagarajan *et al.* 2014)^[10].

Bhardwaj *et al.* (2019)^[2] reported that the ability of wheat rusts to spread by wind over long distances, rapid production of infectious uredospores, and ability to evolve new pathotypes, makes the management of wheat pathogens a very challenging task.

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Admassu *et al.* (2009) [1] stated that it is of paramount importance for the wheat improvement continuously document the prevalence of stem rust of wheat in major wheat growing region and investigate virulence structure and dynamics in pathogen population.

Till date there is general consensus among the wheat fraternity in India that there is little chance of sexual reproduction in India and the rust is spreading through asexual spores (Urediniospores) that is called repeated spore. This assumption leads one to rely on the theory of green bridge; it is also an established fact that under Indian conditions black rust & brown rust from the initial inoculum in nature spread from Nilgiris to Central India via Mahabaleshwar hills and foot hill area of Maharashtra to central India. Keeping in view the above facts it was conceptualized that if we track the rust urediniospores spread pathway from foot hills of Mahabaleshwar and adjoining districts in the period of late of January & first week of February, we get a clue that what are the conditions in foot hill areas. Such information can be very important for the surrounding states. Favorable environmental conditions for black rust outbreak in Madhya Pradesh generally occur from second week of February onwards. Therefore detail survey of Madhya Pradesh and surveillance is very important for strategic black rust management in Madhya Pradesh.

Material and Methods

Continuous roving surveys were conducted to document the status and prevalence of stem rust of wheat in major wheat growing areas in Madhya Pradesh and its adjoining areas and in Maharashtra adjoining areas of Mahabaleshwar during the cropping season 2020-21 and 2021-22. Survey conducted after every 10-15 Km on survey route at 2-5 spots in each location diagonally. Survey information was recorded using Google map and NoteCam Lite-GPS, Geo coordinate (Latitude, Longitude and Elevation) and other essential information such as Location, occurrence of disease (wheat stem rust), disease incidence and wheat varietal scenario in field were also obtained. Survey was conducted during 18 to 19 February 2021 and 10 to 11 February 2022 in Nashik, Ahmednagar, Pune and Satara districts of Maharashtra. In

the Madhya Pradesh, (Narmadapuram, Betul, Sehore, Bhopal, Raisen, Datia Gwalior, Chhatarpur, Panna, Satna, Rewa, Anoopur, Sidhi and Shahdol) it was conducted during 02 to 07 March 2021 and 03 to 08 March 2022 and meteorological information such as Temp°C Max. & Mini, Relative Humidity (RH %) Morning & Evening and Rainfall in mm were obtained from nearest meteorological observatories.

Disease incidence % in each field was assessed in five 1m² quadrants (1m × 1m) Four quadrants from the four corner of the field and the fifth approximately in the centre. An average of 10 plants was assessed along a diagonal within a quadrant to make a total of 50 plants and out of those with symptoms of stem rust disease was counted. The sum of number of infected plants per quadrant was divided by 50 and multiplied by 100. Disease incidence % and severity per field were assessed using modified Cob's scale (Peterson *et al.* 1948).

Table 1: Severity rating scale (Peterson *et al.*, 1948)

Scale	Description
Immune (0)	Immune with no infection
TR	Trace severity of a resistant type of infection
5MR	5 percent severity of a moderately resistant type
10MS	10 percent severity of a moderately Susceptible type
30S or 100S	30 percent or 100 percent severity of a susceptible type of infection.

Result

The survey was conducted in four districts of Maharashtra namely Nashik, Ahmednagar, Pune, Satara and adjoining Mahabaleshwar foot hills during the winter wheat growing season 2020-21 and 2021-22.

