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Karnal bunt disease of wheat: A review

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Abstract
Karnal bunt caused by *Tilletia indica* Mitra (*Neovossia indica* Mitra) (Mundkur) was first recorded in April, 1930 from Botanical Research Station, Karnal (Haryana) on wheat cultivar, foundation and Punjab A. The disease was prevalent in the sub-continent since long, infecting native wheat's grown over North Western India but it never caused serious yield reduction. However, the disease appeared in serious proportions in early 1970s with the introduction of dwarf Mexican Wheat Varieties into India and Pakistan. Till 1974-75 the disease remained restricted to Jammu and Kashmir, Punjab and *Tarai* region of Uttar Pradesh. In some places, it appeared in the epidemic form in different years. In the absence of strict domestic quarantine regulation, it spread to new areas in North Western Wheat belt. However, Madhya Pradesh, southern Rajasthan, Maharashtra and Peninsular India are free from Karnal bunt due to high temperatures. It is also reported from Nepal, Iran, Mexico, United States, South Africa, Brazil, Afghanistan, Syria, Turkey, Lebanon, Sweden, Poland, Italy. The pathogen is floral infecting organism that partially infects seeds of bread wheat, durum wheat and also the triticale. Not all the spikes on a plant are infected and within a spike only a few spikelets are bunted. Infected grains are irregularly distributed in the spike mostly partially infected and sometimes completely infected. The disease in seed, soil and air borne in nature and difficult to manage and different strategies like crop rotation, delayed sowing, avoiding excessive use of nitrogenous fertilizer and irrigation are no more tenable in present day intensive agriculture.

Keywords: Karnal bunt, *Neovossia indica*

Introduction
Wheat (*Triticum aestivum* L.) continues to be the most dynamic sector in world grain production and India is the second largest producer, preceded only by China and major contributor to the agricultural economy of the country. It is the staple food and major source of energy and nutrition of Indian diet. There are a number of factors responsible for lower productivity of wheat crop as compared to certain developed countries and states within the country. Biotic as well as abiotic factors are also posing serious threats in realizing the full potential. Regarding diseases, rusts, foliar blight, loose smut and Karnal bunt and off course, the ear-cockle are major concern in wheat growing regions. On the other hand, the disease UG-99 is also of quarantine importance.

Distribution pattern of Karnal Bunt
Karnal bunt (Mundkur, 1943a, 1943b) [9, 10], new bunt (Mitra, 1931, 1935, 1937) [13, 12, 14] or partial bunt (Bedi *et al.*, 1949) [4] of wheat was first discovered by Mitra in April 1930 in the experimental seed material grown at the Botanical Station, Karnal and was reported by him in 1931.Karnal bunt is a disease of wheat, durum, rye and triticale (9 hybrid wheat and rye). After the first report by Mitra in 1931, McRae reported Karnal bunt in a virulent form at Karnal in 1934, and later the disease was found in Sind Province of Pakistan in 1941 and the erstwhile United Province and the Delhi State of India in 1942 (Mundkur, 1944) [11]. By 1943, it was prevalent in Punjab and North West Frontier Provinces of Pakistan (Mundkur, 1943a) [9].
During 1944-45, the incidence was low but in 1948, serious damage by Karnal bunt was observed in the Punjab and North West Frontier Provinces of Pakistan (Bedi *et al.*, 1949) [4]. Karnal bunt was intercepted on plant materials imported by the United States Department of Agriculture through the Washington inspection house, from Afghanistan. Though the disease native to South Asia but subsequently it has been reported from Iran, Syria, Afghanistan, Iraq, Mexico, Nepal and United States. The disease remained less damaging till 1970s but subsequently severe epidemic started occurring coinciding with the changeover to high yielding irrigated, semi-dwarf and high fertilizer input farming.
Karnal bunt is visible on wheat grains, which are partially or completely converted into black powdery masses enclosed by the pericarp. The pathogen infects the ovaries in the emerging wheat heads and converts the grain partially or completely into dark coloured powdery masses of teliospores. The diseased fields emit a foul smell like that of rotten fish due to production of trim ethylamine. Karnal bunt differ from other diseases of wheat in that the pathogen infects plants during anthesis and it sporulates on the same generation of the host which it infects. Neither all spikes of plant nor all grains in spike are affected by the disease and usually a few irregularly distributed kernels are bunted.
Karnal bunt, which is caused by *Tilletia indica*, occur sporadically but assumes epidemic proportions in certain years and causes substantial losses to both quality and quantity of wheat. In certain varieties such as HD-2009, the percentage of affected grains was as high as 30-40% and it has been estimated that the Karnal bunt disease of wheat causes the yield losses up-to 4000 metric tons of grain per

year. By 1969, Karnal bunt had spread to extensive areas in the states of India viz., Jammu & Kashmir, Punjab, Haryana, Himachal Pradesh, Uttar Pradesh, Delhi and Rajasthan (Swaminathan *et al.*, 1971) [18]. During 1974-75 crop season, the disease was severe at many locations in North India particularly, in the Himalayan foot hills and the "Tarai" region of Uttar Pradesh, Punjab and Himachal Pradesh. The severity of infection was as high as 15 to 50 per cent at Hempur and Pantnagar in Uttar Pradesh (Agarwal *et al*., 1976; Singh *et al*., 1977; Joshi *et al*., 1980) [1, 17, 6].

