

## Disease Incidence and Severity of Paddy Bunt in Punjab during 1996-2004

R.C. SHARMA, GURMIT SINGH, NAVRAJ K. SARAQ AND MONIKA A. JOSHI  
Seed Technology Centre, Punjab Agricultural University, Ludhiana - 141004  
ramesh\_pau@yahoo.com

**ABSTRACT** Under the disease monitoring programme in Punjab, 218, 1049, 1759, 1155, 889, 1286, 1252, 1052 and 936 samples of paddy (*Oryza sativa* L.) were collected, respectively, for the years 1996-2004 for analysis of paddy bunt (kernel smut) caused by *Tilletia barclayana* (*Neovossia horrida*). The disease incidence (per cent infection) and disease severity (coefficient of infection) were worked out for the last nine years. The average disease severity was lowest (0.33) in 2004 and highest (0.47) in 2001 and 2003 as compared to the previous years when the severity remained almost constant at (~0.41). Three clear-cut zones of the disease have emerged in Punjab. The South-western districts of the state like Bhatinda, Faridkot, Ferozepur, Moga and Sangrur have been identified as areas of high disease severity/infection per cent (0.63/9 1.0), respectively, while Central and North-western districts like Kapurthala, Patiala, Ludhiana, Amritsar and Jalandhar had moderate disease severity/infection per cent (0.36/87.0). North-eastern parts of the state viz. Hoshiarpur, Fatehgarh Sahib, Gurdaspur, Nawanshehar and Ropar represented the areas of low (0.26/ 78.8) disease severity/infection per cent. Among the prevalent varieties in Punjab, PR 108 was observed to be most susceptible to bunt as it had maximum severity (2.32) as well as per cent infection (93.59) followed by PR 113 (0.57/ 89.92) and PR 111 (0.50/ 87.20).

**Keywords:** Grain markets, kernel smut, *Neovossia horrida*, paddy bunt, *Tilletia barclayana*

Paddy bunt (Kernel smut) of rice caused by *Tilletia barclayana* (Bref) Sacc. and Syn. *Neovossia barclayana* Bref. *T. horrida* Tak., *N. horrida* (Tak.) Padw, and Khan) was first reported in 1896 from Japan [1] and in 1944 from India [2]. It is prevalent in almost all the major rice growing countries of the world including India [3]. In Punjab paddy bunt was reported by Chowdhary for the first time in 1946 [4]. The disease also known as kernel smut is organospecific and it converts the grain completely or partially into black spore mass, which contains numerous teliospores of the pathogen and causes heavy quantitative and qualitative losses [5 & 6]. The incidence of kernel smut has increased probably with the popularization of high yielding varieties, intensive cropping pattern and use of heavy doses of nitrogenous fertilizers [7]. The Central Seed Certification Board, Government of India, has prescribed maximum certification standards of 0.1% and 0.5% for the foundation and certified seed lots, respectively. The disease was considered to be of minor importance but assumed serious proportions around 1990 when about 13.8% samples of the total graded seed were rejected by the Seed Certification

Agency on account of its failure to meet the minimum seed certification standards [8]. The present study was, hence, undertaken to work out the disease severity and infection per cent for the last nine years (1996-2004) in the Punjab state.

### MATERIALS AND METHODS

To study the distribution and the prevalence of the disease in different areas of Punjab, extensive surveys of various grain markets were conducted from 1996-2004 representing all the agroclimatic zones of the state. During the period, 218, 1049, 1759, 1155, 889, 1286, 1252, 1052 and 936 samples were collected, respectively, in order to observe the frequency of occurrence of paddy bunt, from every grain market visited. Paddy samples were collected randomly from 4-5 places of each uncleaned heap belonging to different farmers. A working sample was drawn and analysis of bunt was done by 'sodium hydroxide soak' method [9]. Average per cent kernel smut infection in each year and of each district was also calculated from the total number of grains analysed. Disease severity was calculated