Incidence of wheat stem rust was observed in all four districts in 32 fields at the range of the Latitude from 17.9425 to 19.8609, Longitude from 73.8759 to 74.4096 and Elevation from 525m.a.s.l to 806m.a.s.l during 2020-21 (Table: 6). The wheat stem rust disease was not found in any district. There are wheat varieties over there Phule samadhan, Trimbak, NIAW 1415, MACS 6478, and NIDW 15 and Susceptible Varieties *viz.*, Ajay 72, GW 496, Ajeet 102, Lok 1, Eagle Daphtari, Bombay super and Local (table: 2).

Table 2: Survey of wheat stem rust incidence in four districts adjoining Mahabaleshwar, Maharashtra dated 18 & 19 February 2021.

S. No.	Locations of Maharashtra	Latitude	Longitude	ASL	DI	Variety
1.	Sinner, Nashik	19.8608	73.9644	668m.a.s.l.	No	Phule- samadhan
2.	Sinner, Nashik	19.8609	73.9652	668m.a.s.l.	No	Local
3.	Gurewadi, Nashik	19.8154	74.0335	569m.a.s.l.	No	Local
4.	Gurewadi, Nashik	19.8138	74.0326	569m.a.s.l.	No	NIDW 15
5.	Ratanmadi, Nadure thane	19.7622	74.0973	550m.a.s.l.	No	Phule- samadhan
6.	Sangamner, Ahmednagar	19.6417	74.1646	580m.a.s.l.	No	NIDW 15
7.	Gulewadi, Sangamner, Ahmednagar	19.6144	74.1824	591m.a.s.l.	No	Local
8.	Karjule Pathar, Sangamner, Ahmednagar	19.4134	74.2088	806m.a.s.l.	No	Local
9.	Bota, Ahmednagar	19.2673	74.1507	680m.a.s.l.	No	Ajay 72
10.	Santwadi, Maharashtra	19.2042	17.1188	723m.a.s.l.	No	NIDW 15
11.	Narayan Gram, Pune	19.132	73.9984	656m.a.s.l.	No	Trimbak
12.	Pacharnewadi, Pune,	18.8762	73.8995	772m.a.s.l.	No	Ajay 72
13.	Tukewadi, Rajgurunagar, Pune	18.8715	73.898	603m.a.s.l.	No	Local
14.	Sidhnathwadi, Wai, Satara	17.9461	73.8759	709m.a.s.l.	No	Phule- samadhan
15.	Phulenagar, Wai, Satara	17.9425	73.9058	709m.a.s.l.	No	Ajay 72
16.	Shabag, Wai, Satara	17.9431	73.9064	714m.a.s.l.	No	NIAW 1415
17.	Khandala Road, Satara	18.058	74.0693	663m.a.s.l.	No	Ajeet102
18.	Sukhed, Khandala Road, Satara	18.0343	74.1214	597m.a.s.l.	No	Ajay 72
19.	Sukhed, Khandala Road, Satara	18.0344	74.1215	597m.a.s.l.	No	NIDW 15
20.	Wadachamda, Khandala, Satara	18.0337	74.1297	663m.a.s.l.	No	MACS 6222

21	Wadachamda, Khandala, Satara	18.034	74.1283	663m.a.s.l.	No	Trimbak
22.	Sirur, Satara	18.113	74.2198	785m.a.s.l.	No	MACS 6222
23	Murti Baramati, Pune	18.1907	74.2741	552m.a.s.l.	No	HD-2189, Garima
24.	Jejuri, morgaon road, Baramati Pune	18.1942	74.2731	535m.a.s.l. 534m.a.s.l.	No No	Kedar MACS 6222
25.	Kedgaon toll Naka, Daund Pune	18.2194	74.2855	537m.a.s.l.	No	Green Gold
26.	Paregaon, Salonnlo Daund, Pune	18.2189	74.2859	525m.a.s.l.	No	NIDW 15
27.	Karde, Sirur, Pune	18.2427	74.2978	611m.a.s.l.	No	Lok-1
28.	Wadegavhan, Parner, Ahemadnagar	18.2423	74.2976	594m.a.s.l.	No	NIDW 15
29	Panali, Parner, Ahemadnagar	18.4922	74.3783	669m.a.s.l.	No	Ajeet102
30.	Akiuti, Parner, Ahemadnagar	18.5565	74.3789	649m.a.s.l.	No	Daphtari
31.	Lonimavala, Parner, Ahemadnagar	18.7394	74.3429	650m.a.s.l.	No	Bombay super
32.	Alebhata, Junnar, Pune	18.8529	74.4096	669m.a.s.l. 656m.a.s.l.	No No	Kedar MACS 6478

