Kamal and Mughal (1968), Khan et al., (1974) and Bhutta & Hussain (1999) observed the presence of Alternaria, Helminthosporium, Fusarium, Curvularia, Stemphylium, Rhizopus, Cladosporium, Aspergillus, and Penicillium species in wheat seeds. Grzelk and Szymer (1982) also found Alternaria tenuis, Botrytis cinerea and Fusarium spp., as predominant fungi in wheat seeds. Quality changes detected in sub samples of wheat grain with high, medium and low levels of black point were very low, the condition having little effect on the value of the grain for bread making. Alternaria alternata was the predominant fungal sp. isolated from surface sterilized grains, being present in 72% of grains with black point and in 39% of symptom less grains. Seed germination was not affected by black point but seedling emergence was reduced by 3.2% from black-pointed seed (Rees et al., 1984). In terms of storage period, grains showed significant increases in the percentage and severity of infection, and the most affected kernels were from the 60 days storage sampling (El-Khalifeh et al., 2002). Through the seed treatment with tolyl Hg acetate, Thiram and Ceresan, each at 0.25% seed weight, promising results has been obtained against Alternaria tenuis (A. alternate) and Helminthosporium sativum (Cochliobolus sativus) a causal organism of black point of wheat by Vir 1972. Helminthosporium sativum (Cochliobolus sativus) and Alternaria tenuis (A. alternata) were the causal organisms of black point and produce different symptoms on different varieties (Adlakha and Joshi, 1974). They also reported that post-anthesis is the optimum stage for infection. Mishra (1974) worked on fungicidal control of the disease and reported that Agrosan 3g/kg was the best to increase the germination and reduce the disease. Kulkarni (1980) reported that widespread of the disease in the Karnataka in 1978-79 due to
Alternaria tenuis (A. alternate), A. triticina, Drechslera sativum (Cochliobolus sativus) and Curvularia lunata (Cochliobolus lunatus). Agrosan GN (tolyl mercuric acetate) gave complete control and also increased emergence when applied as seed treatment (Agarwal et al., 1981). Rao and Bhardwaj (1981 and 1982) reported that the black point incidence was decreases with the increasing rates of nitrogen whereas the irrigation frequency had no effect. Occurrence of black point disease of wheat in West Bengal were worked out by Rana and Gupta in 1982 and resulted that Alternaria alternata was present in 66-68% of affected seed, A. triticina in 2-10% and Curvularia spp. in 6-14%. Black point disease, mainly caused by Alternaria alternata, was effectively controlled by eliminating seed-borne inoculum with hot water treatment and reducing air-borne inoculum with sprays of cheaper chemicals such as dithiocarbamates but this finding is validated till date by any other reports. (Chaudhury et al., 1984). A study on seed-borne pathogen and black point disease of wheat in Rajasthan concluded that 31 fungi were found to be associated with diseased seeds. Alternaria tenuis (A. alternate), Cladosporium oxysporum, Curvularia lunata (Cochliobolus lunatus), Drechslera sorokiniana (Cochliobolus sativus) and D. tetramera (Cochliobolus spicifer) were predominant and of these the last three were most pathogenic (Kailash et al., 1987). Sisterna and Sarandon (1996) studied the black point of wheat (Bipolaris sorokiniana (Sacc) Shoem.) influenced by nitrogen fertilization under no till (NT) and conventional tillage (CT) and reported that a higher number of seeds were contaminated with Bipolaris sorokiniana and a higher proportion of contaminated seeds did not germinate under CT compared with NT conditions, which could be related to differences in plant senescence. Dhruj and Siddiqui (1994) worked on prevalence of black point of wheat in six wheat zones in India and concluded that the disease was most prevalent in the North Western Plains.
Zone followed by the North Eastern Plains Zone, and least in the Peninsular Zone. Hasabnis et al., 2006 evaluate the relative resistance of 25 commercially grown varieties against black point caused by *Alternaria tenuis* (*Alternaria alternate*). Maximum incidence of black point was observed in Sonalika (25.67%), followed by HD 2380 (13.33%) from *T. aestivum* and cultivar MACS 9 (12.00%) from *T. durum*. Occurrence and fungi associated with wheat in Haryana was worked out with the result that three fungi, i.e. *Helminthosporium sativum* (*Cochliobolus sativus*), *Alternaria tenuis* (*A. alternate*) and *A. alternata*, were found associated with infected grains. In shriveled grains, the frequency of *H. sativum* was 75.55%, whereas in tip infection and grain discoloration *A. alternata* was associated in 90.00% and *A. tenuis* in 10.00% (Karwasra et al., 2006). Solanki et al., (2006) reported that black point, caused by *Alternaria alternata*, is one of the serious problems related to wheat trade. Even though the disease did not reduce the grain yield, the qualitative appearance of the grain, particularly the colour and luster, were affected and reduced the market price of wheat by 3.71 to 12.49% in 5 to 50% of the infected seed lots, respectively, compared to healthy seed lots. Oppitz and Hoesser (1979) reported that seed borne pathogens of wheat not only reduced the germination but also affected seedling vigour that resulting in low yield. Kunwar (1989) also isolated *Aspergillus* spp., *Penicillium*, spp., followed by *A. alternata* from 50% samples of the stored wheat seeds. The usual threshold for treatment (or more usually, a threshold for not treating) is 10% seed infection. This threshold was confirmed in the HGCA project ‘Cereal seed health and seed treatment strategies’ (Cockerell et al, 2004). Hungerford (1922) showed a strong positive relationship between the percentage of bunt-infected wheat plants and soil moisture during the period of seed germination. There was no infection at soil moisture levels of less than 10%.
Fusarium avenaceum [Gibberella avenacea], F. culmorum, F. graminearum [G. zeae], F. equiseti and Microdochium nivale (F. nivale) [Monographella nivalis] are reported as the main fungal diseases transmitted through seed in Italy by Pancaldi and Alberti (2002). They also reported that the other fungal pathogens of wheat (Fusarium spp., Septoria nodorum [Leptosphaeria nodorum], Tilletia spp., Ustilago tritici [U. segetum var. tritici] and Drechslera sorokiniana [Cochliobolus sativus]) were transmitted by seed. The importance of seed treatment with fungicides was also emphasized in the result. Lebedev et. al. (2002) tested the mixture of carbendazim + carboxin (as Kolfugo Duplet) at Saratov region of Russia for the control of seed infection of winter wheat cv. Mironovskaya 808 and spring wheat cv. Saratovskaya 66 susceptible to loose smut [Ustilago segetum var. tritici], common bunt [Tilletia tritici] and root rots (Fusarium spp. and Bipolaris sorokiniana [Cochliobolus sativus]). They concluded that “Kolfugo Duplet” was found biological and economic effective for the above mentioned diseases. The effect of pre-sowing seed treatments on winter wheat cultivar Mironovskaya 808 and spring wheat cultivar Voronezhskaya 6 at Russia were studied with 17 plant growth regulators, 9 biological control agents and 17 mixtures of fungicides for the control of brown rust [Puccinia recondita], septorioses [Septoria], powdery mildew, and seed infections with Helminthosporium, Fusarium, Alternaria, Penicillium and bacteria by Vasetskaya et. al., during 1996-99. Out of above 17 plant growth regulators, 9 biological control agents and 17 mixtures of fungicides, Narciss [of unstated composition] + Immunocytofit [of unstated composition], Narciss + Planriz [Pseudomonas fluorescens], Immunocytofit + Planriz, Narciss + Agat-25K, and Narciss + Gumisol [of unstated composition] were reported effective for these pathogens. Pasquini et. al., (2002) studied the extent of fungal and virus diseases incidence in various regions of Italy for the susceptibility of different
wheat varieties. They reported that the *Fusarium culmorum* was the most common pathogen found associated in most of the cereal growing areas and *Microdochium nivale* was found mainly in the central and northern regions. *Gaemanomycyes graminis* and *Rhizoctonia solani* were limited in all areas. *Fusarium, Alternaria, Epicoccum, Cladosporium, Acremonium, Harzia, Ulocladium, Trichotheccium, Gonatobotrys and Penicillium spp.* were found associated with the samples throughout the country. Limited numbers of *Drechslera, Exserohilum and Bipolaris spp.* were also identified in some seed samples.

