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Initial Rust Incidence, Tracking and Tracing in Madhya Pradesh and Maharashtra

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ABSTRACT: Wheat is an important food grain crop and grown all over the world. Among all foliar diseases of wheat, brown rust is important disease of wheat. In this study a survey was conducted in Madhya Pradesh and Maharashtra to detect prevalence and incidence during the *Rabi* season 2021-22 and 2022-23 particularly targeting wheat growing area of both states. The survey spots were selected randomly in each district and stops were made at every 10-15 Km intervals. Three to five sub-locations were observed in each wheat field along a diagonal move at each spot. The information collected such as location, prevalence, incidence and severity of disease and wheat variety from survey were recorded by using Google Map and Notecam lite-GPS, geo coordinate (Latitude, Longitude and Elevation) and other essential information regarding fields were also obtained. In both the years disease score range from 0 to 40S was reported in Maharashtra. In Madhya Pradesh, the maximum disease score 40S reported in 9 locations and the 0 disease score reported in 4 locations in 2021-22 and in 2022-23, the maximum disease score 20S observed in 20 locations and the zero disease score was recorded in 5 locations.

Keywords: Survey, brown rust, Madhya Pradesh, Maharashtra, disease score.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most important stable food crop for more than one third of the world population and contributes more calories and proteins to the world diet than any other cereal crops (Abd-El-Haleem *et al.*, 1998; Adams *et al.*, 2002; Shewry, 2009). Wheat used to be grown in all over the world because of its nutritional value and other uses in many industries. In India 2021-22, Wheat is grown in 30.47 million hectares area with production 106.84 million tonnes. In Madhya Pradesh 2021-22, it was grown in 6.50 million hectares (21.33% of India) with production 22.42 million tonnes (20.98% of India). (Source: E&S Division, DA and FW, 4th advance estimates). It contains carbohydrate 78.10%, protein 12.70%, fat 2.10%, minerals 2.10% and considerable proportions of vitamins (thiamine and vitamin-B) and minerals (zinc, iron). Wheat is also a good source of traces minerals like Selenium and Magnesium, which are essential to good health (Adams *et al.*, 2002; Fraley, 2003; Shewry, 2009; Topping, 2007). It is nutritious, easy to store and transport and can be processed into various types of food. Considering its importance, it needs protection measures in case of disease occurrence. Hence it avoid be almost important to have information regarding biotic stress of wheat. There are many foliar diseases are reported in wheat crop among them brown rust is a major aerial disease caused by *Puccinia triticina* (Joshi *et al.*, 2007). Indian wheat rust epidemics were chronicled historically by Nagrajan and Joshi (1975). Heavy attack of brown rust was recorded in variety C-281, U6, K65, A098, A115, C-273 at Powarkheda farm during 1967-68 in addition to a few local varieties sown in Pipariya tehsil (Mishra and Singh 1969). Effective management of rust diseases and increased wheat production in India are the results of a coordinated strategy that includes regular disease surveys, bolstering research capacity, developing new rust-resistant varieties, and assuring their adoption. Although many other countries have experienced rust outbreaks, India has not experienced a wheat rust epidemic for the past 47 years, providing strong evidence to support the claim (Bhardwaj *et al.*, 2019). If the occurrence of brown rust appears on the early stage of crop it may cause loss 80% and on heading/flowering cause more than 50% which is much more loss than stem rust. Since, brown rust is a obligate pathogen and as per green bridge theory it is suppose to be perpetuate from Nill giri hills and from there it ramifies towards central India through Mahabaleshwar foot hills. In this context it has been conceptualize that if we track the brown rust inoculums in Mahabaleshwar foot hills in the month of January then its further progress and disease development in central India can be predicted well within time and then we can successfully recommended disease contentment strategies by deployment of slow rusting line and

resistance varieties in adjoining area of Maharashtra and Madhya Pradesh. This practice will definitely protect wheat crop in Madhya Pradesh from severe occurrence and epiphytotic development of brown rust. Owing to which it has been decided to carry out details survey and surveillance programme in Mahabaleshwar foot hills. Keeping above facts in view, a comprehensive study of prevalence of brown rust of wheat in central India has been conducted during last week of February onwards. The main aim this study to observe prevalence of this disease in Mahabaleshwar foot hills as early as possible so that precautionary action in adjoining states to break Puccinia path at initial stage of disease appearance. Since, it was conceptualized that brown rust migration/spread start from Nilgiri to Central India then towards North India. In this connection our survey programme is very much important to track the inoculums as well as disease prevalence starting from Mahabaleshwar foothills to Central India and our efforts also continue to trace the incidence in adjoining districts of Uttar Pradesh. If any lead arises out of our work it will be communicated to the adjoining states agriculture administration so that any major outbreak/loss to farmer's can be prevented.