The procedures of survey and surveillance were followed in 2021-22 crop seasons. In the crop season 2021-22, twenty seven (27) fields were observed during 10 to 11 February 2022 at range of the Latitude from 17.9442 to 19.9010, Longitude from 73.8880 to 74.4145 and Elevation from 522.33 ASL to 772 ASL. Wheat stem rust disease was not found to endemic in all four districts of Maharashtra (Table: 3). In this year varietal scenario was almost similar as well with slightly changes. The meteorological information (Table: 6) is clearly indicating that the environmental conditions during the month of February and till the middle of March appear to be favorable for the development stem rust. Therefore, it is worth noting that there was no favorable condition till the middle of February but there was no black

rust establishment. During wheat growing season 2020-21 in Maharashtra the an average maximum temperature range from 28-32 °C whereas average minimum temperature ranges from 12-16 °C, average morning RH% ranged from 81- 88.% and it was evening 33- 66%. Whereas average rainfall at the same time ranged between 35-66mm. In crop season 2021-22 temperature, humidity & rain fall regime as Maximum temperature ranges from 25 to 31 °C while minimum temperature ranges from 10-17 °C, Average RH % in morning from 80-89% whereas average RH in evening was ranges from 36-70%. The rain fall pattern during both crop season 2020-21 and 2021-22 clearly showing that there was more rainfall in all four districts surveyed (Table: 6).

Table 3: Survey of wheat stem rust incidence in four districts adjoining Mahabaleshwar, Maharashtra during 10 to 11 February 2022.

S.N.	Locations of Maharashtra	Latitude	Longitude	ASL	DI	Variety
1.	Hincholi, Nashik	19.0093	73.9192	565.47m.a.s.l	No	Lok-1
2.	Bhatwadi, Sinner Nashik	19.901	73.9192	667.7m.a.s.l.	No	Lok-1
3.	Nadur, Shingle Sinner, Nashik	19.8285	73.9881	639.11m.a.s.l	No	Lok-1
4.	Gluliewadi, sangamner, Ahemadnagar	19.7237	74.1435	600m.a.s.l.	No No	Local Lok-1
5.	Hixvarg, Sangamnagar, Ahemadnagar	19.7239	74.1434	580m.a.s.l.	No	GW 496
6.	Giuliawadi, Sangamnagar	19.6427	74.1638	583.85m.a.s.l.	No	Kedar
7.	Malwadi-Botha, Alabhata, Pune	19.6318	74.1677	692m.a.s.l. 688m.a.s.l.	No	NIDW15 Local
8.	Chalakwadi, Alebhata, Pune.	19.5222	74.207	632.35m.a.s.l.	No	NIDW15
9.	Bhorwadi, Ambegaon, Pune	19.522	74.2068	677m.a.s.l.	No	Ajay 72
10.	Pacharnewadi, Ambegaon, Pune	19.2373	74.1338	772m.a.s.l.	No	MACS 6478I
11.	Wai, Wai, Satara	19.2372	74.1338	708.9m.a.s.l.	No	Local
12.	Sultanpun, Wai, Satara	19.1694	74.0775	706m.a.s.l.	No	NIDW15
13.	Kanjali Wai, Satara	18.9712	73.9456	714m.a.s.l.	No	Local
14.	Paragon, Khandala, Satara	18.8731	73.8982	665m.a.s.l.	No	Ajay 72
15.	Khandala, Khandala, Satara	17.9442	73.9032	616m.a.s.l.	No	MACS 6478
16.	Ahire, khandala, Satara	17.9474	73.888	589m.a.s.l.	No	Ajay 72
17.	Khed, BK, Khandala, Satara	17.9483	73.9247	640m.a.s.l.	No	Local
18.	Pimpore, Khandala, Satara	17.9604	73.9668	560.63m.a.s.	No	NIDW15
19.	Nimbut, Baramati, Pune	18.0491	74.0143	563m.a.s.l.	No	MACS 6222
20.	Murti, Baramati, Pune	18.0549	74.0216	607.25m.a.s.l 609.22m.a.s.l 628.22m.a.s.l	No No No	NIDW15 Ajeet102 Lok-1
21.	Morgaon, Baramati, Pune	18.0589	74.067	610.12m.a.s.l.	No	Local
22.	KhaduKherwadi, Baramati, Pune	18.0458	74.0849	621.03m.a.s.l 625.02m.a.s.l.	No No	Trimbak NIDW15
23.	Padavi, Baramati, Pune	18.034	74.1216	578.81m.a.s.l 545m.a.s.l	No No	MACS 6478 Trimbak
24.	Boripardi, Baramati, Pune	18.036	74.2208	548.05m.a.s.l	No	Ajay 72
25.	Deshmukh, Mala, Baramati, Pune	18.0893	74.2125	522.33m.a.s.l	No	NIDW15
26.	Paregaon, Daund, Pune	18.0891	74.2125	526.18m.a.s.l.	No	Local
27.	Mawalewadi, Parner, Ahemadnagar	18.1183	74.2208	582.62m.a.s.l 586.03m.a.s.l.	No No	NIDW15 MACS 6478

