Natural infection with black point (*Alternaria* sp.) of cultivars and advanced bread wheat lines during the crop season 2018-2019

Infección natural con punta negra (*Alternaria* sp.) en variedades y líneas avanzadas de trigo harinero en el ciclo de cultivo 2018-2019

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ABSTRACT

Veintiniún líneas avanzadas de trigo harinero y las variedades Borlaug 100, Norman F2008, Ónavas F2009 y Roelfs F2007 se evaluaron para resistencia a la punta negra durante el ciclo agrícola otoño-invierno 2018-2019 en el Campo Experimental Norman E. Borlaug. Las fechas de siembra fueron noviembre 12 y 22, 2018. La cosecha se hizo a mano y la evaluación mediante inspección visual contando el número de granos sanos e infectados en 10 espigas por línea y de esta forma se calculó el porcentaje de infección. El rango de infección para la primera fecha de siembra fue de 0 a 15.1% con un promedio de 3.3, y para la segunda fue de 0 a 7.6% con un promedio de 0.8. Dentro de las categorías de infección del grupo en base al promedio de los datos de las dos fechas, 4 líneas no presentaron granos infectados, 11 y las variedades Borlaug 100, Ónavas F2009 y Roelfs F2007 estuvieron en la categoría 0.1-2.5%, 2 y la

variedad Norman F2008 en la de 2.6-5.0% y 4 líneas en la de 5.1-10.0%. Las líneas que presentaron los porcentajes de infección más altos fueron SOKOLL*2/3/BABAX/LR42//BABAX, BORL14*2/5/ATTILA/3* BCN*2//BAV92/3/KIRITATI/WBLL1/4/DANPHE y PBW343//CAR422/ANA/3/ELVIRA con 15.1, 11.4 y 10.8%, respectivamente, todas en la primera fecha.

Keywords: *Triticum aestivum*, bread wheat, black point, *Alternaria* spp.

RESUMEN

Veintiniún líneas avanzadas de trigo harinero y las variedades Borlaug 100, Norman F2008, Ónavas F2009 y Roelfs F2007 se evaluaron para resistencia a la punta negra durante el ciclo agrícola otoño-invierno 2018-2019 en el Campo Experimental Norman E. Borlaug. Las fechas de siembra fueron noviembre 12 y 22, 2018. La cosecha se hizo a mano y la evaluación mediante inspección visual contando el número de granos sanos e infectados en 10 espigas por línea y de esta forma se calculó el porcentaje de infección. El rango de infección para la primera fecha de siembra fue de 0 a 15.1% con un promedio de 3.3, y para la segunda fue de 0 a 7.6% con un promedio de 0.8. Dentro de las categorías de infección del grupo en base al promedio de los datos de las dos fechas, 4 líneas no presentaron granos infectados, 11 y las variedades Borlaug 100, Ónavas F2009 y Roelfs F2007 estuvieron en la categoría 0.1-2.5%, 2 y la variedad Norman F2008 en la de 2.6-5.0% y 4 líneas en la de 5.1-10.0%. Las líneas que presentaron los porcentajes de infección más altos fueron SOKOLL*2/3/BABAX/LR42//BABAX, BORL14*2/5/ATTILA/3* BCN*2//BAV92/3/KIRITATI/WBLL1/4/DANPHE y PBW343//CAR422/ANA/3/ELVIRA con 15.1, 11.4 y 10.8%, respectivamente, todas en la primera fecha.

Palabras clave: *Triticum aestivum*, trigo harinero, punta negra, *Alternaria* spp.

1 INTRODUCTION

Alternaria spp. and *Helminthosporium* spp. (Figure 1), as well as *Fusarium* spp. are among more than 100 species that can be isolated from newly harvested wheat grain (*Triticum* spp.). These fungi are most important in humid field environments, where they infect seed when relative humidity exceeds 90% and seed moisture content exceeds 20%. Black point (BP) or kernel smudge is favored by rainfall during seed maturation, as well as humid weather prevailing for a few days prior to harvest (Prescott *et al*., 1986).

Figure 1. Spores of *Alternaria* spp. and *Helminthosporium* spp. causal agents of black point.