MATERIALS AND METHODS

For studying prevalence of wheat brown rust a roving survey was conducted in adjoining areas of Madhya Pradesh and Maharashtra to record incidence of brown rust during the *Rabi* season 2021-22 and 2022-23 particularly targeting wheat growing area of both states. Survey covered four districts of Maharashtra namely Pune, Nashik, Ahmednagar and Satara and twelve districts of Madhya Pradesh namely Gwalior, Harda, Datia, Sehore, Raisen, Rewa, Shahdol, Tikamgarh, Panna, Satna, Chattarpur, Narmadapuram. A total of 36 farmer's fields were assessed in Maharashtra from four districts *viz.*, Pune, Satara, Nashik, Ahmednagar in 2021-22 and 37 farmer's fields in 2022-23. In Madhya Pradesh 35 farmer's fields were assessed in 2021-22 and 40 farmer's fields in 2022-23. The survey spots were selected randomly in each district and stops were made at every 10-15 Km intervals. Three to five sub-locations were observed in each wheat field along a diagonal move at each spot. Brown rust infected leaves of wheat which were showing characteristics symptoms of disease were collected. The information collected such as location, prevalence, incidence and severity of disease and wheat variety from survey were recorded by using Google Map and Note cam lite-GPS, geo coordinate (Latitude, Longitude and Elevation) and other essential information regarding fields were also obtained. The favourable time for appearance of wheat brown rust disease was February month. Present survey was conducted in first and second week of February both years in different districts of Maharashtra and thereafter up to last week of February in Madhya Pradesh. The samples were kept in paper envelops and each envelope was marked clearly to show details of the location, variety, reaction type and date of disease collection. Disease score was given with the help of modified Cobb scale (Peterson *et al.,* 1948) based upon percentage of the plant infected and type of disease reaction.

RESULT AND DISCUSSION

In Maharashtra state, districts namely; Nashik, Pune, Satara, Ahmednagar and adjoining Mahabaleshwar foot hills area were surveyed in winter wheat cropping season 2021-22. The data recorded at the range of latitude from 17.9421 to 19.9010, longitude from 73.8981 to 74.4145 and elevation from 536m to 760m ASL during 2021-22 in first week of February. Majorly grown wheat varieties in surveyed locations were as MACS 6478, NIAW 3170, NIDW-15, Golden-23, Phule samadhan, Ajeet-102, Trimbak, Amber-28, MACS 6222, Ajay-72, Green gold, NIAW 1994, Garima and local cultivars (Table 1). Out of them MACS 6478, MACS 6222, NIAW 3170 and NIAW 1994 were showed highly resistant to brown rust with disease score zero. Varieties Golden 23, Green gold, Phule samathan, Trimbak and NIDW 15 were showed moderately susceptible reaction for brown rust with disease score 20MS to 40MS. Remaining cultivars *viz*., Local, Ajay 72, Ajeet-102, Amber-28 and Garima were showed susceptible disease reaction with disease score 10S to 40S. During survey and surveillance 2021-22 altitude ranges from 536m to 760m ASL, it was found that in all locations of Maharashtra around Mahabaleshwar foothills, the brown rust incidence was everywhere. Rust score range from 0 to 40S during 2021-22. The maximum brown rust incidence was reported at 5 locations viz; Lonand, Khandala; NH60-Sinnar; SH63-Surul, Wai; Kenjal-Wai and NH48, Khandala of Satara and Nashik districts where disease score was 40S at altitude 629m, 671m, 712m, 758m, 760m ASL. The minimum brown rust incidence was reported at 12 locations of Pune, Ahmednagar, Satara and Nashik where disease score was 10S at altitude 565m (Pune Nashik road, Sinnar), 673m (NH60,Sinnar), 641m(Nandur Shingote Marhal road, Sinnar), 632m (Nandur Shingote Marhal road, Nandur Shingote), 583m (Sangamner, Ahmednagar), 644m (Pune Nashik road, Ambegaon, Pune), 712m (SH63, Surul, Wai, Satara), 556m (NH965D, Margaon, Bramati, Pune), 615m (Songaon Shendre road, Supe, Bramati, Pune), 596m (SH62, Kedgaon, Daund, Pune), 590m (Parner, Ahmednagar) and 596m (Parner, Ahmednagar) ASL. Disease score 20MS was revealed in 7 locations at altitude 665m (NH60, Sinnar, Nashik), 639m (NH60, Nandur Shinghote, Sinnar, Nashik), 627m (SH72, Wai, Satara), 705m (Wai, Satara), 668m (NH48, Khandala, Satara), 668m (Khandala, Satara) and 536m (SH50, Parner, Ahmednagar) ASL. 20S disease score was reported on 4 locations at altitude 572m (Pune, Nashik road, Sinnar, Nashik), 626m (Shirur Satara road, Khandala, Satara), 597m (Kedgaon, Daund, Pune) and 549m (SH62, Pargaon, Daund, Pune) ASL. Around 4 locations were reported where disease score was zero at altitude 537m (Pargaon, Daund, Pune), 604m (Daund, Pune), 560m (Shirur Satara road, Baramati, Pune) and 693m (NH60, Sangamner, Pune) ASL.