Survey and surveillance was also conducted in major wheat growing areas of Madhya Pradesh during 2020-21 and 2021-22. During 2020-21, surveillance was scheduled during 16-19 March 2021 at the range of the Latitude 22.7668 to 24.8864,

Longitude 78.3398 to 81.6560, and Elevation 258m ASL to 737m.ASL. The varieties encountered in this survey programme are WH 147, GW 273, HI 1500, GW 322, MP 3010, HD 2967, Lok-1 and Local (Table: 4).

Table 4: Survey of wheat stem rust incidence in Madhya Pradesh dated from 16 to 19 March 2021.

S. No.	Location of Madhya Pradesh	Latitude	Longitude	Elevation	DI	Varieties
1.	Pipariya Kalan Road, Hatwas	22.7668	78.3398	258m.a.s.l	No	WH 147
2.	Pipariya Kalan Road, Rampur	22.7724	78.4055	340m.a.s.l	No	Local
3.	Pipariya Kalan Road Bankhedi	22.7739	78.528	336m.a.s.l	No	GW273
4.	Unwanted road, Bauchhar	22.9961	79.3362	362m.a.s.l	No	GW 322
5.	National Hwy 45, Bairagi	23.2209	80.3033	561m.a.s.l	No	Local
6.	MP State Hwy 22, Mya Karondi Ryt	23.1989	80.5468	555m.a.s.l	No	MP 3020
7.	MP State Hwy 22, Karondi Mal	23.1956	80.5803	603m.a.s.l	No	Lok-1
8.	MP State Hwy 22, Bhardwara Mal	23.1752	80.6545	586m.a.s.l	No	HI 1500
9.	MP State Hwy 22, Bhardwara Mal	23.1752	80.6545	637m.a.s.l	No	Local
10.	MP State Hwy 22, Bilgaon	23.1234	80.7721	694m.a.s.l	No	GW 273
11.	MP State Hwy 22, Bilgaon	23.1234	80.7722	694m.a.s.l	No	MP 3020
12.	Amarkantak Road, Bargaon Mal	22.8258	81.3122	737m.a.s.l	No	Local
13.	Unknown road, Majhauri	23.1835	81.2224	408m.a.s.l	No	GW 322
14.	Unknown road, Majhauri	23.6646	81.2048	405m.a.s.l	No	HD 2967
15.	Unknown road, Silpara	24.4982	81.2956	301m.a.s.l	No	GW 322
16.	Padra road, COA, Rewa	24.5345	81.2768	300m.a.s.l	No	MP 3020
17.	Rewa road, Nauwa	24.677	81.4954	311m.a.s.l	No	GW 322
18.	Unnamed road, Kalwari	24.8864	81.656	341m.a.s.l	No	GW 322