Black point is the most common and serious disease among the seed borne diseases of wheat (*Triticum aestivum*) reported by Hannan *et. al.*, (2005). The relationships between environmental factors and black point incidence were worked out in Argentinean by Moschini *et. al.*, in 2006. They developed a predictive model that strongest associations were observed throughout the critical period starting at 543 degree-days from heading to 861 degree-days (base temperature=0 degrees C). 

\[ \text{PI} \% = -6.50 + 0.07 \text{DPrDDTd} + 0.23 \text{DRH} \]

was found the best regression equation. The equation accounted for 87% of the total variance in the disease incidence. Using logistic regression techniques, a model including precipitation frequency and DDTd could satisfactorily explain the probability of occurrence of severe, moderate, and light epidemics. Desjardin *et. al.*, (2007) concluded that *Fusarium proliferatum* is a major cause of maize ear rot and *fumonisin* contamination and also can cause wheat kernel black point disease. Christopher *et. al.*, (2007) have reported that black point in wheat has the potential to cost the Australian industry $A30.4 million a year. It is difficult and expensive to screen for resistance, so the vision of this study was to validate 3 previously identified quantitative trait loci (QTLs) for black point resistance on chromosomes 2 B, 4A, and 3D of the wheat variety Sunco.
Mishra(1974) have observed that infected seed treatment of var. NP 839 with agrosan GN, captan, dithane Z-78, thiram and tritisan at 3 g/kg increased germination and reduced the number of fungi associated with black point in pot and blotter tests, agrosan being the best.