Table 1. Comparison of paddy bunt incidence for *Kharif* (1996-2004)

| Years | Total samples | % incidence | Range of incidence(%) | Severity |
|-------|---------------|-------------|-----------------------|----------|
| 1996  | 218           | 90.28       | 0-3.36                | 0.43     |
| 1997  | 1049          | 87.63       | 0-3.98                | 0.43     |
| 1998  | 1759          | 92.76       | 0-4.01                | 0.40     |
| 1999  | 1155          | 85.69       | 0-12.24               | 0.41     |
| 2000  | 889           | 90.70       | 0-4.64                | 0.41     |
| 2001  | 1286          | 80.46       | 0-3.88                | 0.47     |
| 2002  | 1252          | 80.23       | 0-12.75               | 0.39     |
| 2003  | 1052          | 89.37       | 0-5.76                | 0.47     |
| 2004  | 936           | 74.10       | 0-5.28                | 0.33     |

by rating the seed infection from 0-4 scale [10] on the basis of the extent of conversion of seed part into bunt spores. The disease incidence was expressed in percentage.

## RESULTS AND DISCUSSION

The average disease severity was lowest (0.33) in 2004 (Table 1) and highest (0.47) in 2001 and 2003 as compared to the previous years when the severity remained almost constant at (~ 0.41). The extent of damage to the grains depends upon the meteorological factors during flowering, nitrogen level in the soil and time of flowering of a particular cultivar [7]. When the meteorological data over different years was studied (Table 2), it was almost similar for relative humidity and temperature over the years, except for amount of total rainfall and number of rainy days which varied during the month of August when floret infection occurs.

However, in the present study, no well-defined relationship between the meteorological factors and disease severity could be established over the

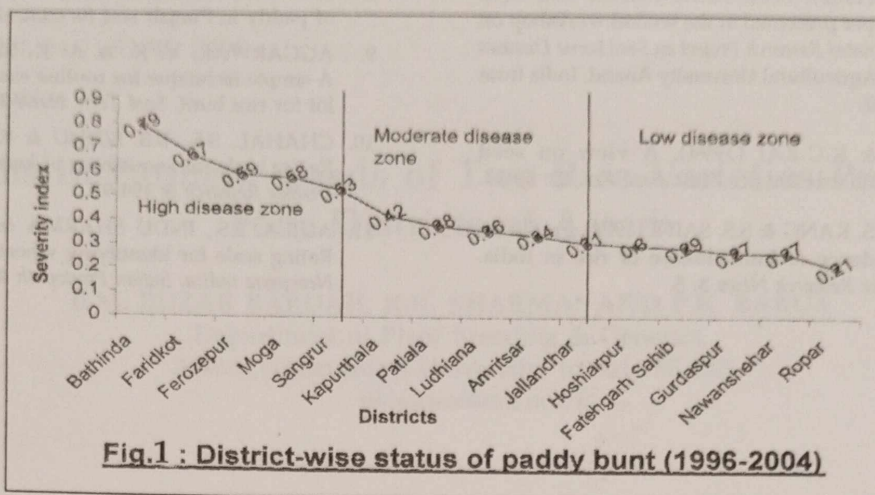
Table 2. Meteorological data for the months of July and August (1996-2004)