Table 1: Different locations of survey in Maharashtra during winter wheat season 2021-22.

Sr. No.	Location	Latitude	Longitude	Elevation (ASL)	Disease score 2021-22	Variety
1.	Pune Nashik Road, Nashik, Sinnar	19.901	73.919	565	10S	Local
2.	Pune Nashik Road, Sinnar, Nashik	19.900	73.919	572	20S	NIDW 15
3.	NH60, Sinnar, Nashik	19.828	73.988	665	20MS	Golden-23
4.	NH60, Sinnar, Nashik	19.828	73.987	671	40S	Local
5.	NH60, Sinnar, Nashik	19.828	73s.987	673	10S	Local
6.	NH60, Nandur Shingote, Sinnar, Nashik	19.723	74.143	645	10MS	Phule Samadhan
7.	Nandur Shingote Marhal Road, Nandur Shingote, Sinnar, Nashik	19.727	74.143	641	10S	Local
8.	NH60, Nandur Shingote, Sinnar, Nashik	19.642	74.163	639	20MS	Golden-23
9.	Nandur Shingote Marhal Road, Nandur Shingote, Sinnar, Nashik	19.636	74.167	632	10S	Ajeet-102
10.	Sangamner, Ahmednagar	19.525	74.206	583	10S	Local
11.	Sangamner, Ahmednagar	19.516	74.211	586	10MS	Trimbak
12.	NH60, Sangamner, Pune	19.237	74.133	693	00	NIAW 1994
13.	Pune Nashik Rd, Ambegaon, Pune	19.169	74.074	644	10S	Amber-28
14.	Pune Nashik Road, Khed, Pune	18.971	73.945	680	10MS	NIDW 15
15.	SH72, Wai, Satara	18.873	73.898	627	20MS	NIDW 15
16.	Wai, Satara	17.942	73.903	705	20MS	NIDW 15
17.	SH63, Surul, Wai, Satara	17.945	73.909	712	10S	Local
18.	Kenjal, Wai, Satara	17.948	73.924	712	40S	Local
19.	Kenjal, Wai, Satara	17.960	73.966	758	40S	Ajay 72
20.	NH48, Khandala, Satara	17.960	73.966	760	40S	Ajay 72
21.	NH48, Khandala, Satara	18.049	74.014	668	20MS	NIDW 15
22.	Khandala, Satara	18.049	74.014	668	20MS	Trimbak
23.	Lonand, Khandala, Satara	18.058	74.066	629	40S	Local
24.	Shirur Satara Road, Khandala, Satara	18.035	74.139	626	20S	Local
25.	Shirur Satara Road, Baramati, Pune	18.089	74.212	560	00	MACS 6478
26.	NH965D, Morgaon, Baramati, Pune	18.118	74.220	556	10S	NIDW 15
27.	Songaon Shendre Road, Supe, Baramati, Pune	18.269	74.315	615	10S	Local
28.	NH965D, Daund, Pune	18.307	74.345	626	10MS	NIDW 15
29.	Daund, Pune	18.379	74.388	604	00	MACS 6222
30.	Kedgaon, Daund, Pune	18.379	74.388	597	20S	Ajay 72
31.	SH62, Kedgaon, Daund, Pune	18.379	74.388	596	10S	Ajay 72
32.	SH62, Pargaon, Daund, Pune	18.471	74.378	549	20S	Local
33.	Pargaon, Daund, Pune	18.503	74.377	537	00	NIAW 3170
34.	SH50, Parner, Ahmednagar	18.503	74.377	536	20MS	Green Gold
35.	Parner, Ahmednagar	18.875	74.414	590	10S	Garima
36.	Parner, Ahmednagar	18.877	74.413	596	10S	Local