Adlakha(1974) concluded that *Helminthosporium sativum* [Cochliobolus sativus] and *Alternaria tenuis* [A. alternata], which cause the disease, produce different symptoms on wheat vars. and can be easily identified. Tolyl Hg acetate, thiram and ceresan, each at 0.25% seed wt. was reported as seed treatment for the control of *Alternaria tenuis* [A. alternata] and *Helminthosporium sativum* [Cochliobolus sativus] by Vir (1972). Kulkarni et. al.,(1980) observed that in Rabi season 1978-79 the disease was widespread. Isolations from seed of infected cvs. included *Alternaria tenuis* [A. alternata], *A. triticina*, *Drechslera sativum* [Cochliobolus sativus] and *Curvularia lunata* [Cochliobolus lunatus]. Pathogenicity was established and cvs. were screened for resistance. Out of 25 varieties screened for resistance to *Helminthosporium sativum* [Cochliobolus sativus] under artificial conditions, the following were free from infection: HW699, HD2189, HI8057, HB501, VL421, Shailaja, WL410, DWR16, DWR6 and HP1209 (Kulkarni 1980).

Rana et. al., 1982 have established that black point disease was characterized by dark brown to blackish discoloration towards the embryonic end of the seed. This disease was present on seed from different cultivars collected in Kalyani during 1978-79. Incidence was 2-16%, least on Kalyansona and Sonalika. *Alternaria alternata* was present in 66-68% of affected seed of all the cultivars, *A. triticina* in 2-10% and *Curvularia sp.* in 6-14%. Pathogenicity of these fungi in causing black point was confirmed experimentally the following year. Rao et. al. (1981) observed that black point of the grain is a genetic character. In trials with 3 cv. in 1976-8, increasing N
rates from 0 to 160 kg/ha increased the av. protein content by 1.8% and decreased the yellow berry incidence from 54.6 to 7.3% and also decreased the black point incidence from 13.5 to 4.5%. Rao1982 observed that in wheat there are three genotypes were grown with three irrigation treatments and five nitrogen applications. HD2160 had the highest incidence of yellow berry [mealy endosperm], followed by HD2177 and HD4530. As N application increased, grain protein content increased and yellow berry and black point incidence decreased. HD2160 also had the highest incidence of black point. Conner(1988) conducted 2-yr field study at 6 locations on the Canadian prairies identified 7 wheat cultivars that consistently had low incidence of black point. In separate tests, the inoculation of resistant wheat cultivars with A. alternata or C. sativus under controlled environmental conditions revealed significant differences in black point incidence. All cultivars were more resistant to A. alternata than the susceptible cultivar Fielder. Glenlea and Era were more resistant to A. alternata than all the other cultivars. Only the cultivars Thatcher, Benito and Sinton were more resistant to C. sativus than Fielder. Occurrence of black point (Maloy1988) concluded that more frequently in fields irrigated by centre-pivot than by rill or wheelline. Helminthosporium and Fusarium species were found in seed from a high proportion of the fields sampled. Surface disinfestation did not eliminate these fungi but, rather, enhanced their development, presumably by eliminating competing organisms. Agrawal(1987) reported that out of 759 wheat seed samples of 12 common cultivars from 25 districts of Rajasthan, 535 showed 0.5-66% incidence of black point. Using a standard blotter method, 31 fungi were found to be associated with diseased seeds. Alternaria tenuis [A. alternata], Bipolaris sorokiniana, Cladosporium oxysporum, Curvularia lunata [Cochliobolus lunatus], Drechslera
sorokiniana [Cochliobolus sativus] and D. tetramera [Cochliobolus spicifer] were predominant.

A relationship C. sativus with the black point disease of wheat was established and intensity of seed discoloration, particularly on cultivar Castello was recorded by Rossi (1991). Seeds often sprouted on the ears of cultivars with a high incidence of black point and the percentage sprouting on ears was higher in seeds with black point than in normal seeds of the same cultivar. Sprouted seeds retained the potential to regerminate, although the germination rate was lower than that of unsprouted seeds reported by Sun (1989). Surveys report of wheat growing states of India was concluded by including Punjab, Haryana, Uttar Pradesh, Jammu and Kashmir, Himachal Pradesh, Delhi, Bihar, West Bengal, Orissa, Assam, Rajasthan, Madhya Pradesh, Maharashtra, Gujarat, Andhra Pradesh and Karnataka. The disease is more common in the NW and NE regions than in central and peninsular India. Rain during grain formation influences the disease. A large number of saprophytic and pathogenic fungi were found to be associated with black-point but Drechslera sorokiniana [Cochliobolus sativus] Alternaria alternata is the major pathogen in western India and in eastern India (Singh 1989). The predominant pathogen Bipolaris sorokiniana [Cochliobolus sativus] was identified as (in 21-54.4% of grains) and its pathogenicity was confirmed of grains causing black point disease (Zhang 1990).

Field studies were carried out in 5 wheat-growing areas of northern and central Italy over 3 years to investigate the relationship between fungal infection of wheat grains during ripening, the incidence of black point at harvesting and meteorological conditions. Alternaria alternata was identified as the predominant cause of black point and was isolated from 14.5% of grains. Drechslera sorokiniana [Cochliobolus sativus] was isolated from 0.3% of the grains. Disease incidence and the rate of A. alternata
grain infection were not significantly correlated. A. alternata infection was positively correlated with rainfall in the first 10 d after heading and negatively correlated with the aridity index. It is concluded that black point incidence at harvest could be forecasted on the basis of mycological analysis of grains at the dough ripening stage or on the basis of meteorological data collected from heading to dough stage. This paper was presented at the Workshop on computer-based DSS on crop protection, held in Parma, Italy, 23-26 Nov. 1993. Languasco, L. (1993).