| Parameter         | Months | Period              | 1996 | 1997 | 1998  | 1999  | 2000  | 2001 | 2002 | 2003  | 2004  |
|-------------------|--------|---------------------|------|------|-------|-------|-------|------|------|-------|-------|
| Rainy days        | July   | 1 <sup>st</sup> FN* | 4    | 3    | 11    | 6     | 4     | 8    | 2    | 7     | 3     |
|                   |        | 2 <sup>nd</sup> FN  | 6    | 6    | 7     | 5     | 5     | 3    | 3    | 9     | 3     |
|                   | August | 1 <sup>st</sup> FN  | 9    | 5    | 4     | 5     | 6     | 5    | 3    | 6     | 7     |
|                   |        | 2 <sup>nd</sup> FN  | 7    | 9    | 2     | 2     | 3     | 1    | 1    | 7     | 6     |
| Rainfall (mm)     | July   | 1 <sup>st</sup> FN  | 32.6 | 23.2 | 296.5 | 211.5 | 138.4 | 357  | 28.8 | 67.5  | 16.0  |
|                   |        | 2 <sup>nd</sup> FN  | 64.0 | 64.8 | 146.1 | 147.7 | 51.0  | 26.8 | 8.0  | 113.1 | 16.1  |
|                   | August | 1 <sup>st</sup> FN  | 138  | 202  | 39.1  | 48.8  | 65.3  | 161  | 17.1 | 143.7 | 123.7 |
|                   |        | 2 <sup>nd</sup> FN  | 113  | 208  | 24.4  | 19.8  | 55.5  | 51.6 | 7.4  | 154.0 | 101.7 |
| Temperature       | July   | Max.                | 33.9 | 34.6 | 34.0  | 33.9  | 33.2  | 33.1 | 36.7 | 33.5  | 35.8  |
|                   |        | Min.                | 26.0 | 27.2 | 26.2  | 26.7  | 26.8  | 26.7 | 28.1 | 26.7  | 27.2  |
|                   | August | Max.                | 31.8 | 32.1 | 34.1  | 33.9  | 34.1  | 34.0 | 34.9 | 33.5  | 32.9  |
|                   |        | Min.                | 25.5 | 25.1 | 26.8  | 25.6  | 26.0  | 26.6 | 27.2 | 26.6  | 26.0  |
| Relative humidity | July   | Max.                | 86   | 75   | 91    | 86    | 88    | 90   | 78   | 88    | 78    |
|                   |        | Min.                | 68   | 47   | 73    | 68    | 73    | 75   | 56   | 69    | 59    |
|                   | August | Max.                | 93   | 85   | 90    | 89    | 89    | 89   | 84   | 90    | 89    |
|                   |        | Min.                | 77   | 65   | 69    | 66    | 69    | 68   | 63   | 78    | 72    |

\* FN - fortnight

Table 3. District-wise status of paddy bunt incidence (1996-2004)

