

SURVEY OF KARNAL BUNT IN MEERUT DIVISION FOR MITIGATING PHYTOSANITARY RISK IN WHEAT EXPORT

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ABSTRACT

Karnal bunt of wheat caused by *Tilletia indica* Mitra (*Nevossia indica* Mundkur), was first reported in Karnal, India, in 1931 hence named as 'Karnal bunt'. The disease mainly occurs in wheat growing regions with low winter temperatures and high humidity and affects mainly common wheat, durum wheat, triticale and other related species. This pathogen poses a serious quarantine problem and thus restricts the international trade of wheat. Therefore, quarantine restriction is applied by approximately 70 countries on wheat trade where Karnal bunt is known to occur. To access the status of Karnal bunt in major wheat growing regions of Meerut Division Western Uttar Pradesh, apost-harvest survey was conducted during the year 2021-22 and 2022-23. In the survey six Districtsof Meerut Division viz., Meerut, Bulandshahar, Hapur, Gautambuddhnagar, Gaziabadand Baghpat comprises 45 blocks were covered and 1125 samples from different wheat varietieswere collected from all blocks of six Districts. During the survey of both year the percent disease incidence of karnal bunt was not exceeding the permissible limit (0.25%) of Indian Minimum Seed Certification Standards for quality seed production except Kanaksona (0.288%) from Bulandshahar District and 1085 (0.42%) from Meerut District which is more than the permissible limit of standards. In both year (2021-22 and 2022-23) of survey the maximum incidence (0.42%) of karnal bunt was recorded in 1085 variety of Meerut District and 0.141% in HD 3226 of Baghpat District followed by 0.288% in Kanaksona of Bulandshahar District and 0.110% in UP 272 of Hapur District, whereas the minimum incidence (0.007%) was recorded in DBW 226 of Bulandshahar District and 0.001% in UP 303 of Meerut District respectively. The incidence percent of karnal bunt was recorded nil (0.00%) in both the year of all varieties of

Gautambuddh Nagar District. Confirmation of karnal bunt pathogen was determined by species specific primers in PCR and RT-PCR on the basis of Diagnostic Protocol (DP4) of International Standard for Phytosanitary Measures (ISPM 27).

Key words: *Karnal bunt, Tilletiaindica, Disease and Incidence.*

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most important cereal crops for the majority of world's population, belongs to family Poaceae. The world acreage under wheat crop accounts 215.48 million hectare area with production of 731.40 million metric tons with average productivity of 339.0 kg/ha. India accounts for approx 13.5% of global wheat production with an area 30.22 million hectare and production of 99.9 million metric tons with an average productivity of 33.71 q/ha. In India Uttar Pradesh is leading wheat growing state with an area of 9.75 million ha, production of 32.74 million tones and productivity of 34.32 q/ha. In Western Uttar Pradesh, Meerut Division has 444.95 thousand hectare area under wheat cultivation with production of 1951.06 million tons and highest productivity i.e. 43.85 q/ha (Anonymous 2021).

Diseases contribute as one of the major aspects to the yield losses of wheat (Jones & Clifford, 1978). The most serious biotic constraints to wheat production are fungal diseases such as rusts (yellow, brown, black), Karnal bunt, powdery mildew, foliar blights and loose smut. Among them Karnal bunt (*Tilletia indica*) affects mainly common wheat, durum wheat, triticale and other related species (Royer, Rytter, & Mastsumoto, 1986; Warham, Mujeeb-Kazi, & Rosas, 1986). The disease received recognition after becoming a major Sanitary and Phytosanitary (SPS) concern as stipulated by World Trade Organization (WTO) during 1999 to avoid spreading the disease through import/export in a worldwide liberalized agricultural trade scenario, thus restricts the international trade of wheat. Therefore, quarantine restriction is applied by approximately 70 countries on wheat trade where Karnal bunt is known to occur (Kumar and Singh, 2014; Kumar *et al.*, 2015). The loss due to Karnal Bunt is difficult to estimate because the disease reduces seed quality, inflicts changes in the chemical composition of infected grains and renders seed useless for consumption. Nevertheless, in India, loss in yield due to the disease has been calculated as $1/3 \times \text{yield} \times \text{per cent infection}$ as the disease covers one third of an area under wheat cultivation in India (Munjali, 1975). The financial losses caused by the disease are substantial, ranging from 5-20%. The disease is seed, soil, and airborne and affects both the quality and quantity of the wheat grains. The presence of the pathogen in a region or country results in quarantine restrictions that prevents international trade of wheat grains from the affected regions (Carrise *et al.*, 2006; Figueroa *et al.*, 2018; Pandey *et al.*, 2019).