After Maharashtra the survey was carried out in major wheat growing areas of Madhya Pradesh during the winter wheat cropping season 2021-22 and 35 fields of farmers were covered. The survey data was collected by using GoogleMap and Notecam lite-GPS. The data recorded at the range of latitude from 22.4458 to 25.7848, longitude from 77.2194 to 81.7500 and elevation from 203m to 900m ASL. In surveyed areas wheat varieties GW-273, HI1500, LOCAL, GW-322, GW-323, MP-4010, MP-3020, WH-147, LOK-1, GW-173, MP1203, Tejash, MP-1605 and MP-3382 were grown by farmers. Out of them zero disease score was recorded on three varieties *viz*., MP-1203, Tejash, MP-1605. Moderately resistant reaction was shown by varieties HI-1500 and moderately susceptible reaction shown by MP-4010, MP-3020. Highly susceptible reaction was shown by varieties GW-273, GW-322, GW323, Local, WH-147, LOK-1 and GW-173. The maximum brown rust incidence with 40S disease score were recorded in 9 locations at the range of altitude 206m (Jhansi- Mirjapur H., Baragaon) to 460m (Gairatganj road, Narwar) ASL. The minimum disease score 00 was reported on 4 locations with altitude 318m (Unnamed road, Chakladi), 362m (Bhainsar), 354m

(Panna- Satna road) and 529m (Amarkantak road, Didwapani) ASL. The disease score 5MR and 10MR were recorded at altitude 305m (Salkanpur road, Maliwayan) ASL and 318m (Unnamed road, Chakladi) ASL respectively. The disease score 20S was reported on 13 locations at the range of elevation i.e. 229m (Unnamed road, Chaubara) to 900m (Bijauri) ASL and 10S was recorded on 3 places at altitude 298m (Panna Khajuraho road, Moraha) , 205m (Jhansi road, Gwalior) and 224m (Panna- Satna road) ASL respectively.

In 2022-23, total 37 farmer's fields were surveyed in Maharashtra at the range of latitude from 18.0684 to 19.9002, longitude from 73.8460 to 74.3407 and elevation from 297m to 703m ASL (from Table 3). The disease score were recorded 00, trace, 10S, 10MS, 20S, 20MS and 40S. The maximum fields (13) showed 10S disease score at the range of latitude from 18.1349 to 19.8673, longitude from 73.8460 to 74.3407 and elevation from 297m to 703m ASL. A very few farmer's fields (02) showed the maximum disease score 40S at the range of latitude from 18.0684 to 18.8517, longitude from 73.8997 to 74.2121 and elevation from 603m to 610m ASL. Six locations were found which showed 20S disease score at the range of latitude from 18.0833 to 19.6522, longitude from 73.9126 to 742924 and elevation from 530m to 685m ASL. The altitude of locations where score was observed to be 00 are as follows 529m (Pune Nashik road, Chincholi, Sinnar), 573m (Sangamner bypass), 604m (Hiwargaon Pawasa, Sangamner bypass) , 668m (SH53, Ghodegaon, Ambegaon, Pune), 558m (NH965D, Baramati, Pune), 560m (Shirur Satara road, Baramati) and 588m (Sangamner, Ahmednagar) ASL respectively.

During 2022-23 in Madhya Pradesh 40 locations were surveyed at the range of latitude from 21.7706 to 25.2772, longitude from 77.0926 to 82.6429 and elevation from 210m to 609m ASL (from Table 4). The maximum disease score was 20S which were observed at 20 locations at the range of latitude from 21.7706 to 24.9927, longitude from 77.1720 to 82.6429 and elevation from 210m to 609m ASL on wheat varieties C 306, Sriram-303, GW-322, LOK 1, Malwa shakti, WBC and local. The 10S disease score were observed at 08 locations at the range of latitude from 21.9112 to 25.2772, longitude from 77.0926 to 82.5307 and elevation from 227m to 508m ASL. The minimum disease score 00 were recorded on 5 locations on varieties HI 8713, Tejash on altitude 309m (Mohari, Tikamgarh), 347m (Sarasdole, Narsinghpur), 345m (Itarsi, Narmadapuram), 352m (Batera, Raisen) and 457m (Dobhi, Sehore) ASL. Moderately resistant reaction was recorded on HI1544, MP 1203 with disease score 5MR and 10MR.