The survey was repeated in next crop season i.e. 3 to 8 March 2022 it was spread over 29 fields across 18 districts of Madhya Pradesh. The Geo coordinates of location surveyed are as under the Latitude ranges from 22.7497 to 26.3136,

Longitude ranges from 77.3761 to 82.2500 and Elevation from 203m.ASL to 900m.ASL. Wheat varieties grow across the area are as GW 273, HI 1500, GW 322, MP 3010, WH 147, Lok⁻¹ and Local varieties (Table: 5)

Table 5: Survey of wheat stem rust incidence in Madhya Pradesh dated from 03 to 08 March 2022.

S. No.	Location of Madhya Pradesh	Latitude	Longitude	ASL	DI	Varieties
1.	Khanda Bad, Salkanpur road Bhopal	22.7731	77.7681	307m.a.s.l.	No	GW273
2.	Maliwayan, Salkanpur, road, rehti, Sehore	22.7497	77.4697	305m.a.s.l.	No	HI1500
3.	Chakai, Khanda Bad, Budni sehore	22.8064	77.3761	318m.a.s.l.	No	Local
4.	Amdoh, ghoda dongari, Betul	23.4556	77.6425	374m.a.s.l.	No	GW 322
5.	Tumda Kheda, raisen road	23.1167	77.6531	479m.a.s.l.	No	GW 322
6.	Narwar, gairatgang Raisen	23.5128	78.6292	460m.a.s.l.	No	GW 273
7.	Narwar, gairatgang, Raisen	23.5128	78.6322	460m.a.s.l	No	Local
8.	Kudari, Dabara, Gwalior	24.5142	79.2214	460m.a.s.l.	No	Local
9.	Panna, Khajuraho-road	25.3342	80.3089	258m.a.s.l.	No	MP 3020
10.	Panna, Khajuraho-road	25.3342	80.3089	258m.a.s.l.	No	WH 147
11.	Panna, Khajuraho-road	25.4406	80.0794	298m.a.s.l.	No	Lok 1
12.	Chaubara, Nowgong, Chhatarpur	25.1358	79.7708	229m.a.s.l	No	Local
13.	Chirula, Datiya	25.9936	78.8186	245m.a.s.l.	No	Local
14.	Jhansi road, Gwalior	26.2803	78.6686	205m.a.s.l.	No	Local
15.	Badera, Bhandair, Datiya	26.3136	78.6628	203m.a.s.l.	No	MP 4010
16.	Khajuraho, Chhatarpur	25.3422	80.5075	231m.a.s.l.	No	MP 3020
17.	Toriya, Chhatarpur	25.2511	80.6603	220m.a.s.l.	No	WH 147
18.	Panna-satna Road	25.2581	80.6281	224m.a.s.l.	No	Lok 1
19.	Dudaha, Satna	24.8408	81.2131	333m.a.s.l.	No	GW 322
20.	Tali Khurd, Sahdol, Sahdol	24.4883	81.6094	405m.a.s.l.	No	GW 273
21.	Mahula, Raipur, Karchuliyan, Rewa	25.0183	81.8253	318m.a.s.l	No	HI 1500
22.	Didwapani, Jaithari, Anoopur	23.1075	82.0556	529m.a.s.l.	No	Local
23.	Bijauri, Pushprajgarh, Anoppur	23.3594	82.25	900m.a.s.l.	No	Gw 322
24.	Malgaon, Bharatpur, sidhi	24.5306	81.6111	309m.a.s.l.	No	Gw 322
25.	Tanghar, Behari, Shahdol	24.1664	81.6108	347m.a.s.l.	No	Local
26.	Sirkhini, raipur, Karchuliyan, Rewa	24.9347	81.6731	337m.a.s.l.	No	Local
27.	Bansa, Rewa	24.6775	81.5197	327m.a.s.l.	No	GW 273
28.	Ganeshpur, Mal, Dindori	23.1031	81.6136	702m.a.s.l.	No	GW 273
29.	Bilgaon, Dindori, Dindori	23.2267	81.2864	696m.a.s.l.	No	GW 273