MATERIAL AND METHODS

To find out the incidence of karnal bunt, a comprehensive post harvest survey was conducted in 45 blocks of 6 District of Meerut Division, Western Uttar Pradesh in collaboration with Uttar Pradesh government authorities (India). Five villages were randomly selected from wheat cultivated area of each block of each District and 200 gram wheat (sample) were collected from five farmers of every selected villages during the year 2021-22 and 2022-23 using Geo Tagging. Surveyed samples were brought to the laboratory of Centre of Excellence for Sanitary and Phytosanitary (SPS), Department of Plant Pathology, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh for analysis of karnal bunt incidence. Karnal bunt infected seeds were detected by visual (Hand lens) and microscopic (Olympus CH20i) examination. The infected seeds were counted and separated from healthy seeds. After laboratory analysis the percent incidence of Karnal bunt was calculated by the following formula:

$$\text{Percent Disease Incidence} = \frac{\text{Number of infected seed}}{\text{Total number of seed}} \times 100$$

District and variety wise observations were recorded on average infection as suggested by Beniwalet *al* (2005). Confirmation of karnal bunt pathogen was determined using species specific primers in PCR (BIORAD T100TM Thermal Cycler) and RT-PCR (BIORAD- CFX ConnectTM Real-Time System) in consonance with Diagnostic Protocol (DP4) of International Standard for Phytosanitary Measures (ISPM 27).

RESULTS AND DISCUSSION

During the first year of survey (2021-22), total 300 samples were collected from 32 wheat varieties in 12 blocks of Meerut District. In laboratory analysis karnal bunt was detected in 37 samples of 7 varieties. The maximum Karnal bunt incidence (0.42%) was recorded in 1085 followed by 0.288% in Kanaksona and minimum (0.018%) in DBW 17. In the second year (2022-23) same no. of samples were taken from 29 wheat varieties of same areas, in which 27 samples of 7 varieties were found to be infected with karnal bunt. The maximum incidence (0.06%) was observed in Kanaksona followed by 0.035% in HD 2967 and minimum incidence (0.001%) in UP 303. Whereas, 263 samples of 25 varieties and 273 samples of 22 varieties were examined zero infestation (0.00%) in both the years 2021-22 and 2022-23 respectively (Table 1).

In Bulandshahar District, total 400 samples from 27 wheat varieties were collected from 16 blocks in 2021-22 and same no. of samples from 19 wheat varieties in 2022-23. Total 80 samples of 14 varieties in the year 2021-22 and 57 samples of 10 Varieties in the year 2022-23 were observed infected with karnal bunt. The maximum incidence (0.201%) of karnal bunt was recorded in Expert 203 followed by 0.108% in WH 1142 and minimum incidence (0.007%) in DBW 226 in the year 2021-22. In the year 2022-23 the maximum incidence (0.090%) was examined in DBW 303 followed by 0.073% in HD 3059 and minimum incidence (0.017%) in PBW 343. Whereas, 320 samples of 13 varieties and 343 samples of 9 varieties was

found zero infestation (0.00%) in both the year 2021-22 and 2022-23 respectively (Table 2).

During 2021-22 and 2022-23 total 150 samples from 13 wheat varieties were collected from 6 blocks of Baghpat District in each surveyed year. Karnal bunt was observed in 8 samples of 4 varieties and 11 samples of 5 varieties respectively. The maximum incidence (0.125%) was recorded in UP 272 and 0.141% in HD 3226 followed by 0.048% and 0.016% in HD 2967 and minimum incidence (0.016%) in Sriram 303 and 0.004% in DBW 303 in the year 2021-22 and 2022-23 respectively. Whereas, 92 samples of 10 varieties in the year 2021-22 and 139 samples of 8 varieties in the year 2022-23 were found to be nil (0.00%) infestation (Table 3).

In Gautambuddh Nagar District, total 75 samples from 13 wheat varieties and 12 wheat varieties were collected from 3 blocks in the year 2021-22 and 2022-23 respectively. All samples of each variety of both surveyed years recorded nil (0.00%) incidence (Table 4).

In Ghaziabad District, 100 samples from 12 varieties were collected in 2021-22 from 4 blocks and nil (0.00%) incidence was examined in all varieties. In the year 2022-23, 100 samples from 9 varieties were collected and 5 samples of one variety DBW 187 was recorded 0.082% incidence. Whereas, 95 samples of 8 varieties were observed zero (0.00%) incidence of karnal bunt (Table 5).