In Maharashtra, total 73 farmer's fields were surveyed in both years and no one field was found free from wheat brown/leaf rust. The varietal scenario was almost similar in both years with slightly changes. In Madhya Pradesh total 75 locations were surveyed in both year and here also no any location field was noted free from disease occurrence. Most probably farmers of this area used to grow susceptible and old cultivars every year. In general, the distribution of leaf rust in both states was less in 2022-23 than 2021-22. This may be due to unfavorable weather condition during cropping season. Resistance reaction was recorded in four places of Maharashtra. It was evident that four varieties *viz.*, MACS-6478, MACS-6222, NIAW-3170, NIAW-1994 were shown to have resistance reaction everywhere under the areas surveyed and this trend of occurrence was also almost similar in both the years of survey and surveillance. Around 5 varieties were recorded to have moderately susceptible reaction *viz.*, golden-23, Phule samadhan, trimbak, NIDW-15, Green gold and trend of this resistance reaction was almost similar in both the years. If we categories the occurrence of disease according to elevation of the location under survey it was found that irrespective of elevation ranging from 536m to 760m ASL, the disease prevalence was there and the disease score was largely found to be dependent on the genotypes under cultivation. It means the varieties which are resistant at lower altitude were also found to be resistant at higher altitude and vice versa. These finding was supported by Game and Mhaske, 2023 who surveyed in the February month at villages Talegaon, Dindori, Awankhed, Ozarkhed, Ambaner, Sajola, Khirad, Tirhal, Budruk, Chankapur and Payarpada in Nashik district of Maharashtra. The varieties under cultivation were found Ajeet 102, Ajay 72, Phule Samadhan, Kohinoor, Supreme MW 74, Lok-1, and GW 496 etc. First natural incidence of leaf rust was reported at Ozarkhed in Dindori tehsil on off types in variety Ajeet 102 which was sporadic and upto 40S and second field with incidence of leaf rust found at Tirhal Budruk in Kalvan tehsil on variety Lok-1, where the incidence was in traces and sporadic with low severity. Wheat rust survey was also conducted by Kumar *et al.* (2023) in Satara, Pune and Ahmednagar districts in Maharashtra. Incidence of leaf-rust was observed upto 20S on off-type wheat and upto 5S on improved varieties

In Madhya Pradesh, brown rust occurrence was observed in various districts *viz.*, Narmadapuram, Harda, Raisen, Sehore, Bhopal, Narsinghpur, Jabalpur, Dindori, Sahdol. During January 22 incidence of leaf rust (5S to 10S) was observed on some off types and local varieties at Sanghi, Satara, Nashik, Pune and Kolhapur districts and other areas including Dhule, Rahuri, Pravaranagar in Maharashtra. Similarly, up to 10S brown rust severity was reported from Fanda and Jagriya villages in Sehore district and Donta Jagir, Bhatuni and other village in district Dewas in Madhya Pradesh. Wheat monitoring teams of different zones also reported the occurrence of wheat rusts in the areas visited by them (Anonymous, 2022). Likewise, leaf (brown) rust was reported during February and March from few farmers field in Bihar and Maharashtra only (Anonymous, 2021).

A continuous survey in hot spot areas against rust of wheat is very important for detecting virulence composition and races development for wheat improvement said by Admassu *et al*. (2009). In present study, the level of disease severity in surveyed locations found in most of areas high this was supported by the findings of Tomar *et al*. (2020) who conducted survey in Uttar Prdesh and adjoining area of Madhya Pradesh. Findings showed that the brown rust occurred in all