| District   | 1996      |          | 1997   |          | 1998   |          | 1999   |          | 2000   |          | 2001   |          | 2002   |          | 2003    |          | 2004   |          | Mean Severity |
|------------|-----------|----------|--------|----------|--------|----------|--------|----------|--------|----------|--------|----------|--------|----------|---------|----------|--------|----------|---------------|
|            | Range     | Severity | Range  | Severity | Range  | Severity | Range  | Severity | Range  | Severity | Range  | Severity | Range  | Severity | Range   | Severity | Range  | Severity |               |
| Ludhiana   | 0-2.24    | 0.47     | 0-1.92 | 0.47     | 0-2.19 | 0.30     | 0-3.7  | 0.28     | 0-4.40 | 0.32     | 0-1.92 | 0.34     | 0-4.40 | 0.44     | 0-1.52  | 0.31     | 0-2.56 | 0.28     | 0.36          |
| Moga       | 0.08-1.20 | 0.42     | 0-2.82 | 0.78     | 0-3.62 | 0.39     | 0-12.4 | 0.64     | 0-1.60 | 0.46     | 0-2.96 | 0.81     | 0-3.20 | 0.65     | 0-2.10  | 0.55     | 0-4.40 | 0.55     | 0.58          |
| Ferozepur  | 0.32-2.32 | 0.79     | 0-1.83 | 0.80     | 0-2.21 | 0.62     | 0-3.60 | 0.74     | 0-3.04 | 0.37     | 0-2.24 | 0.85     | 0-1.84 | 0.44     | 0-6.00  | 0.54     | 0-1.76 | 0.15     | 0.59          |
| Faridkot   | 0-2.32    | 0.57     | 0-3.98 | 0.75     | 0-3.83 | 0.57     | 0-5.28 | 0.55     | 0-3.44 | 0.76     | 0-3.88 | 0.86     | 0-2.72 | 0.54     | 0-5.20  | 0.99     | 0-2.80 | 0.47     | 0.67          |
| Bhatinda   | 0-3.20    | 1.01     | 0-3.23 | 0.73     | 0-3.97 | 0.55     | 0-2.72 | 0.75     | 0-4.64 | 0.87     | 0-2.00 | 0.85     | 0-4.40 | 0.66     | 0.8-5.6 | 1.05     | 0-5.28 | 0.61     | 0.79          |
| Sangrur    | 0.08-3.04 | 0.79     | 0-2.82 | 0.59     | 0-4.01 | 0.49     | 0-1.92 | 0.34     | 0-2.00 | 0.46     | 0-1.76 | 0.60     | 0-2.40 | 0.46     | 0-2.00  | 0.61     | 0-4.00 | 0.47     | 0.53          |
| Patiala    | 0-0.72    | 0.21     | 0-2.63 | 0.41     | 0-3.32 | 0.47     | 0-0.72 | 0.20     | 0-3.12 | 0.45     | 0-1.60 | 0.33     | 0-1.76 | 0.35     | 0-1.60  | 0.35     | 0-2.80 | 0.66     | 0.38          |
| F. Sahib   | 0-1.92    | 0.39     | 0-1.97 | 0.36     | 0-2.23 | 0.33     | 0-1.68 | 0.30     | 0-1.12 | 0.19     | 0-1.28 | 0.22     | 0-1.44 | 0.31     | 0-5.76  | 0.44     | 0-0.16 | 0.15     | 0.29          |
| Jalandhar  | 0-1.68    | 0.41     | 0-1.83 | 0.28     | 0-1.32 | 0.30     | 0-2.32 | 0.19     | 0-1.84 | 0.32     | 0-1.60 | 0.30     | 0-1.44 | 0.34     | 0-2.32  | 0.34     | 0-3.60 | 0.27     | 0.31          |
| Kapurthala | 0.08-1.44 | 0.53     | 0-2.01 | 0.34     | 0-2.01 | 0.37     | 0-1.42 | 0.39     | 0-1.52 | 0.45     | 0-1.60 | 0.47     | 0-4.08 | 0.33     | 0-3.60  | 0.54     | 0-0.40 | 0.35     | 0.42          |
| Gurdaspur  | 0-0.88    | 0.25     | 0-1.36 | 0.35     | 0-0.76 | 0.30     | 0-2.32 | 0.16     | 0-2.56 | 0.32     | 0-0.80 | 0.27     | 0-2.40 | 0.24     | 0-1.52  | 0.30     | 0-0.88 | 0.21     | 0.27          |
| Ropar      | 0-0.48    | 0.19     | 0-1.24 | 0.23     | 0-0.81 | 0.22     | 0-1.22 | 0.27     | 0-0.96 | 0.19     | 0-0.96 | 0.19     | 0-1.76 | 0.25     | 0-0.72  | 0.15     | 0-0.40 | 0.12     | 0.21          |
| Amritsar   | 0-0.96    | 0.41     | 0-1.93 | 0.10     | 0-2.13 | 0.35     | 0-1.36 | 0.24     | 0-1.52 | 0.33     | 0-2.36 | 0.55     | 0-2.72 | 0.33     | 0-2.00  | 0.39     | 0-2.60 | 0.37     | 0.34          |
| N.Shahar   | 0-0.64    | 0.22     | 0-0.88 | 0.12     | 0-1.60 | 0.26     | 0-6.00 | 0.56     | 0-1.68 | 0.36     | 0-0.32 | 0.18     | 0-12.7 | 0.38     | 0-1.52  | 0.28     | 0-0.34 | 0.09     | 0.27          |
| Hoshiarpur | 0-1.60    | 0.40     | 0-1.01 | 0.21     | 0-1.32 | 0.52     | 0-2.24 | 0.49     | 0-2.32 | 0.24     | 0-1.60 | 0.24     | 0-1.52 | 0.19     | 0-3.28  | 0.28     | 0-0.20 | 0.18     | 0.30          |