During the winter wheat growing season 2020-21 in Madhya Pradesh Average maximum temperature range from 27.8-30.0

°C, Average minimum temperature range from 10.0-15.4 °C. Average morning RH% ranged from 60.5-87.5, Average

evening RH% ranged from 29.3-53.7 and Average rainfall ranged from 11.5-94mm. Average maximum temperature range from 25.7 °C-28.3 °C, Average minimum temperature ranged from 9.6 °C-14.2 °C, Average morning RH% ranged from 64.4 to 89.4, during the wheat growing season 2021-22

in Madhya Pradesh. There was rains on both the cropping years between SMW 44 to 52 (2020-21) and SMW 01 to 13 (2021-22). But it was observed that during 2021-22 comparatively there was more rain everywhere in the survey areas except Powarkheda (Table: 6)

Table 6: Mean meteorological data of Nashik, Pune, Satara and Ahemadnagar district of (MH) and Powarkheda, Sehore, Bhopal, Khajuraho, Nowgong, Rewa, Tikamgarh Gwalior and Morena district of (MP) crop season 2020-21 and 2021-22

Observatory	SMW	2020-21					2021-22				
		Mean temp. (°C)		Mean RH %		Total rainfall	Mean temp. (°C)		Mean RH %		Total rainfall
		Max	Mini	Morn	Even	mm.	Max.	Mini.	Morn	Even	mm
Nashik (MH)	SMW 44 to 52 SMW 01 to 13	30.88	13.04	87.8	41	35.7	29.57	11.9	81.5	46.5	62.8
Pune (MH)	SMW 44 to 52 SMW 01 to 13	31.89	14.81	87.5	34.3	46.9	31.2	15.22	89.2	36.5	102.5
Mahabaleshwar Satara (MH)	SMW 44 to 52 SMW 01 to 13	28.08	12.63	88.4	66	65.7	25.25	10.28	89.1	69.8	187.5
Rahori, Ahemadnagar (MH)	SMW 44 to 52 SMW 01 to 13	30.44	15.94	81.9	33.8	66.2	29.9	16.74	79.9	36.5	119.6
Powarkheda (MP)	SMW 44 to 52 SMW 01 to 13	30.07	15.44	66.7	39.7	11.5	25.75	11.49	76.6	37.6	8.2
Sehore (MP)	SMW 44 to 52 SMW 01 to 13	28.54	14.71	74.4	37.5	94	27.2	14.23	75.3	39.7	146
Bhopal (MP)	SMW 44 to 52 SMW 01 to 13	28.54	14.71	74.4	37.5	94	27.2	14.23	75.3	39.7	146
Khajuraho (MP)	SMW 44 to 52 SMW 01 to 13	29.51	11.88	77.2	46.9	13.2	27.65	10.75	81.5	46.8	101.2
Nowgong (MP)	SMW 44 to 52 SMW 01 to 13	29.62	11.76	81.4	50.2	17.2	27.65	10.32	89.4	63.3	99.8
Rewa (MP)	SMW 44 to 52 SMW 01 to 13	28.86	12.06	65.3	29.4	13	28.3	12.04	69.1	31.8	129
Tikamgarh (MP)	SMW 44 to 52 SMW 01 to 13	27.86	10.42	87.3	42.2	37.4	26.49	10.53	84.8	44.5	110
Gwalior (MP)	SMW 44 to 52 SMW 01 to 13	27.86	10.01	87.5	53.7	62	26.29	9.65	85.3	52	47.2
Morena (MP)	SMW 44 to 52 SMW 01 to 13	28.03	11.51	60.5	45.2	36	26.7	12.09	64.5	48.4	33.7