surveyed field with low to high severity and none field was free from leaf rust disease. Similarly, Hailu and Woldeab (2015) surveyed the wheat growing areas and leaf rust severity found up to 80S in Emmer wheat. The monitoring and surveillance in wheat growing areas is very necesarry for sustainable production and food security. Joshi *et al.* (1974) reported rust population from southern foci moves northwards towards Maharashtra and Madhya Pradesh and another population moves from the northern foot hills towards the South and finally both the populations, moving in opposite directions merge into each other. Wheat disease surveys conducted since 1967 have also demonstrated that the first build up of leaf rust like stem rust takes place in the plains of Karnataka in South India, generally in the last week of December. At the same time the infection is also established in the foot hills of Bihar and Eastern part of Uttar Pradesh. Another epidemic of brown rust occurred in 1993 in about 4 million hectares of North Western India. India, Pakistan, Bangladesh, and Nepal grow nearly 37 mha of wheat, of which 30 million are at risk to leaf rust losses. During 1971–1972 and 1972–1973 there were severe outbreaks of leaf rust in North Western India. Losses were estimated for varieties Kalyansona (5.9%), K-68 (24.1%) and Sonalika (2.0%) according to view of Joshi *et al.* (1975). Bilgili (2013) determined wide spread of leaf rust and yellow rust of wheat in all surveyed fields out of three type rust of wheat. This study also occurrence of brown rust found everywhere from low to high disease score means it is required regular monitoring any time become threat for wheat production.

Table 2: Different locations of survey in Madhya Pradesh during winter wheat season 2021-22.

Sr. No.	Location	Latitude	Longitude	Elevation (a.s.l)	Disease score 2021-22	Variety
1.	Salkanpur Road, Khanda Bad	N 22.462	E 77.366	307 m	40S	GW 273
2.	Salkanpur Road, Maliwayan	N 22.445	E 77.281	305 m	20S	HI 1500
3.	Unnamed Road, Chakladi	N 22.482	E 77.219	318 m	00	MP1203
4.	Unnamed Road, Amdoh	N 22.868	E 77.383	374 m	20S	GW322
5.	Kolar Road, Tumda Kheda	N 23.070	E 77.391	479 m	20S	GW323
6.	N.H. 146, Bhopal-Sagar highway road	N 23.284	E 77.697	432 m	40S	LOCAL
7.	Gairatganj Road, Narwar	N 23.304	E 77.974	460 m	40S	GW273
8.	Gairatganj Road, Narwar	N 23.304	E 77.974	460 m	20S	LOCAL
9.	Kudari, Dabara	N 23.905	E 78.731	515 m	20S	Local
10.	Bhainsar	N 24.609	E 78.742	362 m	00	Tejash
11.	Jhansi - Mirjapur H., Sakrar	N 25.350	E 78.888	240 m	20MS	MP4010
12.	Panna Khajuraho Road	N 24.796	E 79.783	258 m	20MS	MP3020
13.	Panna Khajuraho Road	N 24.796	E 79.783	258 m	40S	WH 147
14.	Panna Khajuraho Road, Moraha	N 24.858	E 79.644	298 m	10S	LOK1
15.	Unnamed Road, Chaubara	N 25.080	E 79.457	229 m	20S	LOCAL
16.	Jhansi - Mirjapur H., Baragaon	N 25.233	E 79.195	206 m	40S	GW 322
17.	Jhansi - Mirjapur Highway, Sakrar	N 25.350	E 78.888	240 m	20S	LOK1
18.	Chirula	N 25.589	E 78.490	245 m	20S	Local
19.	Jhansi Road, Gwalior	N 25.764	E 78.400	205 m	10S	Local
20.	Srinagar - Kanyakumari H, Badera	N 25.784	E 78.394	203 m	20MS	MP4010
21.	Khajuraho Airport Road, Khajuraho	N 24.799	E 79.902	231 m	20MS	MP3020
22.	Panna Khajuraho Road, Toriya	N 24.746	E 79.989	220 m	40S	WH 147
23.	Panna-Satna Road	N 24.741	E 79.974	224 m	10S	LOK1
24.	Panna-Satna Road	N 24.623	E 80.355	354 m	00	MP1605
25.	Dudaha	N 24.502	E 80.724	333 m	40S	GW 322
26.	State Highway 9, Tali Khurd	N 23.891	E 81.363	405 m	40S	GW 273
27.	Rewa Road, Mahula	N 24.610	E 81.493	318 m	10MR	HI 1500
28.	Amarkantak Road, Didwapani	N 23.062	E 81.628	529 m	00	MP3382
29.	Bijauri	N 22.809	E 81.750	900 m	20S	GW322
30.	State Highway 9, Malgaon	N 24.315	E 81.364	309 m	20S	GW322
31.	State Highway 9, Tanghar	N 24.095	E 81.359	347 m	40S	LOCAL
32.	Rewa Road, Sirkhini	N 24.560	E 81.402	337 m	20S	LOCAL
33.	State Highway 9, Bansa	N 24.403	E 81.307	327 m	20S	GW273
34.	Ganeshpur Mal.	N 23.057	E 80.964	702 m	20S	GW273
35.	State Highway 22, Bilgaon	N 23.129	E 80.767	696 m	20S	GW173

Table 3: Different locations of survey in Maharashtra during winter wheat season 2022-23.