Expanding green kernels are most susceptible. BP also promotes premature seed senescence because many of the fungi are saprophytic (Wiese, 1987). *Alternaria alternata* and *Bipolaris sorokiniana* are generally considered the primary causal agents of the disease (Mathur and Cunfer, 1993). Infected ears may look normal, but there 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 end of seeds (Figure 2) (Adlakha and Joshi, 1974; Hanson and Christensen, 1953; Rana and Gupta, 1982; cited by Mathur and Cunfer, 1993).

Figure 2. Symptoms of black point caused by the fungus *Alternaria* spp. on the wheat grain.

The 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 (Adlakha and Joshi, 1974). BP is an endemic disease of durum (*Triticum durum* Desf.) and bread wheat (*Triticum aestivum* L.) in southern Sonora, Mexico, although incidence is variable in each crop season. This disease also affects triticale (X *Triticosecale* Wittmack) (Fuentes-Dávila *et al*., 2014b; Wiese, 1987). Wheat breeding programs select for disease resistance during seed evaluation after harvest, however, there is not a formal project on BP in Sonora. The objective of this work was to evaluate the reaction of bread wheat advanced lines and commercial cultivars to BP after harvest in crop season 2018-2019.

2 MATERIALS AND METHODS

Twenty one advanced bread wheat lines and commercial cultivars Borlaug 100 (Chávez-Villalba *et al*., 2021), Norman F2008 (RSI, 2008), Ónavas F2009 (Figueroa-López *et al*., 2013), and Roelfs F2007 (Figueroa-López *et al*., 2011) were evaluated for their reaction to black point under natural conditions, at the Norman E. Borlaug Experimental Stations which belongs to the National Institute for Forestry,

Agriculture, and Livestock Research (INIFAP) located in block 910 of the Yaqui Valley in the state of Sonora, Mexico (27º22´3.01" N, 105º55´40.22" W), during the crop season fall-winter 2018-2019. Sowing dates were November 12 and 22, 2018, in a clay soil with pH 7.8; 8 g of seed were used for a bed 0.7 m long in a single row, and without replications. Fertilization consisted of 150 kg/ha of urea before sowing. An irrigation for seed germination and three complementary ones were applied during the season; 100 kg/ha of urea were applied just prior to the first complementary irrigation. Thirty days after sowing, the herbicide Situi® xl (metsulfuron methyl) was applied at the rate of 25 g/ha of commercial product. Harvest was carried out manually and the evaluation by visual inspection, counting the number of infected and healthy grains in 10 spikes per line/cultivar in order to detemine the percentage of infection; the lesion size was not taking into consideration. The advanced lines evaluated, were produced by the collaborative breeding program between the International Maize and Wheat Improvement Center and INIFAP; commercial cultivars originated from the same program and were released for commercial cultivation by INIFAP.

3 RESULTS AND DISCUSSION

The range of infection for the first sowing date was 0 to 15.1% with an average of 3.3 (Figure 3); six lines and cultivars Roelfs F2007 and Ónavas F2009 did not have infected grains, 6 lines fell within the 0.1-2.5% infection category, 4 lines and cultivars Borlaug 100 and Norman F2008 within 2.6-5.0%, 2 lines within 5.1-10%, and 3 lines within 10.1-30%. The range of infection for the second date was 0 to 7.6% with an average of 0.8; 16 lines and cultivar Borlaug 100 did not have infected grains, 3 lines and cultivars Roelfs F2007 and Ónavas F2009 fell within the 0.1-2.5% infection category, cultivar Norman F2008 within 2.6-5.0%, and 2 lines within 5.1-10%. The average infection of each line and cultivar in both date is shown in Figure 4, and lines that did not have any infected grain in both dates in Table 1.

Figure 3. Percentage of infection with black point of 21 advanced bread lines and 4 commercial cultivars, evaluated under natural conditions in two sowing dates at the Norman E. Borlaug Experimental Station in the Yaqui Valley, Sonora, Mexico, during the crop season 2018-2019. 1= Roelfs F2007, 2= Ónavas F2009, 5= Borlaug 100, 19= Norman F2008.