*Alternaria tenuis* [A. alternata], *Cladosporium cladosporioides*, *Curvularia lunata* [Cochliobolus lunatus], *Drechslera sorokiniana* [C. sativus] and *Fusarium spp.*, were detected from selected varieties of Breeder's, Foundation and Certified wheat seeds collected from 9 sources representing 6 different agroclimatic regions of Bangladesh. Total and individual black point fungi varied in prevalence with respect to cultivar, seed tier, source and category, and disease severity. *C. sativus* predominated over the entire survey and in Foundation and Certified seeds; A. alternata was most prevalent in Breeder's seeds. Fakir, G.A. (1989).

The problems associated with black point disease of wheat (caused primarily by *Alternaria alternata*) in the Geraldton Shipping Zone, Western Australia (WA), were investigated using field trial data and data collected by the Australian Wheat Board during 1987-91. Varietal factors, location, effects of climate, agronomic effects (variety, time of sowing and nitrogen) and the costs of black point were analysed. Of 16 wheat varieties analysed, Warimba, Eradu, Millewa and Gutha were most susceptible, and Wilgoyne, Schomburgk, Madden and Bodallin least susceptible, to the disease. Black point was more prominent in the northern parts of WA than the southern parts and it is suggested that this may be due to the more common use of susceptible varieties (Eradu and Gutha) in the north. Delayed planting and the
application of nitrogen fertilizer reduced disease severity. The av. downgrading caused by the disease was c. 78% overall. Recommendations are made for areas of future research. : Wilson, J. (1993).

Cappelli, C.(1993). The main results are reported of a study conducted on the incidence of black point in 30 cultivars of durum wheat cultivated in 1991-92 in field studies in Umbria, Italy. None of the cultivars tested was resistant to the disease, although some registered only low levels of damage. In 1991, the severity of the disease was high but its incidence was low, while the reverse was true in 1992. This was attributed to the different climatic conditions in the 2 years. Rainfall favouring attacks of the ear by fungal pathogens were concentrated during flowering in 1991 and during seed development in 1992. Alternaria alternata was repeatedly isolated from kernels in both years, while Drechslera sorokiniana [Cochliobolus sativus] was recorded only during 1992, on 7 of the 15 seed samples tested, with a max. incidence of 5%..

Fungi associated with developing wheat grains were investigated in Bangladesh using the black point susceptible wheat cv. Kanchan. Four samples were collected from the soft dough to grain ripening stage at 7-d intervals. The florets were separated into lemma and kernel and a blotter method was used to detect fungi. Of more than 11 species of 10 genera found, the most common, in the order of importance, were Cladosporium cladosporioides, Epicoccum purpurascens [E. nigrum], Alternaria tenuis [A. alternata], Fusarium spp., Bipolaris sorokiniana [Cochliobolus sativus], A. triticina and Curvularia lunata [Cochliobolus lunatus]. Populations of C. cladosporioides and Fusarium spp. decreased and those of other fungi gradually increased with the increase of the grain age. Ahmed, D. N. (1994).
Artificial inoculations of kernels in vitro and heads in planta of durum wheat cultivars Castello (very susceptible to black point) and Vezio (less susceptible) were performed using several strains of *A. alternata* isolated from black point-infected kernels collected from several wheat-growing areas of Italy. All isolates were able to cause black point, but disease severity changed significantly from one strain to another. In some cases, the ability to cause black point was different in in planta and in vitro inoculations. Chiusa, G. (1996).

The effect of the disease and seed treatment with fungicides was determined in the field in 1987 and 1988. Black pointed seeds of Yecora rojo wheat were separated from healthy seeds. Infected and healthy seeds were treated with prochloraz Mn-complex 10.4% + carboxin 50% (as CQ 560 60.6% WP), prochloraz Mn-complex 10.8% + carbenazim 40% (as CQ 628 50%) or carboxin 37.5% + thiram 37.5% (as Vitavax 75% WP) at 3 g a.i/kg seeds. Untreated seeds served as control. Evidence was obtained that the black point disease of wheat had no significant effect on root rot of 30-d-old seedlings and 80-d-old plants. Seed treatment with fungicides significantly reduced the disease incidence at both growth stages. Prochloraz Mn-complex 10.8% + carbenazim 40% were the most effective and carboxin 37.5% + thiram 37.5% the least effective fungicides. Treatment with fungicides significantly increased seed yield in both years. Al Rokibah, A. A. (1995).

The wheat hybrid cultivar Cargill Trigomax 100 was inoculated with *Bipolaris sorokiniana* [*Cochliobolus sativus*] and evaluated at La Plata under conventional tillage (CT) or no-tillage (NT) conditions either in the absence of nitrogen or after the application of 90 kg N/ha (as urea), half at sowing and half at the end of tillering. Wheat heads were sprayed at anthesis with a conidial suspension of *B. sorokiniana* and covered with plastic bags. When ripe, the ears were collected and handthreshed.
The seeds were analysed by the blotter test method, following the rules given by the International Seed Testing Association (ISTA). The presence of the fungus was confirmed by the development of a dark brown mycelium on the surface of the grain. A higher number of seeds were contaminated with *Bipolaris sorokiniana* and a higher proportion of contaminated seeds did not germinate under CT compared with NT conditions, which could be related to differences in plant senescence. No significant differences in disease symptoms were noted due to the different N fertilization treatments. Sisterna, M. N. (1996).

