

Black Point and Black Discolouration Diseases of Wheat in India During 1995-96 to 2002-2003

A.K. SHARMA, M.S. SAHARAN, J. KUMAR, K.S. BABU, A.K. SINGH, MANOJ KUMAR, S.P. SINGH, KAMLESH KUMAR, SUNIL KUMAR, S.K. MANN¹, S.S. KARWASARA², M.S. BENIWAL², P.S. SHEKHAWAT³, R.N. SINGH⁴, A.K. SINGH⁴, V.S. RAO⁵ AND V.A. SOLANKI⁶

Directorate of Wheat Research, Karnal, Haryana 132 001, ¹PAU, Ludhiana, ²HAU, Hisar, ³RAU, Durgapura, ⁴NDUA&T, Faizabad, ⁵AR1, Pune, ⁶GAU, Vijapur
arun_dwr@rediffmail.com

ABSTRACT Black point and black discolouration diseases of wheat are gradually becoming important as they affect the trade. Both these grain maladies are many times, confused with Karnal bunt disease (*Tilletia indica* Mitra) which has great quarantine implications. Wheat grain samples were analyzed for black point for eight years (1995-96 to 2002-03) and for black discolouration for six years (1996-97 to 1997-98 & 1999-2000 to 2002-03) from different wheat growing states of India. The study indicated that black point and discolouration were prevalent during 1995-96 to 2002-03 in most of the states (from where samples were analyzed) but there was difference in the incidence of both diseases. During 1995-96, in Punjab and Haryana, 93.9 and 77.5 per cent samples showed the black point level of infection of 0.1-1.7 and 0.1-3.0 per cent, respectively. During 1996-97, in Haryana, Punjab and U.P. majority of the samples were in the range of 0.05-2.4 per cent disease level. Incidence of black point in India during 1997-98 was very high (85.9% infected samples) whereas, during 1999-00, 74.2 per cent samples were found infected. During 2000-01 and 2001-02, Punjab had maximum infection of 90.5 per cent and 91.4 per cent, respectively, whereas, in 2002-03, the highest number of infected samples were from central and eastern U.P. (83.0%). Black point incidence was the highest during 1997-98, followed by 2001-02 as compared to other years. Black discolouration incidence was observed from 0.05 to 1.0 per cent at most of the places in North West Plain Zone (NWPZ) during 1996-97. Black discolouration samples ranged 41.5 per cent to 77.4 per cent during 1997-98 and during 1999-00, the range was between 39.7 to 81.7 per cent in different states. Black discolouration incidence was the highest in Punjab in 1999-00 to 2002-03. In general, these grain infections were higher in the NWPZ as compared to the central and peninsular zones. However, in certain years, some exceptions were noted.

Key words: Black point, black discolouration, wheat, distribution pattern, *Alternaria alternata*

Black point and grain discolouration or black discolouration are the major grain infecting diseases of wheat (*Triticum* spp.). The black point disease of wheat has been reported from Canada, United States of America, Argentina, Germany, Italy, Morocco, South Africa, India and Java, and a large number of fungi have been reported to be associated with it but species of *Alternaria*, *Helminthosporium* and *Fusarium* have been reported most frequently [1]. It can be serious enough to affect flour quality but generally does not alter seed viability unless species of

Helminthosporium are involved. The term black point was first used by Bolley [2] to describe discolouration in wheat kernels. Dastur [3] was the first to report *Helminthosporium sativum* causing black point disease of wheat from India. Galloway [4] reported *Helminthosporium sativum*, *Alternaria* spp. and *Fusarium* spp. associated with black point of wheat in samples from Pusa (Bihar). For a long time, the disease was of minor importance but its extensive occurrence in the states of Haryana, Punjab, U.P. and Delhi was reported in 1966 [5]. As the name of disease suggests, it

