World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(RESEARCH ARTICLE)

# Reaction of durum wheat cultivars and advanced lines to black point under natural conditions in crop seasons 2017-2018 and 2018-2019

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World Journal of Advanced Research and Reviews, 2025, 27(02), 1057-1065

Publication history: Received on 05 July 2025; revised on 12 August 2025; accepted on 14 August 2025

Article DOI: https://doi.org/10.30574/wjarr.2025.27.2.2960

## Abstract

Thirty one advanced durum wheat lines (ADWL) and cultivars CIRNO C2008, Baroyeca Oro C2013, Quetchehueca Oro C2013, and CENEB Oro C2017 were evaluated for their reaction to black point, under natural conditions at the Norman E. Borlaug Experimental Station in the Yaqui Valley, Mexico, during crop season 2017-2018, and twenty six ADWL and the four cultivars during 2018-2019. Sowing dates were November 14 and 24, 2017, and 12 and 22, 2018, respectively. Healthy and infected grains in ten spikes per line/cultivar were counted. In 2017-18, infection in the first date ranged from 0 to 51.3 %, with an average of 9.4, and for the second date 0 to 12.5 %, with an average of 2.8. Average infection of CIRNO C2008 was 14.4 %, 2.4 % for Baroyeca Oro C2013, 5.9 % for Quetchehueca Oro C2013, and 2.5 % for CENEB Oro C2017. The line with the highest percentage of infection was SWAHEN_2/KIRKI_8//PROZANA_1/4/ADAMAR_15//ALBIA_1/ALTAR84/3/SNITAN/9/GUAYACANINIA/GUANAY/8/GEDIZ/FGO//GTA/3/SRN_1/4/TOTUS/5/ENTE/MEXI_2//HUI/4/YAV_1/3/LD357E/2*TC60//JO69/6/SOMBRA_20/7/JUPAREC2001/10/SILK_3/DIPPER_6/3/ACO89/ DUKEM_4//5*ACO89/4/PLAT in the first date with 51.3 %. In 2018-2019, infection in the first date ranged from 0 to 9.5 %, with an average of 2.3, and for the second date 0 to 4.6 %, with an average of 1.2. The average infection for CIRNO C2008 was 0.8 %, 0.3 % for Baroyeca Oro C2013, 1.0 % for Quetchehueca Oro C2013, and 0.7 % for CENEB Oro C2017. Lines with the highest percentage of infection were: SELIM/10/RCOL/ THKNEE_2/9/USDA595/3/D67.3/RABI//CRA/4/ALO/5/HUI/YAV_1/6/ARDENTE/7/HUI/YAV79/8/POD_9/11/NASR99/6/OSU-3880005/3/STOT//ALTAR84/ALD/4/KUCUK_2/5/CRAKE_10/RISSA/12/MÂALI/6/MUSK_1//ACO89/FNFOOT_2/4/MUSK_4/3/PLATA_3//CREX/ALLA/5/OLUS*2/ILBOR and SOOTY_9/RASCON_37//GUAYACANINIA/11/BOOMER_33/ZAR/3/BRAK_2/AJAIA_2//SOLGA_8/10/PLATA_10/6/MQUE/4/USDA573//QFN/AA_7/3/ALBA-D/5/AVO/HUI/7/PLATA_13/8/THKNEE_11/9/CHEN/ALTAR84/3/HUI/POC//BUB/RUFO/4/FNFOOT/12/P91.272.3.1/3*MEXI75//2*JUPAREC2001/5/ARTIC, both with 9.5 % in the first sowing date.