Examination of 1686 samples indicated that black point disease was most prevalent in the North Western Plains Zone followed by the North Eastern Plains Zone, and least in the Peninsular Zone. *Alternaria alternata* was found in all 168 affected seed lots tested, >20% of seeds being infected in 140 lots. The incidence of *Drechslera sorokiniana* [*Cochliobolus sativus*] was highest in seed from the North Eastern Plains. Other fungi occurring less commonly included *Cladosporium cladosporioides*, *D. tetramera* [*Cochliobolus spicifer*], *D. halodes* [*Setosphaeria rostrata*], *Fusarium moniliforme* [*Gibberella fujikuroi*], *F. semitectum* [*F. pallidoroseum*], *Curvularia lunata* [*Cochliobolus lunatus*], *Curvularia [Cochliobolus] pallescens*, *Trichothecium roseum*, *Nigrospora sp.*, *Ulocladium sp.*, *Stemphylium sp.* and *Verticillium sp.* Dhruj, I. U. (1994).

*F. proliferatum* caused black point symptoms on kernels of Pavon wheat from California, USA. Inoculation of the soft white spring wheat cv. Fielder with *F. proliferatum* produced black point symptoms on the grain that could not be distinguished from those caused by other agents of the disease. Wheat spikes infected by *F. proliferatum* had reduced kernel numbers, and seed weight was inconsistently
affected. Germination of diseased kernels at 10 degrees C was significantly reduced, and mycelial growth impaired the development of seedlings. Conner, R. L.(1996).

Black point in wheat is thought to be caused by *A. alternata*. To obtain a method for screening for resistance to this problem, the process by which *A. alternata* infects wheat grain was observed in resistant and susceptible varieties. No association was found between infection with *A. alternata* and black point symptoms. A technique was developed to produce symptoms in vitro which showed the detection and location of the peroxidase enzymes involved. Isoelectric focusing (IEF) determined considerable differences in peroxidase isoenzyme activity from black point resistant and susceptible wheat varieties. It is concluded that the potential exists for using IEF as a tool for rapid screening for black point resistance. Williamson, P. M. (1997).

*Bipolaris sorokiniana* (*teleomorph Cochliobolus sativus*) is the causal agent of common root rot, leaf spot disease, seedling blight, head blight, and black point of wheat and barley. The fungus is one of the most serious foliar disease constraints for both crops in warmer growing areas and causes significant yield losses. High temperature and high relative humidity favour the outbreak of the disease, particularly in South Asia's intensive 'irrigated wheat-rice' production systems. In this article, we review the taxonomy and worldwide distribution, as well as the strategies to counteract the disease as an emerging threat to cereal production systems. We also review the current understanding of the cytological and molecular aspects of the interaction of the fungus with its cereal hosts, which makes *B. sorokiniana* a model organism for studying plant defence responses to hemibiotrophic pathogens. The contrasting roles of cell death and H2O2 generation in plant defence during biotrophic and necrotrophic fungal growth phases are discussed. Kumar, Jagdish.(2002).
Studies with 8 wheat cultivars carried out in 1997 to 2000 indicated that the rate of occurrence of black point [attributed to a number of pathogens and commonly associated with *Alternaria* spp. and *Cochliobolus sativus*] of wheat ranged from 1.0-34.8% in Henan Province and varied significantly among different cultivars and regions. The 1000-grain weight of diseased wheat was increased by 4.1-13.8%, but the germination and emergence percentages were decreased by 6.1-12.2% and 4.4-10.6%, respectively, as compared with that of non-diseased wheat. No relationship was found between diseased seeds and the disease rate of the plants produced by the seeds. The disease can be effectively controlled by using resistant cultivars, harvesting in time at the dough stage and spraying with diniconazole or carbendazim during the flowering to early filling stage. YuLi, Song (2001).

The occurrence of black point disease on kernels of durum and bread wheat cultivars (Bohouth 6, Cham 4, Bohouth 4 and Bohouth 5) in 184 fields in the Raqqa province, Syria, was surveyed during the 1998/99 and 1999/2000 growing seasons, and the effect of storage on disease development was evaluated. Samples from different sites (southeastern and northeastern) and depths (15 and 25 cm) were taken from grain heaps stored at El-Baleakh purchasing centre and tested to determine the percentage and severity of infection, and the pathogens involved in the disease. Sampling was conducted for 4 times with 2-month intervals. Bohouth 5 (durum wheat) was the most affected cultivar in terms of percentage and severity of infection, in both seasons compared with bread wheat cultivars, but this was more pronounced in 1999/2000 than in 1998/99 season. *Alternaria alternata* and *Fusarium spp.* were the most frequent fungi (94%) associated with affected kernels, but *Cladosporium herbarum, Cochliobolus sativus and Curvularia sp.* were less frequent (6%). In terms of storage period, grains showed significant increases in the percentage and severity
of infection, and the most affected kernels were from the fourth sampling date. Moreover, these differences were highly significant in the central part of the heap, in the southeastern compared with the northeastern site, and at 25-cm depth compared with 15-cm depth. Isolation from the stored grains at different dates showed that: (1) gradual decrease in the frequency of field fungi and (2) increase in storage decay (such as *Penicillium spp.* and *Aspergillus niger*) both occurred. El. Khalifeh, M.(2002).