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appears as a black dot on the surface of seed. The black point infects only the embryonic end of the grain as a small black dot, whereas, in discolouration, the blackening extends beyond the grain tip to cover a major part of the grain. Black point infected grains remain bold and show no signs of shriveling whereas, the grains infected by black discolouration get shriveled to various levels or even mummified depending upon the intensity of infection. In case of black discolouration, though *A. alternata* continues to be the dominant fungus, other fungal species like *Drechslera sorokiniana*, *Curvularia lunata*, *Epicoccum* spp. and *Fusarium* spp. were isolated [6]. *Drechslera sorokiniana* produces light brown to dark brown discrete lesions with typical eye spot symptoms on the seeds, which should not be confused with black point symptoms. *Alternaria alternata* is principal pathogen causing black point of wheat but isolations yielded *Alternaria triticina*, *Stemphylium* spp. and *Helminthosporium sativum* and *Fusarium* spp. in a few cases [6, 7]. Several fungi, viz., *Alternaria alternata* (Fr.) Keissler, *Drechslera sorokiniana* (Sacc.) Subram. & Jain and species of *Fusarium*, *Curvularia*, *Cladosporium*, *Nigrospora* were attributed to the black point of wheat by various workers in the past [7-10]. Grain or seed infecting diseases like black discolouration and black point affect the trade of wheat. Many a times, blackpoint or discolouration are confused with Karnal bunt disease (*Tilletia indica* Mitra) which has great quarantine implications. Hence, monitoring of these two maladies in India carries much importance. However, no comprehensive documentation of the black point disease situation at the national level has been done in the past, though some publications on the regional distribution or for a limited period are available [5, 8, 11, 12, 13]. Hence, present studies were undertaken to record the distribution of black point and black discolouration in different states of India.

MATERIALS AND METHODS

Post-harvest surveys were conducted in different states (Punjab, Haryana, Himachal Pradesh, Rajasthan, Uttar Pradesh, Karnataka, Madhya Pradesh, Bihar, Gujarat and Maharashtra) for collecting wheat grain samples from 1995-1996 to 2002-03 crop seasons. Grain samples were

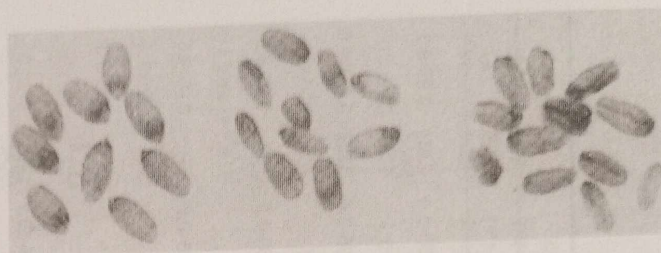


Fig. 1. Symptoms of black point (left), grain discolouration (middle) and Karnal bunt on wheat grains (right)

analyzed for the presence of black point and discolouration. Black point and discolouration can be easily differentiated from Karnal bunt (KB) in having the blackening on the surface of grain whereas, in case of KB, the spores are formed inside the sorus (Fig. 1). Wheat grain samples were analyzed for black point during 1995-96 to 2002-03 and for black discolouration 1996-97 to 1997-98 and 1999-00 to 2002-03. Grain samples weighing around 250 gm each, were collected at random from the grain markets in brown paper bags or cloth bags and brought to the laboratory for analyses. For grain analysis, 2000 grains were taken at random from each of the samples and analyzed visually for the presence or absence of the infected grains. The per cent disease incidence was calculated by using the formula:

Per cent disease incidence =

$$\frac{\text{Number of infected samples}}{\text{Total samples}} \times 100$$

Level of disease infection or severity in each of the samples was calculated by using formula:

Level of infection or severity =

$$\frac{\text{Number of infected grains}}{2000} \times 100$$

The range of infection was taken as severity in the grain samples of a lot or region. Standard blotter technique [14] was used to study the seed microflora associated with black point.

RESULTS AND DISCUSSION

Black point

Data regarding per cent infected samples and severity or range of infection in the samples collected from different states of India during 1995-96 to 2002-03 crop seasons are presented (Table 1).