**Keywords:** Durum wheat; *Triticum durum*; *Alternaria* spp.; Natural infection

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## 1. Introduction

Many fungal species, including *Alternaria*, *Fusarium*, and *Helminthosporium* spp., can be isolated from harvested wheat grain. For example, Kai-Ge *et al*. [1] isolated 21 strains representing 11 genera of these fungi. These fungal species are important in humid field environments, where they infect seed when relative humidity exceeds 90% and seed moisture content exceeds 20%. Rainfall during seed maturation, along with several days of humid weather leading up to harvest, promotes the development of black point (BP); the condition primarily affects expanding green kernels, which are the most vulnerable [2,3]. Many of the fungi that cause BP are saprophytic [4]. *Alternaria alternata* (Fries: Fries) von Keissler and *Bipolaris sorokiniana* (Sacc.) Shoemaker are generally considered the primary causal agents of the disease [5]. Infected ears which could look normal, may be elliptical, brown to dark brown lesions on the inner side of the glumes. The disease is more pronounced as brown to dark brown or blackish, localized discolored areas, usually around the embryo (Figure 1). Discoloration may also occur near the brush, in the crease or any part of the seed. It may be light or dark or with a distinct margin. Severe infection causes discoloration and shrivelling of the whole seed [5]. Vertical sections may show brown to black spots in the endosperm of infected seed [6]. The disease known as red spot caused by *Pyrenophora tritici-repentis* (Died.) Drechs., can also occur in seed affected by BP [7]. Black point not only causes economic losses due to the degradation in the quality of flour and semolina, but also affects seed germination and inhibits seedling growth [1]. It is an endemic disease of durum wheat (*Triticum durum* Desf.) and bread wheat (*Triticum aestivum* L.) in the southern region of the state of Sonora in Mexico [8], although its incidence varies from one agricultural crop season to another; the disease has been also reported to affect triticale (X *Triticosecale* Wittmack) [4]. In this wheat-producing region of Mexico, there is no program designed and financed specifically to evaluate BP, either in introductions, segregating populations and/or advanced lines. It has been demonstrated that inoculation by injection and vacuum infiltration of *Alternaria alternata* (Fr.:Fr.) Keissl. is useful to identify resistant and susceptible germplasm [9]. On the other hand, Kai-Ge *et al*. [1] completed Koch's postulates with several species that cause BP, by spraying plants in the greenhouse. In order to contribute to the monitoring of this disease in southern Sonora, the objective of this work was to evaluate the reaction of durum wheat commercial cultivars and advanced lines candidates for commercial release, during the 2017-2018 and 2018-2019 fall-winter crop seasons.

**Figure 1** Symptoms of black point on grain of durum wheat

## 2. Materials and methods

Thirty one advanced durum wheat lines (ADWL) and cultivars CIRNO C2008 [10], Baroyeca Oro C2013 [11], Quetchehueca Oro C2013 [12], and CENEB Oro C2017 [13] were evaluated for their reaction to black point, under natural conditions at the Norman E. Borlaug Experimental Station which belongs to the National Institute for Forestry, Agriculture, and Livestock Research, located in block 910 in the Yaqui Valley, Sonora, Mexico (27º22´3.01" N and 109º55´40.22" W, 37 masl) in a clay soil with pH of 7.8, during crop season 2017-2018, and twenty six ADWL and the four cultivars mentioned during 2018-2019. Sowing dates were November 14 and 24, 2017, and November 12 and 22, 2018, respectively, using 8 g of seed for a 0.7 m bed with two rows without replications. Fertilization consisted of 150 kg/ha of urea before sowing. One irrigation for seed germination and three complementary irrigations were applied during the season. Before the first complementary irrigation, 100 kg/ha of urea were applied. Thirty days after sowing, the herbicide Situi® XL (metsulfuron methyl) [14] was applied at a dose of 25 g/ha of commercial product. Harvest was done manually and the evaluation by visual inspection counting the number of healthy and infected grains in ten spikes per line/cultivar, in order to determine the percentage of infection. The daily average temperature (°C), the maximum and minimum, relative humidity, and precipitation were recorded from March 1 to 31, during 2018 and 2019, by the

weather station CIANO-910, located in block 910 in the Yaqui Valley which belongs to the automated weather station network of Sonora [15].

## 3. Results and discussion

During the crop season 2017-2018, the range of infection for the first sowing date was 0 to 51.3 % with an average of 9.4 (Figure 2); 3 lines did not have infected grains, 13 lines and cultivars Baroyeca Oro C2013 and CENEB Oro C2017 fell within the 0.1-2.5 % infection category, 2 lines within 2.6-5.0 %, 3 lines within 5.1-10 %, 8 lines and cultivars CIRNO C2008 and Quetchehueca Oro C2013 within 10.1-30 %, and 2 lines showed more than 30.1 % infected grains. The range of infection for the second date was 0 to 12.5 % with an average of 2.8; 5 lines did not have infected grains, 15 lines and cultivars CIRNO C2008 and Quetchehueca Oro C2013 fell within the 0.1-2.5 % infection category, 6 lines and Baroyeca Oro C2013 and CENEB Oro C2017 within 2.6-5.0 %, 3 lines within 5.1-10 %, and 2 lines within 10.1-30 %.