Wang, H. (2002). This study was undertaken to determine the effect of fungicides on the incidence of black point (caused by *Alternaria spp.* and *Cochliobolus sativus*) in wheat (*Triticum* spp.) in southern Saskatchewan, Canada. Experiment 1 was conducted at Swift Current and Indian Head for 3 years (1997-99). Folicur 3.6F (tebuconazole) and Bravo 500 (chlorothalonil) were applied at different growth stages from stem elongation to head emergence. Three spring common wheat (*Triticum aestivum*) and three durum wheat (*Triticum turgidum var. durum [T. turgidum]*) genotypes were used in this study. Experiment 2 was conducted at Indian Head for 3 years. Folicur 3.6F was applied from stem elongation to early milk stage for a durum cultivar. The incidence of black point was very low at Swift Current. Severe black point incidence occurred at Indian Head in 1999, which could be related to low temperature and high rainfall during the grain filling stage. Durum wheat cultivars had higher black point incidence than the common wheat cultivars. Fungicide applications from stem elongation to flag emergence could increase black point infection and it was, in many cases, associated with an increase in kernel mass. Fungicide applications at or after head emergence could reduce the incidence of black point, although this was not consistent.
Lehmensiek, A. (2004) Quantitative trait loci (QTLs) for black-point resistance have been mapped in two doubled haploid-derived wheat populations, each thought to contain unrelated sources of resistance. In the 'Sunco' x 'Tasman'-derived population, QTLs were located on chromosomes 1D, 2B, 3D, 4A, 5A and 7A with each QTL explaining between 4 and 15% of the observed phenotypic variance. QTLs were contributed by both parents. In the 'Cascades' x 'AUS1408'-derived population, QTLs from 'Cascades' were identified on chromosomes 2A, 2D and 7A with each QTL explaining between 12 and 18% of the phenotypic variance. Several markers were identified which are promising candidates for use in marker-assisted selection programmes. If one, two or three of these markers would have been used to select for black-point resistance in the 'Sunco' x 'Tasman' population, then with one marker 34 of 39 resistant lines, with two markers 23 of 32 and with three markers 17 of 32 would have been selected. At the same time, 67 false positives obtained by selecting with one marker are reduced to 24 by selection with two markers and to 11 by selection with three markers. Similarly, if one, two or three markers are used to select for black-point resistance in the 'Cascades' x 'AUS1408' populations, then with one marker 25 of 31 resistant lines, with two markers 26 of 31 and with three markers 10 of 31 are selected. At the same time, 14 false positives are obtained with one marker are reduced to six by selection with two markers and no false positives are selected using three markers.

An experiment was conducted at Swift Current and Indian Head, Saskatchewan, Canada, during 1997-99 on 3 Canadian Western Red Spring wheat (CWRS) and 2 Canadian Western Amber Durum wheat (CWAD) cultivars to determine the effects of fungicides (Folicur [tebuconazole] and Bravo [chlorothalonil]) and application timing on the incidence of black point, which is
often associated with the presence of *Alternaria* spp., *Cochliobolus sativus* and *Pyrenophora tritici-repentis*. The fungicides were applied from stem elongation to head emergence stages. The incidence of black point at Swift Current showed a yearly average of less than 1%. Neither smudge nor penetrated smudge-damaged kernels were observed. There were very few smudged kernels and no penetrated smudge-damaged kernels were observed at Indian Head in 1997. The CWAD cultivars had significantly higher incidence of black point than CWRS cultivars. Early Folicur application alone (at stem elongation) showed more kernels with black point than late fungicide application. There were very few kernels with smudge damage at Indian Head in 1998. In general CWAD cultivars had higher incidence of black point and heavier kernels than CWRS cultivars. For both fungicides, early application (at flag leaf emergence) significantly increased black point incidence for all CWAD cultivars compared to the non-fungicide controls. The treatments including a late fungicide application showed lower black point incidence compared to early applications for all cultivars. An increase in black point incidence by fungicide treatments was always associated with an increase in kernel weight of CWAD cultivars. High black point incidence and kernels with smudge and penetrated smudge damage were observed at Indian Head in 1999. CWAD had higher kernel discoloration incidence and heavier kernels than CWRS. A related experiment was conducted at Indian Head during 1997-99 where Folicur was twice applied on CWAD wheat at stem elongation and head emergence stages, once at early milk stage and thrice at stem elongation, head emergence and early milk stages. In 1997, Folicur treatments reduced black point incidence. In 1998 and 1999, Folicur applied twice at stem elongation and head emergence stages increased black point incidence and kernel weight. Wang, H (2002)
Black point, caused by *Alternaria alternata*, is one of the problems related to wheat trade. Even though the disease did not reduce the grain yield, the qualitative appearance of the grain, particularly the colour and lustre, were affected and reduced the market price of wheat by 3.71 to 12.49% in 5 to 50% of the infected seed lots, respectively, compared to healthy seed lots. Field experiments were conducted in Vijapur, India, during the 1998/99 and 2000/01 rabi seasons, to determine an effective and economical management of wheat black point and its effect on wheat quality and market price. One spray of either mancozeb at 0.25% or chlorothalonil at 0.2% at the hard dough stage effectively managed the black point incidence. Positive correlation of 1000 grain weight with disease incidence exhibited that bolder grains in spike were most vulnerable to black point development. Solanki, V. A.(2006).