Table 1. Distribution pattern of black point in different states of India during 1995-2003

State	1995-96		1996-97		1997-98		1998-99		1999-00		2000-01		2001-02		2002-03		Total	
	T.S. (%I.S.)	R.I. (%)	T.S. (%I.S.)	R.I. (%)	T.S. (%I.S.)	R.I. (%)	T.S. (%I.S.)	R.I. (%)	T.S. (%I.S.)	R.I. (%)	T.S. (%I.S.)	R.I. (%)	T.S. (%I.S.)	R.I. (%)	T.S. (%I.S.)	R.I. (%)	T.S. (%I.S.)	R.I. (%)
Punjab	213 (93.9)	0.1-1.7 (72.6)	161 (72.6)	0.05-1.4	300 (89.0)	0.1-6.5	98 (69.8)	0.05-0.7	871 (77.3)	0.05-3.7	95 (90.5)	0.05-1.05	256 (91.4)	0.05-1.7	307 (42.0)	0.05-1.4	2301 (77.1)	0.05-6.5
Haryana	160 (77.5)	0.1-3.0 (84.6)	117 (84.6)	0.1-2.4	519 (97.5)	0.1-22.0	626 (90.1)	0.05-3.3	219 (68.0)	0.05-4.9	191 (81.7)	0.05-2.4	411 (70.5)	0.05-1.2	1029 (72.2)	0.05-3.6	3272 (80.4)	0.05-22.0
Western U.P.	268 (88.4)	0.1-8.5 (77.2)	79 (77.2)	0.1-2.2	257 (93.3)	0.1-4.1	57 (94.7)	0.05-1.0	-	-	31 (77.4)	0.05-1.0	14 (78.6)	0.05-0.7	248 (44.7)	0.05-1.5	954 (77.4)	0.05-8.5
Himachal Pradesh	8 (100.0)	0.1-1.2 (100.0)	12 (100.0)	1.4-9.0	-	-	-	-	-	-	-	-	-	-	31 (45.2)	0.05-0.7	51 (66.7)	0.05-9.0
Uttaranchal	-	-	-	-	-	-	-	-	-	-	-	-	85 (17.6)	0.05-3.3	-	-	85 (17.6)	0.05-3.3
Rajasthan	-	-	-	-	276 (81.5)	0.1-23.0	179 (86.0)	0.1-13.0	206 (49.5)	0.0-9.7	345 (53.3)	0-11.0	358 (54.5)	0.05-1.6	497 (82.2)	0.05-20.7	1861 (68.2)	0-23.0
Central & Eastern U.P.	-	-	-	-	-	-	89 (90.6)	0.05-2.2	-	-	140 (76.4)	0.05-3.05	112 (59.8)	0.05-2.0	470 (83.0)	0.05-10.4	811 (79.5)	0.05-10.4
Bihar	26 (7.7)	0.1-5.7 (90.0)	30 (90.0)	0.2-0.0	-	-	30 (93.3)	0.1-2.2	-	-	-	-	7 (85.7)	0.05-3.2	8 (75.0)	0.1-0.5	101 (68.3)	0.05-50.0
M.P.	230 (89.1)	0.1-4.5 (59.1)	357 (59.1)	0.05-13.5 (80.0)	501 (80.0)	0.1-36.0	223 (90.6)	0.1-25.0	148 (68.2)	0.05-1.9	314 (51.5)	0.05-2.5	322 (41.0)	0.05-3.5	220 (68.2)	0.1-5.0	2315 (67.6)	0.05-36.0
Gujarat	76 (80.3)	0.1-17.5 (96.0)	100 (96.0)	0.1-28.0	-	-	204 (35.3)	0.1-25.0	666 (39.5)	0.05-20.2	777 (34.2)	0.03-21.0	173 (61.0)	0.05-5.2	1056 (34.7)	0.02-16.8	3052 (40.3)	0.03-28.0
Maharashtra	39 (41.0)	1.0-12.0 (64.0)	-	-	200 (64.0)	0.1-26.2	-	-	-	-	151 (55.0)	0.05-3.5	245 (70.8)	0.05-2.2	277 (65.3)	0.1-2.5	912 (63.7)	0.05-26.2
Karnataka	-	-	-	-	-	-	-	-	-	-	-	-	75 (24.0)	0.05-0.7	35 (22.8)	0.05-0.4	110 (23.6)	0.05-0.4
Total	1020 (38.0)	0.1-17.5 (72.8)	856 (72.8)	0.5-50.0	2053 (85.9)	0.1-36.0	1506 (77.6)	0.05-13.0	2110 (74.2)	0.0-20.2	2058 (52.0)	0.03-21.0	5165 (78.9)	0.05-9.3	4178 (51.2)	0.05-20.7	15827 (66.8)	0.05-50.0