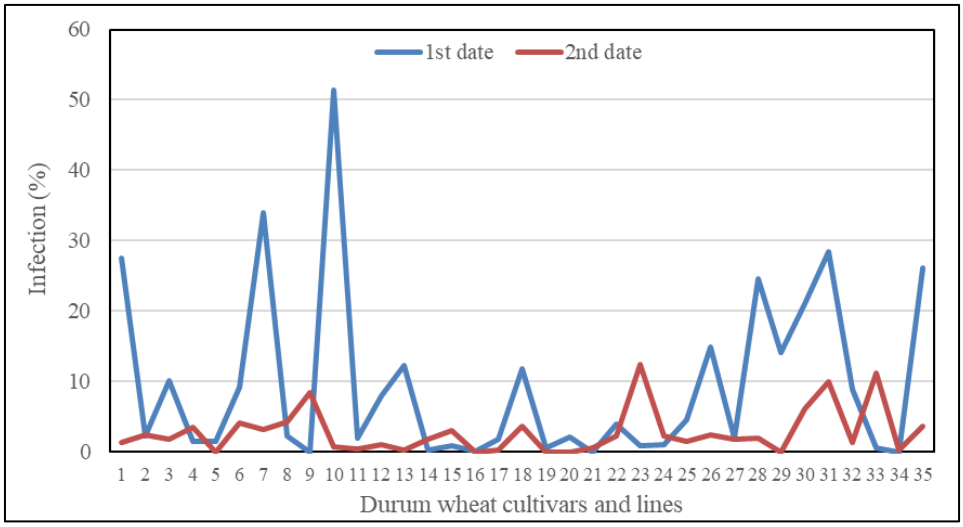


**Figure 2** Percentage of infection with black point (*Alternaria* spp.) in two sowing dates, of 31 durum wheat advanced lines and 4 commercial cultivars, evaluated under natural infection in the field, during the fall-winter crop season 2017-2018, at the Norman E. Borlaug Experimental Station in the Yaqui Valley, Sonora, Mexico. 1= CIRNO C2008, 2= Baroyeca Oro C2013, 3= Quetchehueca Oro C2013, 4= CENEB Oro C2017

Some lines showed consistency in their reaction to black point, cultivar Baroyeca Oro C2013 and lines ALTAR 84/STINT//SILVER_45/3/GUANAY/4/GREEN_14//YAV_10/AUK/5/GUAYACANINIA/YEBAS_8/3/TOPDY_18/ FOCHA_1//ALTAR84/9/CBC509CHILE/6/ECO/CMH76A.722//BIT/3/ALTAR84/4/AJAIA_2/5/KJOVE_1/7/ AJAIA_12/F3LOCAL(SEL.ETHIO.135.85)//PLATA_13/8/SOOTY_9/RASCON_37//WO (No. 16), BHA/3/SORA/ 2*PLATA_12//SRN_3/NIGRIS_4/4/AG1-22/2*ACO89//2*UC1113/8/2*STOT//ALTAR84/ALD/3/THB/CEP7780// 2*MUSK_4/6/ECO/CMH76A.722//BIT/3/ALTAR84/4/AJAIA_2/5/KJOVE_1/7/RASCON_37/2*TARRO_2/4/ROK/ FGO//STIL/3/BISU_1/5/MALMUK_1/SERRATOR_1 (No. 19), CBC509CHILE/6/ECO/CMH76A.722//BIT/3/ALTAR84 /4/AJAIA_2/5/KJOVE_1/7/AJAIA_12/F3LOCAL(SEL.ETHIO.135.85)//PLATA_13/8/SOOTY_9/RASCON_37// WODUCK/CHAM_3/9/TOPDY_18/FOCHA_1//ALTAR84/3/AJAIA_12/F3LOCAL(SEL.ETHIO.135.85)//PLATA_13/4/ SOMAT_3/GREEN_22/5/VRKS (No. 21), ARMENT//SRN_3/NIGRIS_4/3/CANELO_9.1/4/TOSKA_26/RASCON_37// SNITAN/5/PLAYERO/11/CLAUDIO/4/YAZI_1/AKAKI_4//SOMAT_3/3/AUK/GUIL//GREEN/10/TARRO_1/2*YUAN_1 //AJAIA_13/YAZI/9/USDA595/3/D67.3/RABI//CRA/4/ALO/5/HUI/YAV_1/6/ARDENTE/7/HUI/YAV79/8/POD_9 (No. 27), and PLANETA/PIQUERO//BERGAND/KNIPA/6/YAZI_1/AKAKI_4//SOMAT_3/3/AUK/GUIL//GREEN/5/ 2*NETTA_4/DUKEM_12//RASCON_19/3/SORA/2*PLATA_12/4/GREEN_18/FOCHA_1//AIRON_1/12/ALTAR84/ STINT//SILVER_45/3/GUANAY/4/GREEN_14//YAV_10/AUK/10/CMH79.959/CHEN//SOOTY_9/RASCON_37 (No. 34), showed a difference in percentage of infection between the first and second dates that ranged between 0.22 and 0.65 %. Those lines with a difference that ranged from 1.12 to 1.97 % were No. 5, 8, 11, 14, 17, 22, and 24. Lines with the lowest average percentage of infection were ALTAR 84/STINT//SILVER_45/3/GUANAY/4/ GREEN_14//YAV_10/AUK/5/GUAYACANINIA/YEBAS_8/3/TOPDY_18/FOCHA_1//ALTAR84/9/CBC509CHILE/6/ ECO/CMH76A.722//BIT/3/ALTAR84/4/AJAIA_2/5/KJOVE1/7/AJAIA_12/F3LOCAL(SEL.ETHIO.135.85)//PLATA_13 /8/SOOTY_9/RASCON_37//WO (No. 16) with 0.11, followed by PLANETA/PIQUERO//BERGAND/KNIPA/6/YAZI_1/ AKAKI_4//SOMAT_3/3/AUK/GUIL//GREEN/5/2*NETTA_4/DUKEM_12//RASCON_19/3/SORA/2*PLATA_12/4/GRE EN_18/FOCHA_1//AIRON_1/12/ALTAR84/STINT//SILVER_45/3/GUANAY/4/GREEN_14//YAV_10/AUK/10/