Sr. No.	Location	Latitude	Longitude	Elevation (a.s.l.)	Disease score 2022-23	Variety
1.	Pune Nashik Road, Nashik, Sinnar	19.900	73.920	604	00	MACS 6478
2.	Pune Nashik Road, Chincholi, Sinnar	19.878	73.947	529	00	NIAW 3170
3.	NH60, Chincholi, Sinnar	19.866	73.961	703	10S	Local
4.	Pune Nashik Road, Chincholi, Sinnar	19.867	73.961	703	10MS	Trimbak
5.	NH60, Sinnar, Nashik	19.858	73.965	703	10MS	NIDW 15
6.	MDR52, Dubere Gaon, Dubere, Sinnar	19.826	73.991	702	10S	Amber-28
7.	NH60, Nandur Shingote, Sinnar, Nashik	19.729	74.130	297	10S	Local
8.	NH60, Ghulewadi, Sangamner	19.652	74.161	668	20MS	NIDW 15
9.	Ghulewadi, Sangamner, Ahmednagar	19.596	74.183	588	20MS	Golden-23
10.	Sangamner Bypass, Ghulewadi, Sangamner, Ahmednagar	19.597	74.183	588	10S	Local
11.	Sangamner Bypass, Sangamner	19.538	74.204	573	00	MACS 6222
12.	Sangamner Bypass, Sangamner	19.523	74.204	588	10S	Local
13.	Sangamner, Ahmednagar	19.516	74.211	588	TRACE	MACS 6222
14.	Hiwargaon Pawasa, Sangamner Bypass, Sangamner, Ahmednagar	19.508	74.208	604	00	NIAW 1994
15.	NH60, Bota, Sangamner, Ahmednagar	19.270	74.150	685	20S	Local
16.	NH60, Sangamner, Ahmednagar	19.237	74.133	698	10S	Ajay 72
17.	NH60, Junnar, Pune	19.162	74.062	628	10S	Ajay 72
18.	Junnar, Pune	19.157	74.048	642	10S	Local
19.	SH53, Ghodegaon, Ambegaon, Pune	19.037	73.846	668	00	MACS 6478
20.	SH53, Ambegaon, Pune	19.037	73.846	668	10S	Local
21.	SH53, Ambegaon, Pune	19.016	73.884	689	10S	Local
22.	SH53, Ambegaon, Pune	19.015	73.890	670	10S	Local
23.	Pune Nashik Road, Rajgurunagar, Khed, Pune	19.009	73.912	669	20MS	NIDW 15
24.	NH48;NH965DD, Shirwal, Khandala	18.851	73.899	610	40S	Local
25.	Pandharpur Road, Khandala, Satara	18.136	73.980	544	20MS	NIDW 15
26.	Pandharpur Road, Loni, Khandala, Satara	18.134	74.000	530	20S	Local
27.	Pandharpur Road, Loni, Khandala, Satara	18.117	74.047	587	20S	Ajay 72
28.	Pandharpur Road, Lonand, Khandala, Satara	18.111	74.096	541	20S	Ajay 72
29.	Pandharpur Road, Lonand, Khandala	18.083	74.147	589	20S	Local
30.	Shirur Satara Road, Khandala, Satara	18.068	74.158	603	40S	Local
31.	Shirur Satara Road, Baramati, Pune	18.088	74.212	560	00	NIAW 3170
32.	NH965D, Baramati, Pune	18.117	74.219	558	00	MACS 6222
33.	Shirur Satara Road, Modhave, Baramati, Pune	18.134	74.224	561	10MS	Green Gold
34.	Shirur Satara Road, Modhave, Baramati, Pune	18.193	74.272	599	10S	Local
35.	NH965D, Morgaon, Baramati, Pune	18.193	74.272	622	20S	Local
36.	Songaon Shendre Road, Supe, Baramati, Pune	18.234	74.292	612	20MS	NIDW 15
37.	Trimbak Road, Trimbakeshwar, Nashik	18.302	74.340	596	10S	Local

Table 4: Different locations of survey in Madhya Pradesh during winter wheat season 2022-23.