T.S. = Total grain samples analyzed; I.S. = Infected grain samples; R.I. = Range of infection; - = Survey not conducted

Table 2. Distribution pattern of black discolouration in different states of India over the years

State	1996-97		1997-98		1999-00		2000-01		2001-02		2002-03		Total	
	T.S. (%I.S.)	R.I. (%)	T.S. (%I.S.)	R.I. (%)	T.S. (%I.S.)	R.I. (%)	T.S. (%I.S.)	R.I. (%)	T.S. (%I.S.)	R.I. (%)	T.S. (%I.S.)	R.I. (%)	T.S. (%I.S.)	R.I. (%)
Punjab	161 (40.4)	0.05-1.0	300 (51.7)	0.1-4.5	871 (81.7)	0.05-2.5	2326 (99.4)	0.05-3.1	256 (48.8)	0.05-0.70	307 (70.3)	0.05-1.5	4221 (84.9)	0.05-4.5
Haryana	117 (35.0)	0.05-0.40	519 (55.0)	0.1-10.8	219 (79.0)	0.05-2.6	191 (87.4)	0.05-2.1	411 (45.6)	0.05-1.7	510 (33.9)	0.05-3.4	1967 (52.2)	0.05-10.8
Western U.P.	79 (7.6)	0.10-0.7	257 (77.4)	0.1-2.5	96 (79.2)	0.05-1.4	31 (77.4)	0.05-1.0	14 (42.8)	0.05-0.15	248 (73.0)	0.05-0.8	725 (75.3)	0.05-2.5
Himachal Pradesh	12 (7.5)	0.05-0.4	-	-	-	-	-	-	-	-	31 (48.4)	0.05-0.7	43 (37.2)	0.05-0.7
Uttaranchal	-	-	-	-	-	-	-	-	110 (39.1)	0.05-0.7	-	-	110 (39.1)	0.05-0.7
Rajasthan	-	-	145 (62.8)	0.1-2.3	-	-	140 (17.1)	0.05-0.8	370 (10.3)	0.05-12.0	105 (16.1)	0.05-0.2	760 (22.4)	0.05-12.0
Central & Eastern U.P.	-	-	-	-	-	-	140 (32.1)	0.05-0.8	112 (8.9)	0.05-0.6	206 (77.2)	0.05-2.1	458 (46.7)	0.05-2.1
Bihar	30 (0)	0	-	-	-	-	-	-	7 (71.4)	0.05-0.3	8 (100)	0.1-1.2	45 (28.9)	0.05-1.2
M.P.	357 (10.1)	0.05-1.5	501 (57.1)	0.1-88.0	148 (50.7)	0.05-0.9	314 (22.6)	0.05-0.7	322 (11.0)	0.05-0.75	220 (28.2)	0.1-1.2	1862 (30.4)	0.05-88.0
Gujarat	100 (70.0)	0.1-3.4	-	-	179 (39.7)	0.05-1.3	158 (11.4)	0.05-0.3	173 (10.4)	0.05-0.7	-	-	610 (29.0)	0.05-3.4
Maharashtra	-	-	200 (41.5)	0.1-4.0	-	-	151 (14.6)	0.05-0.85	245 (31.8)	0.05-1.2	277 (19.4)	0.1-1.3	873 (27.1)	0.05-4.0
Karnataka	-	-	-	-	-	-	-	-	75 (9.3)	0.05-0.4	35 (11.4)	0.05-0.1	110 (10.0)	0.05-0.4
Total	856 (26.5)	0-3.4	1922 (57.1)	0.1-88.0	1513 (73.2)	0.05-2.6	3451 (75.5)	0.05-73.0	2095 (25.5)	0.05-12.0	1947 (45.6)	0.05-3.4	11784 (54.5)	0.05-88.0