CMH79.959/CHEN//SOOTY_9/RASCON_37 (No. 34) with 0.17 %, and those with the highest average percentage of infection were SWAHEN_2/KIRKI_8//PROZANA_1/4/ADAMAR_15//ALBIA_1/ALTAR84/3/SNITAN/9/ GUAYACANINIA/GUANAY/8/GEDIZ/FGO//GTA/3/SRN_1/4/TOTUS/5/ENTE/MEXI_2//HUI/4/YAV_1/3/LD357E/ 2*TC60//JO69/6/SOMBRA_20/7/JUPAREC2001/10/SILK_3/DIPPER_6/3/ACO89/DUKEM_4//5*ACO89/4/PLAT (No. 10) with 26.1 and HUBEI//SOOTY_9/RASCON_37/3/2*SOOTY_9/RASCON_37/4/2*SOOTY_9/RASCON_37/6/ SOMAT_3/PHAX_1//TILO_1/LOTUS_4/3/GUANAY/5/NETTA_4/DUKEM_12//RASCON_19/3/SORA/2*PLATA_12/4/ GREEN_18/FOCHA_1//AIRON_1/7/ALTAR84/STINT//SILVER_45/3/GUANAY/4/GREEN_14//YAV_10/AUK/5/G (No. 31) with 19.2 %. On the other hand, lines that showed the highest percentage of infection were: Line No. 10 in the first date with 51.3 %, followed by CNDO/VEE//PLATA_8/3/6*PLATA_11/6/PLATA_8/4/GARZA/AFN//CRA/3/GTA/5/ RASCON/9/USDA595/3/D67.3/RABI//CRA/4/ALO/5/HUI/YAV_1/6/ARDENTE/7/HUI/YAV79/8/POD_9/10/ ALTAR84/BINTEPE85/3/STOT//ALTAR84/ALD/4/POD_11/YAZI_1/5/VANRRIKSE_12/SNITAN/6/SOOTY_9/ RASCON_37 (Line No. 7) with 34.0 %, also in the first date.