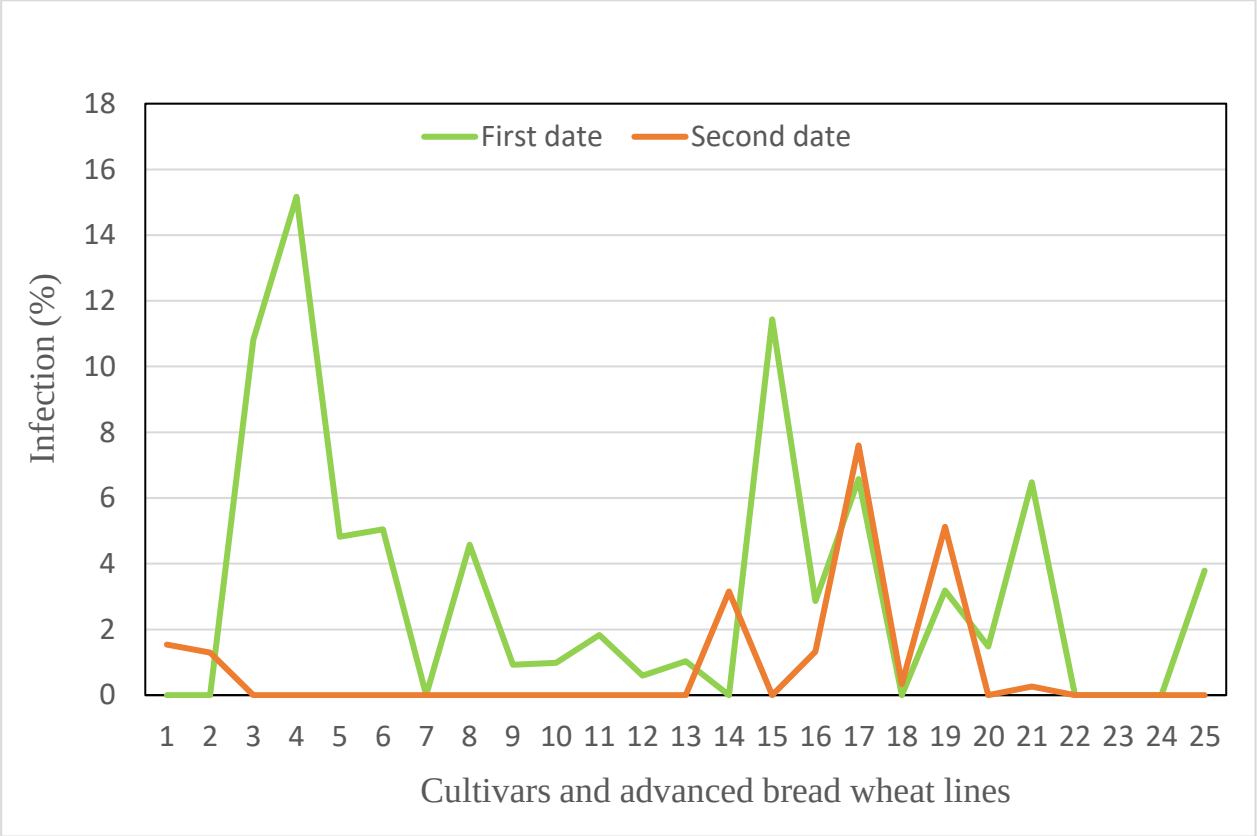
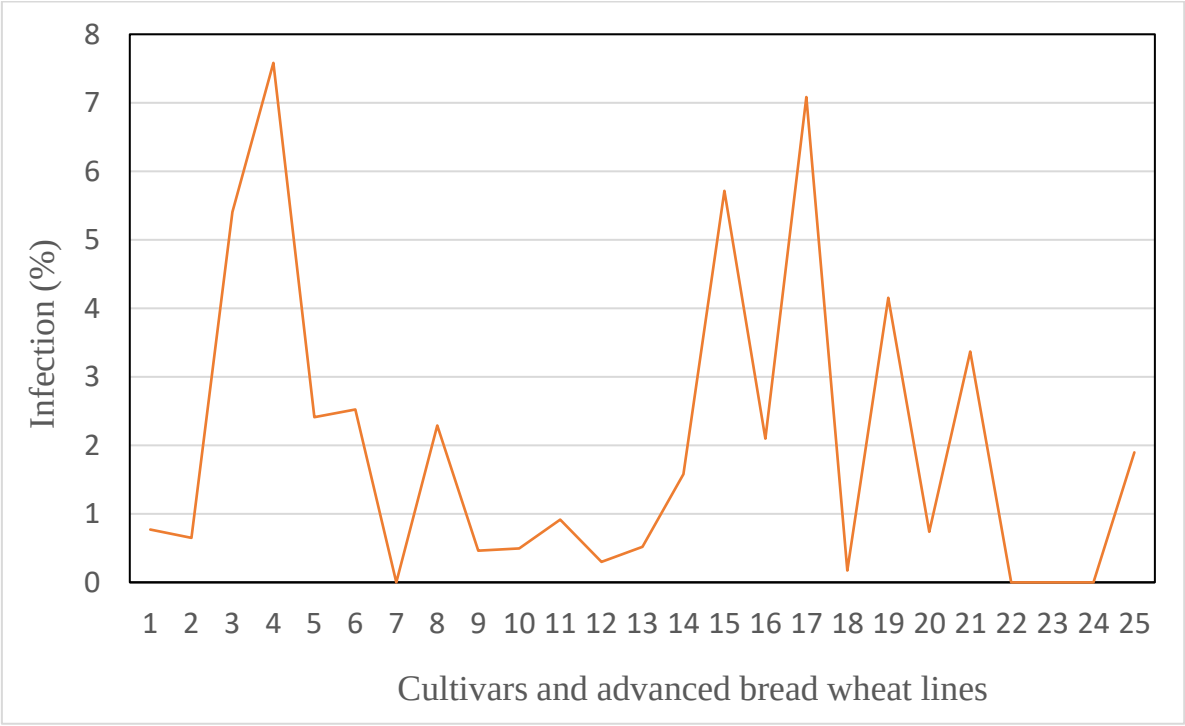