T.S. = Total grain samples analyzed; I.S. = Infected grain samples; R.I. = Range of infection; - = Survey not conducted

During 1995-96, in Punjab and Haryana, 93.9 and 77.5 per cent samples showed the black point incidence of 0.1-1.7 and 0.1-3 per cent, respectively. During 1996-97, in Haryana, Punjab and U.P., majority of the samples fall in the infection range of 0.05-2.4 per cent. In M.P., 59.1 per cent samples were infected with black point within the infection range of 0.05-13.5 per cent. Incidence of black point was very high in samples collected from various states in India during 1997-98. During 1997-98 and 1998-99, 85.9 per cent and 77.6 per cent samples, respectively, showed black point infection. The highest percentage infected samples 77.3 per cent, 90.5 per cent and 91.4 per cent were from Punjab in 1999-00, 2000-01 and 2001-02, respectively. During 2000-01 season, the NWPZ had the maximum number of black point infected samples, followed by peninsular and central zones. During 2002-03, the highest number of infected samples were from central and eastern U.P. (83.0%). Black point incidence was the highest during 1997-98, followed by 2001-02 as compared to other years for which analysis has been done.

Alternaria alternata, *Fusarium moniliforme* and *F. solani* were found associated with black point samples collected from Punjab, Haryana and U.P. Out of 35 black point samples of Punjab, *Alternaria alternata* was found in 97.1 per cent samples. In Haryana, *Alternaria alternata* was found in 87.5 per cent samples. From 19 black point samples of U.P., *Alternaria alternata* was present in all samples. Above mycoflora were detected earlier in black point samples [6].

Black discoloration

Incidence of black discoloration ranged between 25.5 to 75.5 per cent at national level, with the lowest incidence during 2001-02 and the highest during 2000-01 (Table 2). During 1996-97, the highest incidence (70.0%) was observed in Gujarat. In general, during that year the extent of black discoloration was high because of untimely rains towards crop maturity. During 1999-00, incidence of black discoloration was again very high in samples collected from various states in India. Out of 1513 samples analyzed, 73.2 per cent samples showed black discoloration within the range of 0.05 to 2.6 per cent. Percentage of samples infected with black discoloration ranged between 39.7 to

81.7 per cent in different states. In NWPZ, especially in Punjab, during 2000-01, the incidence of black discoloration was very high. The discoloration gradually decreased on moving from Punjab (99.0%) and Haryana (87.4%) to western U.P. (77.4%), central and eastern U.P. (32.1%) and Rajasthan (17.1%). During 2001-02, Punjab, Haryana and western U.P. showed the highest percentage of infected samples. During 2002-03, parts of NWPZ, viz., western U.P. and Punjab, showed the higher percentage of infected samples. Analysis of the disease data, show that the NWPZ experiences the maximum infection whereas, the central and peninsular zones showed less incidence, though wherever, the rainfall and high humidity are encountered at grain filling or at maturity stage, the black discoloration is likely to occur.

The study indicates that black point and black discoloration are prevalent in most of the states (from where samples were analyzed). There was difference in the incidence of both these diseases in different states. During 1995-96 and 1997-98, disease incidence was more as compared to other years. This difference in the infection level may be due to different environmental parameters prevalent during different crop seasons. Environmental conditions (rain, humidity, temperature, etc.) are reported to affect the production of black point symptoms [15-19]. In general, as is evident from the tables 1 and 2, the disease incidence was more in the NWPZ as compared to the central and peninsular zones, though there were exceptions in certain years at some of the locations in M.P. and Gujarat. Data of Joshi, Singh and Srivastava for the period 1979-80 to 1983-84 covering different states of India, cited by Gaur 1986 [9], indicate a similar trend. Normally, the central and peninsular zones are considered to be relatively dry during crop maturity stage with no or rare rainfall, whereas, the northern plains experience high humidity as well as rainfall once in a few years during this period. This makes the crop more vulnerable to the black point/black discoloration infection.