During the crop season 2018-2019, the range of infection for the first sowing date was 0 to 9.5 % with an average of 2.3 (Figure 3); 7 lines and cultivars CIRNO C2008, Baroyeca Oro C2013, Quetchehueca Oro C2013, and CENEB Oro C2017 did not have infected grains, 9 lines fell within the 0.1-2.5 % infection category, 4 lines within 2.6-5.0 %, and 6 lines within 5.1-10 %. For the second date, the range of infection was 0 to 4.6 % with an average of 1.2; 8 lines did not have infected grains, 14 lines and the four cultivars fell within the 0.1-2.5 % infection category, and 4 lines within 2.6-5.0 %. This group of lines showed more consistency in their reaction to BP in both dates than the group in crop season 2017-2018, since disease incidence and severity were much lower. Lines RANCO//CIT71/CII /3/COMDK/4/TCHO// SHWA/MALD/3/CREX/5/SNITAN/6/YAZI_1/AKAKI_4//SOMAT_3/3/AUK/GUIL//GREEN/7/CIRNOC2008 (Line No. 5) and SARAGOLLA/CIRNOC2008/9/ARNACORIS/8/WID22209/5/RASCON_33/TISOMA_2/3/CANELO_8//SORA/ 2*PLATA_12/4/SOMAT_4/INTER_8/7/CHEN_1/TEZ/3/GUIL//CIT71/CII/4/SORA/PLATA_12/5/STOT//ALTAR84/ ALD/6/SOMAT_3/PHAX_1//TILO_1/LOTUS_4 (Line No. 26) did not show any infected grains in both dates, and 8 showed a difference ranging from 0.19 to 0.94. Only one line showed a difference of 7.83, and a few more lines showed greater infection in the first date than in the second one.

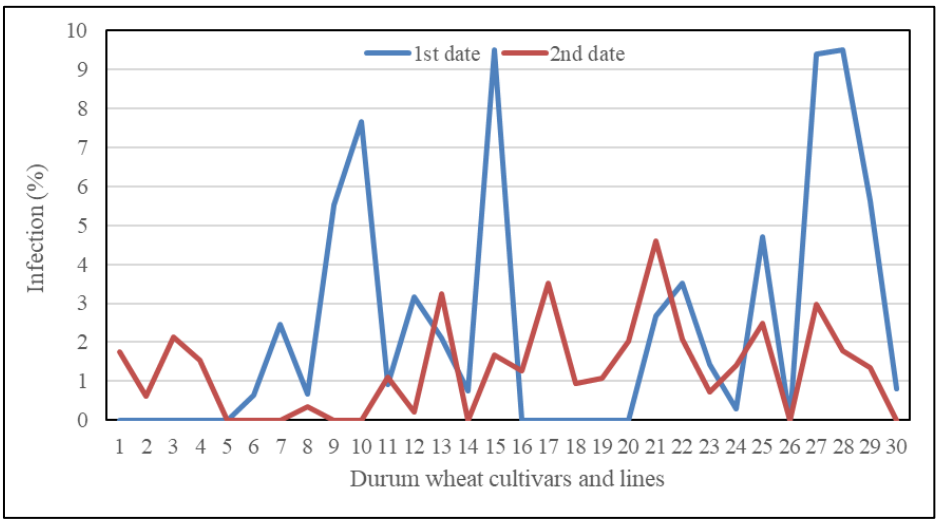


**Figure 3** Percentage of infection with black point (*Alternaria* spp.) in two sowing dates, of 26 durum wheat advanced lines and 4 commercial cultivars, evaluated under natural infection in the field, during the fall-winter crop season 2018-2019, at the Norman E. Borlaug Experimental Station in the Yaqui Valley, Sonora, Mexico. 1= CIRNO C2008, 2= Baroyeca Oro C2013, 3= Quetchehueca Oro C2013, 4= CENEB Oro C2017

Lines with the highest percentage of infection were: SELIM/10/RCOL/THKNEE_2/9/USDA595/3/D67.3/RABI// CRA/4/ALO/5/HUI/YAV_1/6/ARDENTE/7/HUI/YAV79/8/POD_9/11/NASR99/6/OSU-3880005/3/STOT// ALTAR84/ALD/4/KUCUK_2/5/CRAKE_10/RISSA/12/MÂALI/6/MUSK_1//ACO89/FNFOOT_2/4/MUSK_4/3/ PLATA_3//CREX/ALLA/5/OLUS*2/ILBOR (Line No. 15) and SOOTY_9/RASCON_37//GUAYACANINIA/11/ BOOMER_33/ZAR/3/BRAK_2/AJAIA_2//SOLGA_8/10/PLATA_10/6/MQUE/4/USDA573//QFN/AA_7/3/ALBA-D/5/AVO/HUI/7/PLATA_13/8/THKNEE_11/9/CHEN/ALTAR84/3/HUI/POC//BUB/RUFO/4/FNFOOT /12/P91.272.3.1/3* MEXI75//2*JUPAREC2001/5/ARTIC (Line No. 28), both with 9.5 % in the first sowing date. The average percentage of infection was quite different in both seasons (Figure 4), and in general higher in 2017-2018. Cultivars CIRNO C2008, Baroyeca Oro C2013, Quetchehueca Oro C2013, and CENEB Oro C2017 had higher infection in

the first season (2017-2018) with a difference of 93.8, 87.2, 82.1, and 69.8 %, respectively. Aside from the four cultivars, the difference in percentage of infection between the 26 lines in 2017-2018 and the 31 in 2018-2019 was 6.13% higher in the first crop season.