Figure 4. Average percentage of infection with black point in two sowing dates, on 21 advanced bread lines and 4 commercial cultivars, evaluated under natural conditions at the Norman E. Borlaug Experimental Station in the Yaqui Valley, Sonora, Mexico, during the crop season 2018-2019. 1= Roelfs F2007, 2= Ónavas F2009, 5= Borlaug 100, 19= Norman F2008.



Lines with the highest percentage of infection were SOKOLL*2/3/BABAX/LR42//BABAX, BORL14*2/5/ATTILA/3*BCN*2//BAV92/3/KIRITATI/WBLL1/4/DANPHE, and PBW343// CAR422/ANA/3/ELVIRA with 15.1, 11.4, and 10.8%, respectively, all in the first date. Within the infection categories of the group based on the average of the two dates, 4 lines did not show any infected grains, 11 lines and cultivars Borlaug 100, Ónavas F2009, and Roelfs F2007 fell in the 0.1-2.5% category, 2 and Norman F2008 in 2.6-5.0%, and 4 lines in 5.1-10.0%%. The overall average of the group was 2.1% with a range of 0 to 7.6%.

Table 1. Advanced bread wheat lines that did not have any infected grains with black point (*Alternaria* sp.), and that were evaluated under natural conditions in two sowing dates, during the crop season 2018-2019, in the Yaqui Valley, Sonora, México.

No.	Pedigree	Selection history
1	KACHU/BECARD//WBLL1*2/BRAMBLING/3/FRNCLN*2/TECUE #1	CMSS12B00317S-099M-0SY-33M-0WGY
2	BORL14*2//KFA/2*KACHU	CMSS12Y00770T-099TOPM-099Y-099M-099NJ-099NJ-30Y-0WGY
3	KACHU/KINDE*2//KACHU/KIRITATI	CMSS12Y01080T-099TOPM-099Y-099M-099NJ-099NJ-15Y-0WGY
4	BORL14/7/MUU/5/WBLL1*2/4/YACO/PBW65/3/KAUZ*2/TRAP//KAUZ/6/WBLL1*2/SHAMA	CMSS13Y00045S-099Y-099M-0SY-2M-0WGY

