

# Karnal bunt

## A threat to export of Indian wheat

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*Karnal bunt (KB) is a disease of quarantine, thus affects the wheat export. The disease is prevalent in North western states of India which contributes the maximum share to the national pool. At present, none of the recommended variety is resistant to Karnal bunt in these states. Thus, there is a dire need to manage the disease. Further, the disease is highly dependent on environmental factors and it is difficult to predict. Thus, an attempt was made to study the effects of factors responsible for KB high years. The data showed a clear cut role of inoculum build up along with prevalent weather and presence of susceptible cultivars in all the KB high years. The data analyzed can be helpful in managing the KB at various levels to make the country disease free.*

**Keywords:** Infection, Karnal bunt, Wheat

THE menace of Karnal bunt (KB) of wheat is very well established as it affects the quality of wheat and therefore international trade of wheat. The situation is further worsened by the non the availability of host resistance. The disease is caused by a fungus *Tilletia indica* which is highly variable and had multiple modes of transmission. Further, resistance to this disease has a complex genetic control. All these factors are responsible for its re-occurrence. It is appearing every year in severe to moderate form in almost all the parts of Northern India. This is the main reason for not being able to export surplus wheat.

### Prevalence

The disease was first reported in 1931 by Mitra from Karnal (Haryana, India) but now it is present in whole Northern western India particularly in Jammu and Kashmir, lower Himachal Pradesh, Punjab, Haryana, Delhi, Uttar Pradesh, Madhya Pradesh and Rajasthan but it has not been reported from other wheat growing

states of India. Most of the North West is irrigated and temperature is favourable for germination of *T. indica* teliospores. There is no restriction on the movement of wheat grains within the country as such for checking the spread of disease. The main concern comes if we see the contribution of these states to the national pool. These most affected states are contributing maximum share to the national pool and thus spreading the disease to the areas where it was not reported earlier due to its seed borne nature. Recently, it has been reported from Central India, which was believed to be KB free. This is an alarming situation for the KB free areas of the country.

### Economic importance

A serious concern for the export of the surplus Indian wheat as almost 75 foreign countries disqualifies the KB infected grains in order to meet the export standards. Apart from being a non-tariff barrier, it may reduce flour quality. In view of the importance of colour, odour, and palatability of whole meal and chapattis, 1-4%

infected kernels may be sufficient to render wheat grain unacceptable for human consumption. At 5% infection, quality distinctly deteriorates. There is also a loss in flour recovery and chemical changes in composition of flour and gluten content cause poor dough strength. If grains are washed and steeped, wheat lots with 7-10% infected grains are acceptable for consumption. Punjab being a surplus state might strive to produce Karnal bunt free wheat for profitable marketing.

### Karnal bunt in Punjab – a look at the past and present

Among north western states, Punjab is contributing about 43.2% of wheat grains to the central pool along with KB inoculum in the form of infected grains. Thus, it is very important to look at the KB scenario of Punjab. The disease is present in the state since the early 1930s and it has appeared in varying intensities and severities over the years. During 1930, 1931, 1933, 1942, 1948, 1954, 1956, 1968, 1973, 1975, 1976, 1978, 1979, 1980, 1981 and 1982, the KB

incidence was higher. The disease remained at its lowest ebb after the outbreaks which occurred in 1981 and 1982. Thereafter it was found prevalent in 62.8% samples with average grain infection of 0.67 % in 1990. The data on average KB infection from 1991 to 2017 is being presented here in Fig. 1. A look at this data of three decades showed four KB high years *viz.*, 1991, 1996, 2006 and 2015 with 1.90, 0.64, 0.95 and 2.20 % KB infection respectively. The highest KB incidence ever recorded was 2.20 % in the year 2015.

#### Factors responsible for KB high years with special reference to 2015

The occurrence, distribution, severity and incidence of Karnal bunt during the KB high years threw light on the fact that there are factors which are responsible for its irregular but consistent distribution.

#### Conducive environmental conditions – Ludhiana a case study

Weather plays a pivotal role in disease development. Over the last 30 years, the disease was high in four years 1992, 1996, 2007 and 2015 crop seasons and showed strong evidence of the role of weather particularly rainfall and temperature in February and March. The highest KB incidence of 2.20 % in the year 2015 was correlated with the highest rainfall in the months of February and March followed by the KB incidence of 0.96 in 2007 and 0.64 in 1996. A clear cut role of rainfall of the March of the previous year has been depicted in **Table 1**. This helps in the build-up of KB inoculum.

Rainfall or high humidity at flowering was more important than any of the cultural practices for conditioning KB. Adjustment of sowing dates did not appear to be beneficial because weather fluctuations at anthesis were probably more important. Limiting irrigation during flowering would have adverse effects on yield.