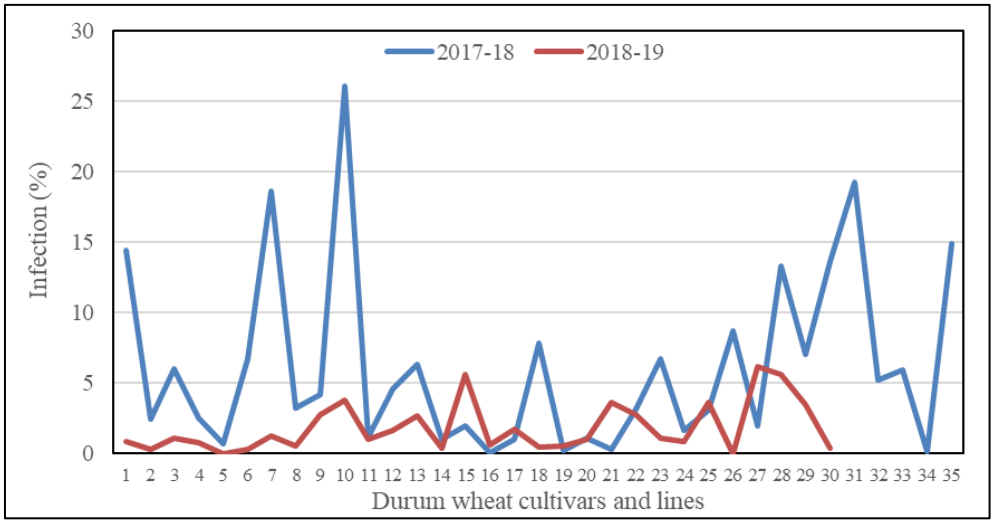


**Figure 4** Average percentage of infection with black point (*Alternaria* spp.) in two sowing dates and in two crop seasons (2017-2018 and 2018-2019), of 31 durum wheat advanced lines and 4 commercial cultivars in the first season and 26 and the four cultivars in the second one, evaluated under natural infection in the field, at the Norman E. Borlaug Experimental Station in the Yaqui Valley, Sonora, Mexico. 1= CIRNO C2008, 2= Baroyeca Oro C2013, 3= Quetchehueca Oro C2013, 4= CENEB Oro C2017

The average relative humidity during March 2018 ranged from 48.4 to 79.8 % with an average of 65.9 %, while in 2019 the range was 61.1 to 83.8 % with an average of 68.9 % (Figure 5). Average relative humidity was higher in 2018 than in 2019 on 10 days, with a range of 0.68 to 14.41 %, while higher in 2019 on 21 days with a range of 0.06 to 25.3 %. Despite this, greater infection by BP in cultivars and lines was found in 2018 (Figure 4). Fuentes-Dávila *et al*. [16] reported that in crop season 2015-2016 the natural incidence of BP was higher than in 2016-2017, based on the fact that the daily relative humidity during March 2016 had a range of 31.2 to 100 % with an average of 75.3 %, while in 2017 the range was 24.4 to 99.6 % with an average of 70.8 %. However, BP can be also prevalent if weather is hot and dry and when wheat maturity is delayed [17], as well as when there are stress factors like premature seed senescence or other environmental stressors [18]. The cultivars used in this work have an average of 121 days to physiological maturity [10,11,12,13], so by March 7, cultivars and lines had reached from 113 to 115 days in the first sowing date and from 103 to 105 days in the second dates of both crop seasons, and therefore, kernels were in full expansion close to physiological maturity (stages 83-91, Zadoks scale [19]). As reported previously [2,3], rainfall during seed maturation favors BP, as well as humid weather prevailing for a few days prior to harvest.