In Hapur District total 100 samples from 15 wheat varieties were collected in 2021-22 and same no. of samples were collected from 16 varieties in 2022-23 from 4 blocks. Total 7 samples of 5 varieties and 11 samples of 7 varieties were examined infected with karnal bunt in both the year 2021-22 and 2022-23 respectively. The maximum incidence (0.370%) was recorded in PBW 550 followed by 0.17% in DBW 226 and minimum incidence (0.009%) in HD 2967 in the year 2021-22. During the year 2022-23 the maximum incidence (0.110%) was recorded in UP 272 followed by 0.049% in Sriram 303 and minimum incidence 0.010% in DBW 187. However, 93 samples of 10 varieties and 89 samples of 9 varieties were found nil (0.00%) infestation in both the year 2021-22 and 2022-23 respectively (Table 6).

Similar findings were recorded by Singh *et al.* (2003), they found, that wheat samples collected from Punjab had high level of karnal bunt infestation (35.4%) followed by HP. (26.7%) and J. & K. (22.8%) on an average basis, whereas states like U.P. (6.1%) and Delhi (5.3%) had comparatively low level of infestation.

Jakhar *et al.* (2019) surveyed northern Districts of Haryana and observed the average infection in Karnal districts was maximum (0.413%) followed by Hisar (0.278%), and minimum in Sirsa (0.012%).

Amplified sequences showed maximum similarity with the respective reference gene in the whole genome sequence of *T. indica* DAOM236416 (NCBI database) (Gurjar *et al.*, 2021).

Table 1. Variety wise data of Meerut District

2021-2022					2022-2023				
S.No	Variety	Total Sample	Infected sample	% DI	S.No	Variety	Total Sample	Infected sample	% DI
01	HD 2967	68	10	0.068	01	HD 2967	48	05	0.035
02	HD 2851	02	-	0.000	02	HD 3226	04	-	0.000
03	HD 247	01	-	0.000	03	HD 303	02	-	0.000
04	HD 362	01	-	0.000	04	HD 3059	03	-	0.000
05	HD 3086	15	03	0.198	05	HD 3086	15	03	0.014
06	HD 3059	04	-	0.000	06	HD 1124	01	-	0.000
07	DBW 17	14	01	0.018	07	HD 171	01	-	0.000
08	DBW 303	82	15	0.096	08	DBW 303	107	10	0.027
09	DBW 226	37	-	0.000	09	DBW 187	31	02	0.008
10	DBW 187	06	-	0.000	10	DBW 226	33	04	0.011
11	DBW 71	01	-	0.000	11	DBW 17	01	-	0.000
12	DBW 222	02	-	0.000	12	DBW 222	07	-	0.000
13	PBW 343	03	-	0.000	13	PBW 343	02	-	0.000
14	PBW 292	14	04	0.141	14	PBW 550	02	-	0.000
15	PBW 252	02	-	0.000	15	PBW 723	01	-	0.000
16	PBW373	01	-	0.000	16	PBW 292	04	-	0.000
17	Raj 4267	02	-	0.000	17	Sriram 231	02	-	0.000
18	Sriram 52	02	-	0.000	18	Sriram 303	04	-	0.000
19	PBW 550	08	-	0.000	19	UP 303	06	01	0.001
20	Kanaksona	08	03	0.288	20	UP 271	05	-	0.000
21	Ashirbad	01	-	0.000	21	UP 711	02	-	0.000
22	PV 303	05	-	0.000	22	1317	02	-	0.000

23	UP 271	01	-	0.000	23	Savitri	01	-	0.000
24	UP 226	04	-	0.000	24	5522	01	-	0.000
25	UP 292	01	-	0.000	25	1550	01	-	0.000
26	UP 303	06	-	0.000	26	PV 303	04	-	0.000
27	UP 272	01	-	0.000	27	Rusi	01	-	0.000
28	Gauri 75	01	-	0.000	28	Kanaksona	04	01	0.060
29	1085	01	01	0.420	29	Raj 4037	05	-	0.000
30	WH 1105	02	-	0.000	-	-	-	-	-
31	286	02	-	0.000	-	-	-	-	-
32	258	02	-	0.000	-	-	-	-	-
Total		300	37		Total		300	26	