**Varietal susceptibility:** Role of susceptible varieties has been indicated to play an important role for KB high years. All the wheat varieties under cultivation from 1994 till date except PBW502 (2004) and

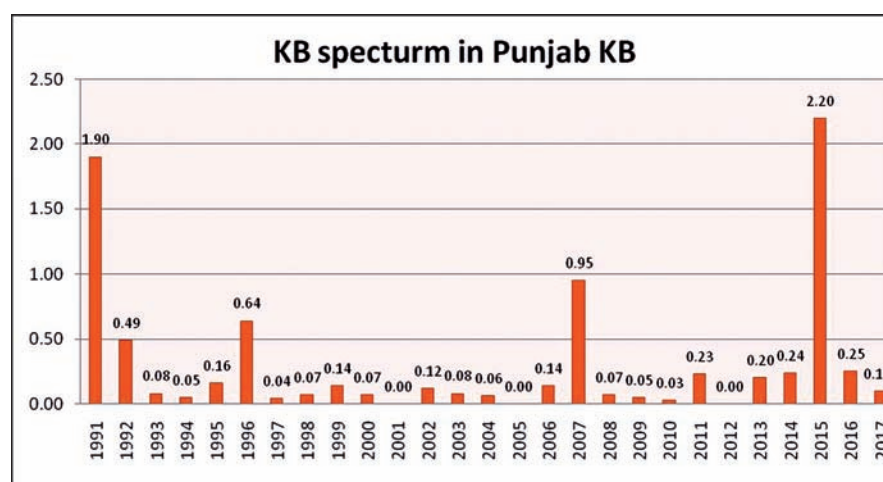


Fig 1. Karnal bunt in Punjab during the period 1991 to 2017

DBW17 (2008) are susceptible to KB. There was no varietal difference w. r. t KB incidence or severity (Table 2). Although data of screening nurseries showed that PBW 343, DBW17 and PBW 660 carry a moderate level of KB resistance, but the first two are highly susceptible to rusts and the third one is meant for rainfed conditions. Thus, among the commercial/popular set of cultivars management strategies may be more relevant. So it is imperative to breed for KB resistant varieties besides rust resistance.

The importance and distribution of KB in India appear to be related to periodic widespread cultivation of susceptible or tolerant cultivars, although the impact of weather during these periods is also recognized. Prior to about 1968, indigenous tall wheats grown in the main wheat belt were KB susceptible, and the disease was often widespread, although usually not severe. The semidwarf wheats Kalyansona, PV18, and Sonalika (introduced in the late 1960s) were more resistant than indigenous wheats and KB decreased

somewhat in importance. In 1975, high yielding but KB susceptible cultivars were released, and as their popularity grew, disease severity increased throughout northern India. After 1982, cultivars with KB tolerance were introduced and efforts were made to diversify the cultivars grown by farmers. These changes coincided with a reduction in disease incidence up to 1989. However, the situation changed again with the widespread use of KB susceptible cultivars. Cultural Practices Cultural practices appear to have been of little practical value because most recommendations have been based on observation rather.

Variation in KB infection also varies from variety to variety due to some of the physiological characters. Flowering or awn-emergence stage is different in different varieties affect the entry of pathogen into developing ear e.g. in case of HD2329 and WL 711 it is extended over two weeks and is not synchronous in all the ears which give them more exposure to *T. indica* spores thus, more KB. On the other

**Table 1.** Role of rainfall in the KB development during high KB years

| Years | Rainfall in Feb during incidence year (mm) | Rainfall in Feb during previous year (mm) | Rainfall in Mar during incidence year (mm) | Rainfall in Mar during previous year (mm) | High KB level (%) |
|-------|--------------------------------------------|-------------------------------------------|--------------------------------------------|-------------------------------------------|-------------------|
| 1992  | + (24)                                     | + (22)                                    | + (36)                                     | + (39)                                    | + (1.92)          |
| 1996  | + (69)                                     | + (51)                                    | + (26)                                     | + (20)                                    | + (0.95)          |
| 1998  | + (91)                                     | - (7)                                     | - (13)                                     | - (7)                                     | - (0.07)          |
| 2003  | + (135)                                    | - (14)                                    | - (21)                                     | -(9)                                      | - (0.08)          |
| 2007  | + (78)                                     | - (0)                                     | + (41)                                     | + (33)                                    | + (0.64)          |
| 2013  | + (96)                                     | - (5)                                     | + (36)                                     | - (0)                                     | - (0.20)          |
| 2015  | + (82)                                     | + (38)                                    | + (85)                                     | + (35)                                    | + (2.20)          |

hand PBW 343, this stage is synchronous and hence less infection. But HD 2967 inspite of its synchronous flowering habit, it is a highly susceptible genotype.