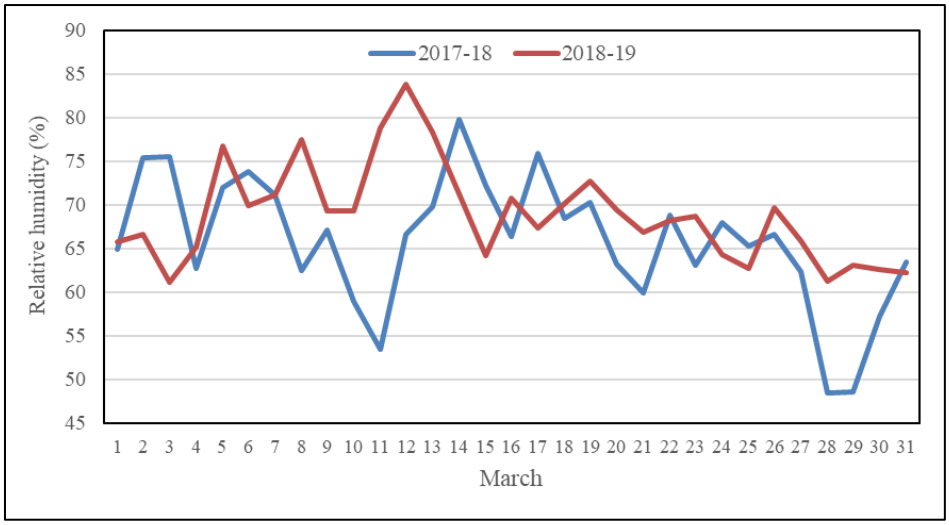


**Figure 5** Average relative humidity during March 2018 and 2019, recorded by the weather station CIANO-910, located in block 910 at the Norman E. Borlaug Experimental Station in the Yaqui Valley, Sonora, Mexico

Within the infection categories of the groups based on the average of the two dates in each crop season, in 2017-2018, twelve lines fell within the 0.1-2.5 % infection category, 5 lines and cultivars Baroyeca Oro C2013 and CENEB Oro C2017 within 2.6-5.0 %, 8 lines and cultivar Quetchehueca Oro C2013 within 5.1-10.0 %, and 6 lines and CIRNO C2008 within 10.1-30.0 % (Figure 6). The overall average of the group was 6.1 % with a range of 0.11 to 26.0 %. In 2018-2019, two lines did not show any infected grains, 14 lines and the four cultivars fell within the 0.1-2.5 % category, 7 lines within 2.6-5.0 %, and 3 lines within 5.1-10.0 %. The overall average of the group was 1.8 % with a range of 0 to 6.2 %. The incidence of BP in areas of southern Sonora where wheat is cultivated during the fall-winter season varies across bread [20], durum wheat, and triticale [8]. This variability may be attributed not only to prevailing seasonal weather conditions, but also to distinct climatic zones identified in the region [21,22]. Another important factor is the primary inoculum, which is influenced by weather conditions and the ability of certain fungal species, such as *Alternaria triticina*, *Helminthosporium sativum*, and *Fusarium* spp. to act as saprophytes, as they may survive in plant debris [4].

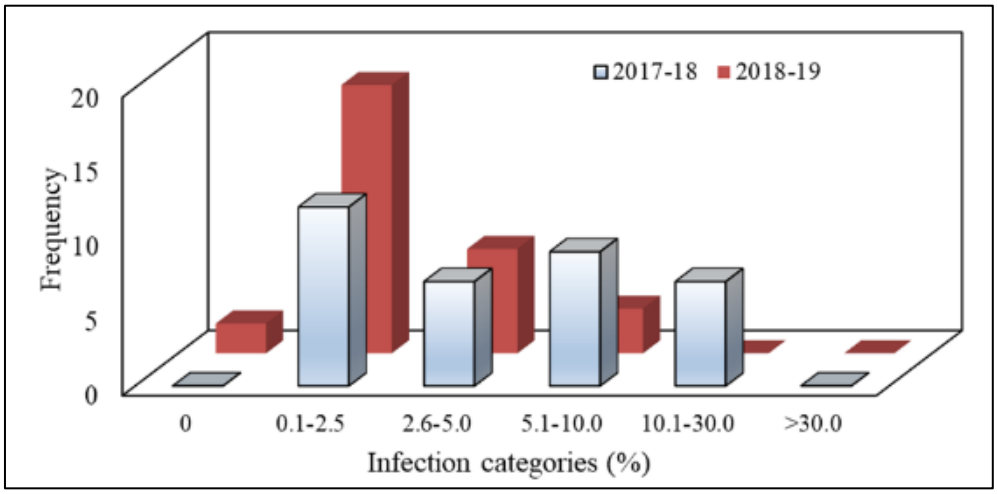


**Figure 6** Infection categories (%) with black point (*Alternaria* spp.) in two sowing dates and in two crop seasons (2017-2018 and 2018-2019), of 31 durum wheat advanced lines and 4 commercial cultivars in the first season and 26 and the four cultivars in the second one, evaluated under natural infection in the field, at the Norman E. Borlaug Experimental Station in the Yaqui Valley, Sonora, Mexico