Sr. No.	Location	Latitude	Longitude	Elevation (a.s.l)	Disease Score 2022-23	Variety
1.	Sitorikala, Raisen	23.194	77.472	402	20S	GW 322
2.	Batera, Raisen	23.054	78.201	352	00	MP 1203
3.	Khargon, Raisen	23.516	78.195	508	10S	Lok1
4.	Chargaon, Raisen	23.049	78.107	506	20S	C306
5.	Koshiyari, Raisen	23.194	77.472	470	20S	Sri Ram 303
6.	Mana, Raisen	23.294	77.705	465	10S	Malwa Shakti
7.	Dobhi, Sehore	23.254	77.250	457	00	HI 8713
8.	Jawarkheda, Sehore	23.370	77.180	499	10S	Local
9.	Budhani, Sehore	22.774	77.678	311	20S	GW 322
10.	Rehti, Sehore	22.739	77.436	269	10S	Lok1
11.	Seoni Malva, Narmadapuram	22.451	77.464	320	20S	Local
12.	Dharam Kundi, Narmadapuram	22.510	77.548	271	20S	Local
13.	Sawal Kheda, Narmadapuram	22.651	77.675	307	20S	C306
14.	Palasdoh, Narmadapuram	22.686	77.684	308	10S	Local
15.	Kandra Khedi, Narmadapuram	22.649	77.644	305	20S	Lok1
16.	Dolaria, Narmadapuram	22.600	77.633	306	20S	GW 322
17.	Ratwada, Narmadapuram	22.560	77.601	288	20S	Local
18.	Itarsi, Narmadapuram	22.611	77.768	345	00	HI 8713
19.	Babai, Narmadapuram	22.704	77.935	300	10S	GW 322
20.	Narmadapuram city	22.754	77.715	278	20S	Local
21.	Khudiala, Tikamgarh	24.141	78.637	412	20S	Sri Ram 303
22.	Palera, Tikamgarh	24.992	79.237	210	20S	Local
23.	Mohari, Tikamgarh	25.120	80.056	309	00	MP 1203
24.	Tikamgarh	24.747	78.830	349	20S	WBC
25.	Dhamora, Chhatarpur	24.976	79.541	226	20S	Local
26.	Khapa, Chhatarpur	24.745	79.879	460	10MS	HI1544
27.	Ramnagar, Panna	24.337	80.274	381	20S	Local
28.	Tara, Panna	24.533	80.088	227	5MR	MP 1203
29.	Jharkuwa, Panna	24.356	80.047	225	20S	GW 322
30.	Basauda, Singarauli	23.867	82.642	609	20S	Local
31.	Chachar, Singarauli	23.971	82.530	599	10S	GW322
32.	Parasdehi, Singarauli	23.958	82.555	460	TRACE	MP3382
33.	Kumhiya, Singarauli	23.886	82.543	506	20MS	HI1544
34.	Sarasdole, Narsinghpur	23.110	79.055	347	00	Tejash
35.	Katangi, Narsinghpur	21.770	79.803	380	20S	Sriram-303
36.	Deori, Narsinghpur	21.911	79.676	363	10MS	HI1544
37.	Dighwan, Narsinghpur	25.277	78.821	307	10MS	MP 1203
38.	Charkheda, Harda	22.366	77.172	309	5MR	HI1544
39.	Timerni, Harda	22.365	77.225	309	20S	Local
40.	Kodala Upari, Harda	22.350	77.092	296	10S	Local

CONCLUSIONS

Maharashtra is providing initial inoculums for disease development in central India. Because of this reason, a survey was conducted in those areas to find out the prevalence of brown rust of wheat. By this study, an effective management strategy may be made for Madhya Pradesh. Because in Madhya Pradesh, primary inoculums for this disease is comes from Mahabaleshwar foot hills in the month of February onward. This survey may also give guidance in recommendation of preventive and prophylactic spraying of fungicides in Madhya Pradesh. There was disease reported in 2021-22 and 2022-23 in all areas of both states clearly pointing to establishment of initial inoculums of disease in source area of Nilgiri hills and also responsible for inoculums multiplication and spread in Central India.

FUTURE SCOPE

Survey is a regular process for tracking of pathogen behavior in growing field. It is also important for developing gene deployment frame for this particular area to minimize the disease occurrence.

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