Postharvest surveys during the 2003-04 crop season revealed the incidence of black point in wheat grain samples from all districts of Haryana, India. However, severity, in terms of percentage of infected samples, maximum infection and average infection, was higher in the south-western zone than that in the north-eastern zone. Three fungi, i.e. *Helminthosporium sativum* [*Cochliobolus sativus*], *Alternaria tenuis* [*A. alternata*] and *A. alternata*, were found associated with infected grains. In the south-western zone, the frequency of *A. tenuis* was maximum, followed by *A. alternata* and *H. sativum*, whereas in the north-eastern zone, *H. sativum* was predominant followed by *A. alternata* and *A. tenuis*. In shrivelled grains, the frequency of *H. sativum* was 75.55%, whereas in tip infection and grain discoloration *A. alternata* was associated in 90.00% and *A. tenuis* in 10.00%. There was significant reduction in germination, root and shoot length in shrivelled grains, whereas negligible effect in tip infection and grain discoloration. Karwasra, S. S.(2006).
Grain samples from 7 wheat cultivars (C 306, WH 147, WH 283, WH 542, HD 2329, PBW 343 and UP 2338) grown in Haryana, India, were evaluated for the incidence of Karnal bunt (caused by *Neovossia indica* [*Tilletia indica*]) and black point from 1998-99 to 2002-03. Samples were collected from grain markets, tractor trolleys and threshing floors after harvesting. Among the districts in the south-western (dry) zone, the incidence of Karnal bunt was highest in Mohindergarh (52.27% of the samples were infected) and lowest in Bhiwani (11.18%). Among the districts in the north-eastern zone, the incidence of Karnal bunt was greatest in Yamuna Nagar (50.49%) and lowest in Kaithal (21.34%). The overall incidence of Karnal bunt was greater in the south-western zone (21.07%) than in the north-eastern zone (35.48%). Among the cultivars, samples from HD 2329 were the most infected (40.36%), whereas those from WH 283 were the least infected (7.74%). Infection of grain samples by black point ranged from 0.05-4.65% in the south-western zone, and from 0.05 to 4.45% in the north-eastern zone. Black point incidence was greatest in samples from WH 147 (91.94%) and lowest in samples from C 306 (77.27%).


Investigations were conducted to evaluate the relative resistance of 25 commercially grown varieties from *Triticum aestivum* and *T. durum* against black point (*Alternaria tenuis* [*Alternaria alternata*]). Cultivars were grown in Maharashtra, India, during the rabi season of 1999-2000. Maximum incidence of black point was observed in cultivar Sonalika (25.67%), followed by cultivar HD 2380 (13.33%) from *T. aestivum* and cultivar MACS 9 (12.00%) from *T. durum*. Percent relative resistance was in the range 48.07-100.00%. Cultivar DWR 162 had 0.33% incidence. Cultivars DWR 39, DWR 162, DWR 195, Lal Bahadur, NI 747-19, NI 917, PBN 142 (*T. aestivum*); MACS 2846 and NIDW 15 (*T. durum*) were reported to be resistant and
MACS 2496 (*T. aestivum*) was reported as immune to black point disease. These cultivars possessing good resistance against black point of wheat can be used as donors in breeding for multiple disease resistance. Hasabnis, S. N. (2006).

Black Point in wheat is a dark discoloration at the embryo end of the grain, which causes substantial financial losses to wheat growers due to down-grading of otherwise high-grade wheat. There does not appear to be a single cause for Black Point, although evidence suggests that fungal infection is the main link to Black Point symptoms. We sought to identify grain proteins from Black Point-affected and Black Point-free wheat cultivar SUN239V, which is known to be very susceptible to Black Point. The proteomes of both the germ and endosperm-bran components of Black Point-affected and Black Point-free grain were compared using two-dimensional gel electrophoresis (2-DE) with six replicate gels run for each protein sample. Approximately 1478 discrete protein spots were found in 2-DE gels from the germ fraction of the grain, of which 354 were identified by mass spectrometry (MS). Similarly, 1360 discrete protein spots were found from the endosperm-bran fraction, of which 303 were identified by MS. No proteins of fungal or bacterial origin were positively identified, suggesting that, at least in some cases, Black Point is not associated with microbial activity. Of the germ proteins, 252 were differentially expressed in Black Point-affected tissue, with 67 of these proteins identified by MS. Of the endosperm-bran proteins, 317 were differentially expressed in Black Point-affected tissue, with 86 identified. The largest of 12 functional classes to which the differentially abundant proteins were assigned was the 'stress' class, i.e. products of genes associated with stress, disease and defence. Higher levels of these proteins were found in Black Point-free grain, suggesting that protection from the disease might be afforded by increased levels of the 'stress' proteins. Mak, YunXian (2006).
Seed samples of 33 wheat cultivars grown in Tarnab during 2002-04 were assessed visually for black point (caused by several fungi, including *Alternaria*, *Aspergillus*, *Curvularia*, *Cladosporium*, *Fusarium*, *Helminthosporium*, *Penicillium* and *Stemphylium species*) incidence, Peshawar, Pakistan. Significant differences in percent disease incidence were observed among the cultivars. However, comparatively higher incidence was noted in Faisalabad-85, Zardana, Shahkar-95, Kohsar-93, Suleman-96, Punjab-96, Faisalabad-83 and Watan-94 in 2002-03 (6.8-20.07%) and 2003-04 (6.87-16.67%) harvests. A significant positive correlation \(r=0.591, 0.731\) was observed between 1000-grain weight and percent black point incidence, whereas a significant negative correlation \(r=-0.513, -0.835\) was evident between the number of grains/10 g and percent disease incidence in 2002-03 and 2003-04. Gul, Zishan.(2005).