Table 2. Variety wise data of Bulandshahar District

2021-2022					2022-2023				
S.No	Variety	Total Sample	Infected sample	% DI	S.No	Variety	Total Sample	Infected sample	% DI
01	HD 2967	132	37	0.084	01	HD 2967	123	22	0.046
02	HD 3226	04	-	0.000	02	HD 3086	40	10	0.050
03	HD 3086	40	07	0.052	03	HD 3059	03	01	0.073
04	DBW 303	61	07	0.044	04	HD 3226	15	-	0.000
05	DBW 17	14	04	0.086	05	DBW 187	26	-	0.000
06	DBW 226	18	02	0.007	06	DBW 303	111	14	0.090
07	DBW 187	06	01	0.073	07	DBW 88	07	-	0.000
08	DBW 88	01	-	0.000	08	DBW 222	20	04	0.051
09	DBW 173	02	-	0.000	09	DBW 226	02	-	0.000
10	PBW 517	02	01	0.100	10	DBW 17	05	-	0.000
11	PBW 373	03	-	0.000	11	PBW 343	10	01	0.017

12	PBW 343	08	01	0.030	12	PBW 550	10	02	0.024
13	PBW 502	04	-	0.000	13	PBW 373	01	-	0.000
14	PBW 292	07	-	0.000	14	PBW 723	01	-	0.000
15	PBW 550	11	02	0.042	15	WH 1142	02	01	0.060
16	Ashirbad	06	01	0.080	16	SR 72	03	-	0.000
17	Sultan	02	-	0.000	17	Sriram 303	11	02	0.055
18	Sriram 303	53	13	0.094	18	Sultan	09	02	0.047
19	Sriram 272	02	01	0.040	19	MSW 3232	01	-	0.000
20	WH 1142	05	01	0.108	-	-	-	-	-
21	Kanaksona	04	-	0.000	-	-	-	-	-
22	Veer	01	-	0.000	-	-	-	-	-
23	1182	03	-	0.000	-	-	-	-	-
24	Halna	01	-	0.000	-	-	-	-	-
25	Satya	02	-	0.000	-	-	-	-	-
26	Expert 203	07	02	0.201	-	-	-	-	-
27	Kaveri 11	01	-	0.000	-	-	-	-	-
Total		400	80		Total		400	59	

Table 3. Variety wise data of Baghpat District

2021-2022					2022-2023				
S.No	Variety	Total Sample	Infected sample	% DI	S.No	Variety	Total Sample	Infected sample	% DI
01	HD 2967	71	05	0.048	01	HD 2967	45	05	0.016
02	HD 3086	26	01	0.026	02	HD 3226	07	03	0.141
03	HD 2851	01	-	0.000	03	HD 3086	27	01	0.014
04	DBW 187	12	-	0.000	04	HD 3059	01	-	0.000
05	DBW 303	06	-	0.000	05	HD 2885	02	-	0.000

06	DBW 173	03	-	0.000	06	DBW 187	27	01	0.010
07	PBW 343	08	-	0.000	07	DBW 222	11	-	0.000
08	PBW 373	01	-	0.000	08	DBW 303	18	01	0.004
09	Sriram 231	05	-	0.000	09	DBW 226	03	-	0.000
10	Sriram 303	11	01	0.016	10	PBW 550	02	-	0.000
11	WH 1105	01	-	0.000	11	PBW 723	02	-	0.000
12	WH 1142	03	-	0.000	12	Sriram 231	01	-	0.000
13	UP 272	02	01	0.125	13	Sriram 303	04	-	0.000
Total		150	08		Total		150	10	

Table 4.Variety wise data of Gautambuddh Nagar District

2021-2022					2022-2023				
S.No	Variety	Total Sample	Infected sample	% DI	S.No	Variety	Total Sample	Infected sample	% DI
01	HD 2967	25	-	0.000	01	HD 2967	18	-	0.000
02	HD 3086	06	-	0.000	02	HD 3086	07	-	0.000
03	HD 2626	03	-	0.000	03	HD 1124	01	-	0.000
04	DBW 187	03	-	0.000	04	HD 3226	07	-	0.000
05	DBW 303	17	-	0.000	05	HD 3059	02	-	0.000
06	DBW 17	06	-	0.000	06	DBW 187	05	-	0.000
07	DBW 90	05	-	0.000	07	DBW 303	12	-	0.000
08	DBW 88	01	-	0.000	08	DBW 222	07	-	0.000