REFERENCES

1. WIESE, M.V. (1987). Compendium of Wheat Diseases. 2nd (ed). Am. Phytopath. Soc., St. Paul, MN, pp. 112.

2. BOLLEY, H.L. (1913). Wheat: Soil Troubles and Deterioration. North Dakota Agriculture Experimental Station Bulletin, pp. 107.
3. DASTUR, F.J. (1932). Foot rot and black point disease of wheat in central provinces. Agriculture Livestock in India, 275-282.
4. GALLOWAY, L.D. (1936). India: New plant diseases recorded in 1935. Int. Bull. Plant Prot., 10: 121-122.
5. DHARAMVIR, K.L. ADLAKHA, L.M. JOSHI & K.D. PATHAK (1968). Preliminary note on the occurrence of black point disease of wheat in India. Indian Phytopath., 21: 234-235.
6. SHARMA, A.K., J. KUMAR, M. KUMAR & S. NAGARAJAN (1997). Black point and seed discolouration in wheat and their identification from Karnal bunt. Indian Wheat Newsletter, 3: 7-9.
7. AGGARWAL, P.C., K. ANITHA, U. DEV, B. SINGH & R. NATH (1993). *Alternaria alternata*, real cause of black point and differentiating symptoms of two other pathogens associated with wheat (*Triticum aestivum*) seeds. Indian J. Agric. Sci., 63: 451-453.
8. ADALAKHA, K.L. & L.M. JOSHI (1974). Black point of wheat. Indian Phytopath., 27: 41-44.
9. GAUR, A. (1986). Black point of wheat. In: L.M. Joshi, D.V. Singh, K.D. Srivastava (eds). Problems and Progress of Wheat Pathology in South Asia. Malhotra Publishing House, New Delhi, pp. 230-241.
10. AGARWAL, K., J. SHARMA, T. SINGH & D. SINGH (1987). Black point disease of wheat in Rajasthan: Causal fungi and their pathogenicity. Annals Biol., 3: 7-16.
11. RANA, J.P. & P.K.S. GUPTA (1982). Occurrence of black point disease of wheat in W. Bengal. Indian Phytopath., 35: 700-702.
12. RANDHAWA, H.S. & H.L. SHARMA (1985). Detection and distribution of *Cochliobolus sativus* on wheat seed in the Punjab state. Indian Phytopath., 38: 341-343.
13. SHARMA, A.K., J. KUMAR, M. KUMAR, S.P. SINGH, V.S.P. RAO & S. NAGARAJAN (1996). Wheat crop health during 1995-96 crop season-position regarding black point at the national level presented at National Symposium and Annual Conference of Indian Phytopathological Society (North Zone), Shimla, Nov. 15-16, 1996, 85: (Abstr).
14. ANONYMOUS (2004). Seed Health Testing, In: International Rules for Seed Testing. Chapter 7: 7.1-7.5.
15. CONNER, R.L., J.M. CAREFOOT, J.B. BOLE & G.C. KOZUB (1992). The effect of nitrogen fertilizer and irrigation on black point incidence in soft white spring wheat. Plant and Soil., 140: 41-47.
16. FERNANDEZ, M.R., R.M. CLARKE, R.M. DEPAUW, R.B. IRVINE & R.E. KNOX (1994). Black point and red smudge in irrigated durum wheat in southern Saskatchewan in 1990-1992. Canad. J. Plant Pathol., 16: 221-227.
17. JOSHI, L.M., DHARMVIR & K.L. ADLAKHA (1969). Black point disease of wheat. Proc. Indian Sci. Cong., 56th Session, p. 12.
18. KHETARPAL, R.K., V.K. AGARWAL & K.P.S. CHAUHAN (1980). Studies on the influence of weather conditions on the incidence of black point and Karnal bunt of triticale. Seed Res., 8: 108-110.
19. REES, R.G., D.J. MARTIN & D.P. LAW (1984). Black point in bread wheat: Effects on quality and germination and fungal associations. Aust. J. Expt. Agri. & Husband., 24: 601-605.