As observed in the present study, the percentage of BP infection can be high in certain crop seasons. For example, during the 2009-2010 season, the durum wheat line SOMAT_4/INTER_8/4/GODRIN/GUTROS//DUKEM/3/THKNEE_11/5/ CNDO/PRIMADUR//HAI-OU_17/3/ SNITAN exhibited 50.6 % infection under natural conditions [20]. In the same season, bread wheat lines BABAX/LR42//BABAX/3/ER2000, BABAX/LR42//BABAX*2/4/SNI/TRAP#1/3/KAUZ*2/ TRAP//KAUZ, and TC870344/GUI//TEMPORALERAM87/AGR/3/2*WBLL1 showed infection rates of 30.8 %, 27.3 %,

and 20.5 %, respectively. Similarly, during the 2013-2014 season, the bread wheat lines SOKOLL*2/3/BABAX/LR42//BABAX and KISKADEE#1/CHYAK both showed 31.4 % infected grains [23]. A high percentage of wheat grains infected with BP negatively impacts grain quality, and consequently the market value of wheat products. In addition to the use of resistant cultivars [24], BP can be partially managed by reducing irrigation frequency after heading and lowering nitrogen application rates, practices that do not compromise grain yield or quality. Continuous evaluation of experimental durum wheat germplasm for BP reaction is essential to identify tolerant or highly resistant genotypes that may be suitable for future commercial release. In the Yaqui Valley, 77.1 % of the wheat-growing area was planted with durum wheat during the 2017-2018 and 2018-2019 fall-winter seasons [25,26]. This trend not only enhances the economic returns for wheat producers, but also contributes positively to the regional and national economy.

## 4. Conclusion

Within the infection categories of the groups based on the average of the two dates in each crop season, in 2017-2018, 12 lines fell within the 0.1-2.5 % infection category, 5 within 2.6-5.0 %, 8 within 5.1-10.0 %, and 6 within 10.1-30.0 %. Cultivars Baroyeca Oro C2013, CENEB Oro C2017, Quetchehueca Oro C2013, and CIRNO C2008 showed 2.4, 2.5, 5.9, and 14.4 average percent infection, respectively.

In 2018-2019, 2 lines did not show any infected grains, 14 lines and the 4 cultivars fell within the 0.1-2.5 % category, 7 lines within 2.6-5.0 %, and 3 lines within 5.1-10.0 %.

Lines with the highest percentage of infection were: SWAHEN_2/KIRKI_8//PROZANA_1/4/ADAMAR_15//ALBIA_1/ALTAR84/3/SNITAN/9/GUAYACANINIA/GUANAY/8/GEDIZ/FGO//GTA/3/SRN_1/4/TOTUS/5/ENTE/MEXI_2//HUI/4/YAV_1/3/LD357E/2*TC60//JO69/6/SOMBRA_20/7/JUPAREC2001/10/SILK_3/DIPPER_6/3/ACO89/DUKEM_4//5*ACO89/4/PLAT in the first date with 51.3 %, followed by CNDO/VEE//PLATA_8/3/6*PLATA_11/6/PLATA_8/4/GARZA/AFN//CRA/3/GTA/5/RASCON/9/USDA595/3/D67.3/RABI//CRA/4/ALO/5/HUI/YAV_1/6/ARDENTE/7/HUI/YAV79/8/POD_9/10/ALTAR84/BINTEPE85/3/STOT//ALTAR84/ALD/4/POD_11/YAZI_1/5/VANRRIKSE_12/SNITAN /6/SOOTY_9/ RASCON_37 with 34.0 %, also in the first date, both in crop season 2017-2018

Despite the higher relative humidity present in 21 days of March of 2019 than in 2018, greater incidence of black point was detected in 2018.

## Compliance with ethical standards

*Acknowledgments*

This research was financially supported by the Mexican National Institute for Forestry, Agriculture, and Livestock Research (INIFAP).

*Disclosure of conflict of interest*

The authors declare that No conflict of interest.

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