**Fig.1 : District-wise status of paddy bunt (1996-2004)**

**Table 4. Variety-wise status of paddy bunt (1996-2004)**

| Variety | % infection | Range   | Severity |
|---------|-------------|---------|----------|
| PR 103  | 100         | 0-0.72  | 0.28     |
| PR 106  | 78.18       | 0-6.00  | 0.40     |
| PR 111  | 88.20       | 0-3.60  | 0.50     |
| PR 113  | 89.92       | 0-4.40  | 0.57     |
| PR 114  | 80.97       | 0-5.20  | 0.36     |
| PR 116  | 83.24       | 0-12.75 | 0.37     |
| IR 8    | 88.98       | 0-5.28  | 0.45     |
| Jaya    | 96.30       | 0-3.60  | 0.37     |
| Pusa 44 | 89.87       | 0-5.76  | 0.47     |

different years during the period of study. This may be due to water remaining stagnant in the field throughout the growing period of the crop and the necessary microclimate (relative humidity) required for the successful infection was maintained at almost the same level irrespective of the other meteorological parameters.

Disease surveys of the state conducted for the last nine years revealed that there is not a single district or variety, grown in the state, which is free from the disease. Statistical analysis revealed districts to be significantly different from each other. On the basis of data on disease incidence (per cent infection) and disease severity (coefficient of infection), three clear-cut zones of the disease have emerged in Punjab (Fig. 1). The South-western districts of the

state like Bathinda, Faridkot, Ferozepur, Moga and Sangrur have been identified as areas of high disease severity/infection per cent (0.63/91.0), respectively, while Central and North-western districts like Kapurthala, Patiala, Ludhiana, Amritsar and Jalandhar had moderate disease severity/infection per cent (0.36/87.0). North-eastern parts of the state viz. Hoshiarpur, Fatehgarh Sahib, Gurdaspur, Nawanshehar and Ropar represented the areas of low (0.26/ 78.8) disease severity/infection per cent (Table 3). There has not been any shift or change in the distribution and severity of the disease in Punjab as earlier reported by Sharma and Gill [8] for the period of 1990-95.

PR 113 was the most susceptible cultivar wherein the disease severity/infection per cent was the highest (0.57/89.92) followed by PR 111 (0.50/ 87.20) and IR8. (0.45/88.98) (Table 4). The overall disease severity/infection per cent was lowest (0.36/80.97) in PR114. In rest of the varieties moderate severity and infection per cent was recorded. In Jaya and PR 103, the infection per cent was as high as 96.3 to 100, but the severity was low (0.37 and 0.28, respectively). This can be attributed to genotypic differences [11].

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Table 1. District wise status of paddy bunt (1982-1994)

| Year    | % incidence | Area | Severity |
|---------|-------------|------|----------|
| 1982-83 | 10.00       | 0.00 | 0.00     |
| 1983-84 | 12.10       | 0.10 | 0.10     |
| 1984-85 | 15.10       | 0.20 | 0.20     |
| 1985-86 | 18.10       | 0.30 | 0.30     |
| 1986-87 | 21.10       | 0.40 | 0.40     |
| 1987-88 | 24.10       | 0.50 | 0.50     |
| 1988-89 | 27.10       | 0.60 | 0.60     |
| 1989-90 | 30.10       | 0.70 | 0.70     |
| 1990-91 | 33.10       | 0.80 | 0.80     |
| 1991-92 | 36.10       | 0.90 | 0.90     |
| 1992-93 | 39.10       | 1.00 | 1.00     |
| 1993-94 | 42.10       | 1.10 | 1.10     |

During the period of study, the bunt incidence was found to be low in the field during the growing period of the crop and the severity was found to be low in the field. The incidence of bunt was found to be low in the field during the growing period of the crop and the severity was found to be low in the field. The incidence of bunt was found to be low in the field during the growing period of the crop and the severity was found to be low in the field.

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