The incidence of black point (BP) varies in each crop season in the Yaqui Valley and other regions of southern Sonora on bread and durum wheat, as weather conditions are different (Torres-Cruz *et al*., 2021a, b). Another important aspect is the initial availability of primary inoculum which will be influenced by weather; some of the fungi that cause BP act as saprohytes during part of their life cycle like *Alternaria triticina*, *Helminthosporium sativum*, and *Fusarium* spp. and may survive in plant debris (Wiese, 1987). The percentage of infection by BP may be high in some crop seasons like in 2009-2010 when the bread wheat lines BABAX/LR42//BABAX/3/ER2000, BABAX/LR42//BABAX*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ, and TC870344/GUI// TEMPORALERA M87/AGR/3/2*WBLL1 had 30.8, 27.3, and 20.53% infected grains, respectively (Fuentes-Dávila *et al*., 2013); in 2013-2014, lines SOKOLL*2/3/BABAX/LR42// BABAX and KISKADEE #1/CHYAK both had 31.4% infected grains (Fuentes-Dávila *et al*., 2016); in 2014-2015, the same line SOKOLL*2/3/BABAX/LR42//BABAX had a maximum of 22.6% infected grains (Fuentes-Dávila *et al*., 2017); in 2016-2017, SITE/MO//PASTOR/3/TILHI /4/WAXWING/KIRITATI/5/KACHU#1/KIRITATI//KACHU, SOKOLL*2/3/BABAX/LR42// BABAX, and PBW343//CAR422/ANA/3/ELVIRA had 25.9, 24.3, and 22.7% infected grains, respectively (Fuentes-Dávila *et al*., 2019); in 2015-2016 ND643/2*WBLL1/5/PRL/2*PASTOR /4/CHOIX/STAR/3/HE1/3*CNO79//2*SERI/6/PRL/2*PASTOR/4/CHOIX/STAR/3/HE1/3*CNO79//2 *SERI had 15.9% infected grains (Fuentes-Dávila *et al*., 2018); in crop season 2012-2013, NL1048/4/CHIBIA//PRLII/CM65531/3/SKAUZ/BAV92 showed a maximum of 12.3% infected grains

(Fuentes-Dávila *et al*., 2015); and in 2011-2012, cultivar Villa Juárez F2009 showed the highest percentage of infected grain with 7.4% (Fuentes-Dávila *et al*., 2014a). This levels of infected grain affect the quality and consequently the value of this product. BP can be partially controlled by reducing irrigation frequency after heading and by reducing nitrogen rates, without sacrificing either yield or quality. Because BP can occur at damaging levels in some seasons despite modifications in cultural practices, the best option for control is to combine reduced input practices with BP resistant cultivars (Davis and Jackson, 2007). The evaluation of experimental bread wheat germplasm for their reaction to black point must be a continuous effort in order to secure tolerant, and even more resistant genotypes that could be candidates for commercial release. This will contribute to improve bettter economics for the wheat producers which in turn will positively be reflected in the region and their country.

4 CONCLUSIONS

Lines that did not have any infected grains with black point in both dates were KACHU/BECARD//WBLL1*2/BRAMBLING/3/FRNCLN*2/TECUE#1, BORL14*2//KFA/2*KACHU, KACHU/KINDE*2//KACHU/KIRITATI, and BORL14/7/MUU/5/WBLL1*2/4/YACO/PBW65/3/KAUZ*2/TRAP//KAUZ/6/WBLL1*2/SHAMA.

Lines with the highest percentage of infection were SOKOLL*2/3/BABAX/LR42//BABAX, BORL14*2/5/ATTILA/3*BCN*2//BAV92/3/KIRITATI/WBLL1/4/DANPHE, and PBW343//CAR422/ANA/3/ELVIRA with 15.1, 11.4, and 10.8%, respectively, all in the first date.

The average percentage of infection of cultivars Borlaug 100, Ónavas F2009, Roelfs F2007, and Norman F2008 was 2.4, 0.6, 0.7, and 4.1%, respectively.

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