#### Abundance of spore load or inoculum builds up

What leads to high KB incidence in 2015 was worked out by taking into consideration, the available data on Karnal bunt incidence, severity and weather parameters from 1991 onwards to see the pattern of its growth if any. This rise was not all of a sudden but was followed by inoculums build up in previous years (i.e. 1990 followed by 1991, 1995 followed by 1996, 2006 followed by 2007 and 2013, 2014 followed by 2015. The consistent increase in the disease over the last 3 years is a serious concern to the farmers as well as traders. The year 2015 witnessed the highest KB incidence in Punjab as already shown in Fig. 1.

Karnal bunt incidence was non-contiguous over the years sometime high and sometime low and sometime even meagre. From Fig. 1, it is clear that KB incidence was high during the years 1996, 2007 and 2015. The graph also revealed a small rise in KB followed by the high KB in subsequent year i.e. a small rise in 1995 followed by 1996. The similar pattern can be seen in 2006 followed by 2007 but in 2015, there a small rise of two years i.e 2013 and 2014 followed by 2015. The similar pattern has been observed in other two KB high years i.e 1997 and 2007. Thus all the high KB years were preceded by a buildup.

#### Difference in timing of spray for rusts and KB

The high KB infection in 2020 year was due to frequent rainfall and lower temperature during February and March. Further, the widespread use of fungicide (propiconazole) failed to contain KB infection probably due to a difference in timing of spray for the two diseases.

#### Non contiguous District wise distribution of KB

None of the districts remained free from Karnal bunt since 2013, the

**Table 2.** Genotype susceptibility at PAU, Ludhiana during 2015 and 2016

| Genotype | Reaction to KB | Year of release/ cultivation | Average % KB infection |
|----------|----------------|------------------------------|------------------------|
| HD2329   | S              | 1985                         | 15.56-18.98            |
| WH 542   | S              | 1992                         | 25.88-52.68            |
| PBW 343  | MS             | 1995                         | 10.47-18.08            |
| PBW502   | MR             | 2004                         | 7.89-10.56             |
| PBW550   | S              | 2007                         | 27.96-41.55            |
| DBW17    | MR             | 2008                         | 6.58-10.69             |
| PBW621   | S              | 2011                         | 26.67-42.85            |
| HD2967   | S              | 2011                         | 28.18-59.51            |
| WH1105   | S              | 2014                         | 25.53-41.78            |
| HD3086   | S              | 2015                         | 23.80- 30.24           |

highest percentage of KB infected samples were from districts Gurdaspur, Bathinda and Pathankot (submontaneous areas). The incidence was although non-contiguous across the districts. It can be seen anywhere from the last 2-3 years, the districts Amritsar, Kapurthalla and Tarantarn had highest KB infected samples. But the predictions came to be true in some of the places of Amritsar and Kapurthalla where almost 80 % KB infection was found during 2015-16. Although there is less rains in February as well as March during the crop season accompanied with hot climate but the late rainfall coincided with the anthesis of late sown crops after pea. These conditions were not adequate to create the highly conducive conditions for the disease inspite of high inoculum build up (for the last two years) and availability of susceptible genotypes.

#### Managing Karnal bunt of wheat

##### Cultural practices

Maintaining dry soil conditions at heading stage of crop grow also helps in reducing the disease. Seeing the 2015 average infection of grain markets in Punjab, which was 2.20% and almost 100% infection in the samples collected there is dire need to control KB so that further build up of the disease can be avoided. Although disease being a seed, soil and airborne are difficult to manage. However, KB free seed crop can be raised for all the improved recommended varieties if the seed plots are sprayed with Tilt/Folicur 25 EC @ 200ml/acre in 160 litres of water at heading stage. There should

be almost 100 % ear emergence or we can repeat the sprays at 15 days interval. This will gradually help in depleting the inoculum load prevalent in the soils but farmers often go for tilt spray for yellow rust and never worried about the Karnal bunt.

##### Shifting resistant varieties to moderately resistant lines

Resistance breeding can be taken up by setting feasible goals. This may be the reduction in the number of highly susceptible lines and development of moderately resistant lines. In resistance breeding, there are certain resistant varieties namely, PDW 291, PDW 274, PDW 233, TL 2908 and TL 1210 under irrigated conditions and PBW 527 and PBW 175 under rainfed conditions may be grown in high disease-prone areas to minimize inoculum load in soil.

##### Understanding the unexplained variation over KB incidence

There are unexplained variation in Karnal bunt incidence over time as well as space and solve some of the issues, we have to go back to basics. Several other aspects of pathogen biology i.e. inoculum threshold level, pathogen fitness at every stage and probability of encounters between compatible sporidia needs to be understood which may also contribute to disease escape or variation in Karnal bunt incidence over the period. Re-discovering the pathogenicity cycle of *Tilletia indica*.

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