Black point is the most common and serious disease among the seed borne diseases of wheat (*Triticum aestivum*). This disease is mainly caused by *Alternaria alternata*. The disease directly affects the quality of grains and flour. Various plant extracts were used on seeds to investigate the development of black point infection due to *Alternaria alternata* in wheat grains. Henna (*Lawsonia inermis*), jimson weed (*Datura stramonium*) and neem (*Azadirachta indica*) were the most effective and suitable for the control of *Alternaria alternata*. Hannan, Abdul. (2005).

The weight of 1000 cereal grains and fungal population on harvested wheat and barley grains were assessed in Poland. The application of fungicides as seed treatments or by foliar spraying during the vegetative season resulted in reduced infection by *Fusarium* spp. and, in most cases, increased 1000 grain weight. Korbas, M. (1998).
A study was carried out to demonstrate the effect of black point (caused mainly by *Cladosporium, Curvularia, Drechslera and Fusarium spp.*) on the changes of biochemical constituents in wheat seed at different levels of manuring. Starch, total soluble carbohydrates, prolamin, glutelin and phenolics were significantly affected by manure application treatment. Nitrogen alone, or in combination with cattle manure, increased the number of infected wheat seeds. Black point pathogens decreased starch, soluble carbohydrates and increased phenolics, prolamin and glutelin content in infected wheat seed. Due to infection, marked fluctuation was observed in the contents of reducing sugar, total phenol and prolamin of the seed. Kashem, M. A (1999).

Notes are given on the following species of fungi that use seeds of wheat as vectors for their propagation: *Fusarium spp.*, *Microdochium sp.*, *Stagonospora nodorum* [*Leptosphaeria nodorum*], *Ustilago tritici* [*Ustilago segetum var. tritici*], *Tilletia spp.*, and *Drechslera sorokiniana* [*Cochliobolus sativus*]. The importance of using seed dressings to control these fungi is emphasized. Pancaldi, D. (1999).

The incidence of dwarf bunt of wheat (*Tilletia controversa*) as a function of inoculum density was studied in a susceptible (Cheyenne) and a partially resistant wheat cultivar (Meridian) at 3 disease-conducive locations in Montana, USA, for 3 seasons (1993-96). Prior to seeding, plots were fumigated with methyl bromide to eliminate residual inoculum. The soil surface was inoculated with 0, 16x10\(^{2}\), 16x10\(^{3}\), 16x10\(^{4}\), 16x10\(^{5}\) and 16x10\(^{6}\) teliospores of T. controversa per row, or seed was inoculated with 0, 2x10\(^{2}\), 2x10\(^{3}\), 2x10\(^{4}\), 2x10\(^{5}\) and 2x10\(^{6}\) teliospores per gram. To determine maximum possible infection, two rows of each cultivar were soil-surface inoculated at 10x the highest treatment rate. In the soil-inoculated plots, a minimum of 16x10\(^{3}\) teliospores/row
was needed to cause trace amounts of disease (0.6% maximum). Only trace amounts or no disease occurred below the 16x105 rate. In the seed-inoculated plots, infection was rare and occurred only at inoculation rates of 2x105 teliospores/g or higher, with the highest disease incidence being 0.4%. Goates, B. J.(1999).

The effects of 3 fungicide seed treatments (triazole + imidazole, fuberidazole, and carboxin + thiram) was examined on the establishment and yield of a number of paired seed lines of wheat cultivars with different levels of Fusarium infection. Without seed treatment, lines of 4 cultivars with an average of 48% of seeds infected with Fusarium, had between 9 and 23% lower establishment than lines with 7% of seeds infected. This reduction in establishment was not always directly related to laboratory germination. Triazole + imidazole slowed or reduced establishment of some seed lines. Seed lines infected with Penicillium spp. or bacteria had greatly reduced emergence and hence yield, and only carboxin + thiram improved emergence and yield of infected lines. A second trial examined the effects of triazole + imidazole and carboxin + thiram seed treatment on the establishment and yield of a number of lines of barley cv. Valetta differing in Fusarium seed infection. In this trial, treatment with triazole + imidazole reduced field establishment in some seed lines, but did not affect yield, although treatment with carboxin + thiram produced a greater yield than triazole + imidazole. Martin, R. J. (1998).

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