Karnal bunt incidence in the districts surveyed are based on variable number of wheat grain samples received seed testing laboratory of N.D. University of Agriculture & Technology, Kumarganj, Faizabad. Karnal bunt is widely distributed in various western and eastern districts of Uttar Pradesh, while northern hill and southern dry areas are generally free from the disease. Wheat variety K-7903 was infected from Karnal bunt with average infection was 0.66 per cent followed by PBW-343 with average infection 0.15 per cent, where as trace level of Karnal bunt infection were found in PBW-502, PBW-550 and UP-262. The wheat cultivars, DBW-17, K-307, NW-1012, HD-2733 and Raj 3077 were found free from Karnal bunt infection, while the districts wise survey concluded that Sultanpur district was free from Karnal bunt infection (Shukla *et al.*,2018) [15, 16]. An extensive survey in eastern Uttar Pradesh from 2003-2007 and find out the frequency of infected samples were high in the eastern part of state during 2006 (30.90%) followed by 2005 (25.46%) and was less in 2004 (17.98%) and in 2003 (18.36%). Range of Karnal bunt prevalence in the samples were high in Basti (25.00-84.61%) followed by Bahraich (30.77-77.78%), Mahrajganj (40.00-75.00%) and rest collected samples varied from 5.45-48.00% (Singh *et al*., 2010) [8]. A monitoring of wheat crop, pre and post-harvest, was done for recording incidence of various diseases in Punjab state during the period 2013–14 to 2015–16. The data indicated a change in virulence of stripe rust pathogen among the preharvest diseases, whereas, among the post-harvest diseases, Karnal bunt, a minor disease earlier, has become a matter of concern as its incidence has increased over the years (highest 2.20% in 2014–15). The trend is considered mainly due to prevalence of favourable environmental conditions during the most vulnerable growth stage of the crop (Kaur *et al*., 2018) [7].

Aujla *et al*., (1987b) [3] have reported a loss of 42.4% in the variety of WL-711 and 57.5% in the variety HD-2009 in Punjab during the epidemics of 1978-79. The disease remained endemic for considerable period of time in the Northern area of Pakistan later it spread to south and was reported from Jhang, Khanewal and Muzaffargarh district of Punjab (Bhati and Ilyas, 1986) [5]. A little later the disease became wide spread throughout the Punjab and was prevalent in 23 districts with a frequency range of 0.32 to 3.50 per cent.

There is no estimate of exact losses, due to this disease, occurring in Pakistan, however, survey in India conducted during the years of heavy disease revealed a total loss of 0.5 per cent, but in some fields where 89 per cent of kernels were infected, the yield losses ranged from 20-40 per cent in highly susceptible varieties (Anonymous, 2004) [2].

Management for the Karnal bunt

It is a monocyclic disease in which teliospores germinate on soil surface during the crop season to produce large number of monokaryotic haploid, primary sporidia. Optimum germination occurs at average temperature of 18-22^{0}C under floating conditions on water surface. The primary sporidia either produce secondary sporidia and germinate to develop hyphal mass which in turn generates secondary allantoid shaped sporidia. The sporidia become air-borne and lodges on plant surfaces where they may germinate and produce additional generations of allantoid shaped sporidia. Control of Karnal bunt has now become a major concern in India due to lack of desired resistance in popular bread wheat cultivars in Northern plain and Central zones coupled with favourable weather conditions at flowering stage favour the high incidence of Karnal bunt.Fungicides namely corboxin (Vitavax 75WP), Carbendazim (Bavistin 50WP), Subeej (Bavistin 25SD), Propiconozole (Tilt 20EC), Vitavax power (Cromp. Uni. Royal) alongwith one untreated control. All these five fungicides were tested at three concentrations i.e. 0.1%, 1.0% and 2.5%. The radial growth was measured after 15 days and per cent inhibition radial growth was calculated and propiconazole (Tilt 20EC) was found most inhibitory against the radial growth (Shukla *et al.*,2018) [15, 16]. An integrated disease management (IDM) system, combining host resistance, regulatory measures, cultural practices, bio suppression techniques and chemical measures as its sub-systems to manage wheat disease. However, there is a urgent need to develop appropriate experimental models to study relative importance of the sub-systems of the integrated management system in terms of their effectiveness and economics. Successful management of a disease like Karnal bunt, which is seed borne, soil-borne and air-borne, would depend on our understanding of the sub-systems mentioned above and their integration into an appropriate package of practices for use by the wheat growers.

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