09	PBW 343	02	-	0.000	09	PBW 343	10	-	0.000
10	PBW 621	01	-	0.000	10	PBW 723	03	-	0.000
11	Sriram 303	03	-	0.000	11	PBW 252	01	-	0.000
12	Sultan	02	-	0.000	12	Sultan	02	-	0.000
13	PBW 723	01	-	0.000	-	-	-	-	-
Total		75			Total		75		

Table 5. Variety wise data of Ghaziabad District

2021-2022					2022-2023				
S.No	Variety	Total Sample	Infected sample	% DI	S.No	Variety	Total Sample	Infected sample	% DI
01	HD 2967	50	-	0.000	01	HD 2967	16	-	0.000
02	HD 3086	02	-	0.000	02	HD 3086	18	-	0.000
03	DBW 303	27	-	0.000	03	HD 3226	04	-	0.000
04	PBW 343	07	-	0.000	04	DBW 303	41	-	0.000
05	PBW 711	02	-	0.000	05	DBW 222	03	-	0.000
06	PBW 502	02	-	0.000	06	DBW 187	07	05	0.082
07	PBW 550	01	-	0.000	07	DBW 226	09	-	0.000
08	PBW 723	03	-	0.000	08	PBW 723	01	-	0.000
09	UP 2338	02	-	0.000	09	PBW 343	01	-	0.000
10	Ashirbad	02	-	0.000	-	-	-	-	-
11	SW 23	02	-	0.000	-	-	-	-	-
Total		100	-		Total		100	05	

Table 6 Variety wise data of Hapur District

2021-2022					2022-2023				
S.No	Variety	Total Sample	Infected sample	% DI	S.No	Variety	Total Sample	Infected sample	% DI
01	HD 2967	28	01	0.009	01	HD 2967	22	01	0.042
02	HD 3226	04	-	0.000	02	HD 3086	02	-	0.000
03	DBW 187	10	-	0.000	03	HD 3226	01	-	0.000
04	DBW 303	13	01	0.026	04	DBW 187	08	01	0.010
05	DBW 88	03	-	0.000	05	DBW 303	21	03	0.037
06	DBW 226	02	02	0.170	06	DBW 222	03	-	0.000
07	PBW 343	06	-	0.000	07	DBW 226	06	01	0.016
08	PBW 550	01	01	0.370	08	PBW 343	04	-	0.000
09	Unnat 303	02	-	0.000	09	PBW 502	01	-	0.000
10	Ashirbad	01	-	0.000	10	UP 272	01	01	0.110
11	Kohinoor	01	-	0.000	11	Sultan	09	01	0.028
12	Kanaksona	01	-	0.000	12	Unnat 303	02	-	0.000
13	WH 1142	12	-	0.000	13	Sriram 303	14	03	0.049
14	Sultan	13	02	0.030	14	Sriram 231	03	-	0.000
15	Panjab 11	03	-	0.000	15	279	02	-	0.000
-	-	-	-	-	16	Kalagehu	01	-	0.000
Total		100	07	-	Total		100	11	-

*DI= Disease Incidence

CONCLUSION

The fungus *Tilletiaindicainciting* Karnal bunt disease of wheat is a major concern for import of wheat to Karnal bunt free countries. Due to strict phytosanitary regulations, their is serious implications in the global wheat trade. Contamination levels of more than 1% affect wheat quality and palatability due to toxic compound trimethylamine. More than 3% infected grains in a wheat lot renders it completely unfit for human consumption leading to economic losses to the producer countries (Warham, 1990). In 1996, the governments of Poland detained some wheat export consignments due to Karnal bunt infection (Kumar *et al.*, 2015). In 1 June, 2022 Turkish authorities have rejected a consignment of exported wheat, citing phytosanitary concerns (Krishak Jagat Indian News Paper, 2022).

In the present investigation, % incidence of KB was observed between 0.007-0.420% and 0.001-0.141% in the year 2021-22 and 2022-23 respectively. In both years varieties viz. HD 2967, DBW 303 and HD 3086 were found to be infected with karnal bunt almost in all wheat growing areas of Meerut Division. However, Karnal bunt was not detected in all samples of each varieties cultivated in Gautambuddh Nagar and out of 100 samples of 9 wheat varieties only 5 samples of

one variety (DBW 187) were found to be infected with karnal bunt in the year 2022-23.

The findings of the present investigation recommends to conduct official survey and larger sampling in north western and north central parts of the Indian states for identification and establishment of disease free areas/area of low pest prevalence. In the present study, karnal bunt infestation was found below prescribed contamination limit i.e. 1%, Hence, WTO member countries may import wheat from Meerut Division, Meerut, India without phytosanitary risk.

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