Discussion

The objective of this survey and surveillance programme was to detect the initial establishment of disease during first and second week of February for further spraying. Central India was informed that this effort will help develop a black rust management strategy suitable for Madhya Pradesh. Here generally black rust favorable environment comes here in the third week of February onward. In addition we have also collected the black rust resistance (*Sr* genes) broth brake of varieties grow in those regions (Peninsular region) to identify the brake down of rust resistance genes leading to the development of new pathotypes. Timely sowing, vigil will enable us to know the likely spread possible prevalence of black rust in similar *Sr* genes brevieri cultivars in central India.

This effort will be helpful in releasing preventive measures and prophyladic spraying can be done if required that there was no incidence of black rust during 2020-21 and 2021-22 neither in Mahabaleshwar foot hills nor in Madhya Pradesh Clearly pointing to the no establishment of initial inoculum of black rust, even through some susceptible cultivars it is found to be non susceptible even in the source area of Nilgiri hills or required environmental conditions and north face urinal current may be responsible for inoculum multiplication, sporulation. Because of above there was no must occur in Central India as evidenced by (tables 1 & 2). However the varietal scenario in Madhya Pradesh envisages resistant as

well as some susceptible varieties as evidenced by (Tables 3 & 4).

Ongoing documentation of the prevalence of wheat stem rust in major wheat growing regions and investigation of species virulence structure and dynamics in pathogen population is of paramount importance for the wheat improvement (Admassu *et al.* 2009) ^[1]. Examined the prevalent and intensity of the wheat stem rust and detected the virulence spectrum of pathogen (*Puccinia graminis* f. sp. *tritici*) in wheat growing areas of eastern Showa of central ethiopia (Leema *et al.* 2014). Bhardwaj *et al.* (2019) ^[2] monitoring of wheat rusts in India was initiated in the 1920s, systematic monitoring of wheat rusts started around 1967. Wheat Disease Trap Plot Nurseries (TPN) have been planted since then to monitor the occurrence of wheat diseases in different parts of India allowing the occurrence and migration pathways of the wheat rust pathogens and in particular the rusts to be determined. It has been extended to neighboring countries through the establishment of another nursery from South Asian Association for Regional Cooperation (SAARC) countries. Which have also planted in saplings neighboring Countries.

Conclusion

This study revealed that even in presence of susceptible varieties of wheat like Ajay 72, GW 496, Ajeet 102, Lok 1, Eagle Daphtari and Bombay super, wheat stem rust in Maharashtra region was not there. Subsequently in Madhya

Pradesh region as well no black rust occurrence was observed, even on prevailing susceptible genotypes viz. GW 273, HI 1500, GW 322, MP 3010, WH 147 and LOK-1. Similar trend of result of not rust occurrence was found in both the crop seasons i.e. 2020-21 and 2021-22. Based on the two years observation it can be concluded that if inoculum establishment in Mahabaleshwar foothills was not there up to 1st week of February then risk of its further spread in Central India is very meager and in turn there will be very less feasibility of stem rust occurrence in Madhya Pradesh. According to the agro ecological region facts provided on prevalence of wheat stem rust, it will be very useful in monitoring and management of the existing factors that affect the disease levels. Hence such type of study must be conducted every year in order to know the potential threat of black rust occurrence in Madhya Pradesh and to have adequate interventions timely and effectively if at all required.

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