Global Advanced Research Journal of Agricultural Science (ISSN: 2315-5094) Vol. 7(8) pp. 268-271, August, 2018 Issue.
Available online http://garj.org/garjas/home
Copyright © 2018 Global Advanced Research Journals

Short Communication

Evaluation of Bread Wheat Lines for Resistance to Karnal Bunt

Guillermo Fuentes-Dávila[1], Ravi Prakash-Singh[2], Ivón Alejandra Rosas-Jáuregui[1], José Luis Félix-Fuentes[1], and Carlos Antonio Ayón-Ibarra[1]

[1]INIFAP, Campo Experimental Norman E. Borlaug, Apdo. Postal 155, Cd. Obregón, Sonora CP 85000; [2]CIMMYT Int. km 45 S/N, Col. El Batán, Texcoco, Edo. de México CP 56130. Author for correspondence:

Accepted 24 August, 2018

Eighty five wheat lines were evaluated for resistance to karnal bunt by artificial field inoculation during the season 2015-2016 in three sowing dates. The range of infection for the first date was 0-37.9%, 0-57.7% for the second, and 0-50.5% for the third. Categories of the avg. of infection of the three dates were as follows: seven lines were in the 0.1-2.5% infection category, 13 within 2.6-5.0%, 19 within 5.1-10.0%, 45 within 10.1-30%, and one line showed more than 30% infection. The line with the lowest percentage of infection was NELOKI/4/MARCHOUCH*4/SAADA/3/2*FRET2/KUKUNA//FRET2/5/PBW343 *2/KUKUNA*2//FRTL/PIFED with 0.60%.

Keywords: *Tilletia indica*, *Triticum aestivum*, resistance.

INTRODUCTION

Karnal bunt caused by the fungus *Tilletia indica* Mitra [syn. *Neovossia indica* (Mitra) Mundkur] occurs in nature in bread wheat (*Triticum aestivum*; Mitra 1931), durum wheat (*T. turgidum*), and triticale (X *Triticosecale*; Agarwal *et al*., 1977). Infected grains generally are partially affected (Mitra, 1935; Bedi *et al*., 1949; Chona *et al*., 1961). This disease was first reported in India (Mitra, 1931), then, in Mexico (Duran, 1972), Pakistan (Munjal, 1975), Nepal (Singh *et al*., 1989), Brasil (Da Luz *et al*., 1993), the United States (APHIS, 1996), South Africa (Crous *et al*., 2001), and Afghanistan (CIMMYT, 2011). Control of *Tilletia indica* is difficult since teliospores are resistant to physical and chemical factors (Krishna and Singh, 1982; Zhang *et al*., 1984; Smilanick *et al*., 1985, 1988). Chemical control can be accomplished by applying fungicides during flowering (Fuentes-Dávila *et al*., 2005, 2016; Salazar-Huerta *et al*., 1997); however, this measure is not feasible when quarantines do not allow tolerance levels for seed production (SARH, 1987). The use of resistant wheat cultivars is the best control method for this disease, and it also would reduce the possibilities of its introduction into karnal bunt-free areas. Since the 1940's several species of *Triticum* have been evaluated for resistance to karnal bunt (Bedi *et al*., 1949; Singh *et al*., 1986; 1988a, 1988b). Bread wheat is the species most affected by the disease; under artificial inoculation some lines may show more than 50% infected grain (Fuentes-Dávila *et al*., 1992; 1993); therefore, it is important to keep evaluating the new

*Corresponding Author's Email: fuentes.davila@gmail.com

advanced lines and wheat cultivars. The objective of this work was to evaluate the reaction of elite bread wheat lines for resistance to *Tilletia indica* under artificial inoculation in the field.

Experimental Procedures

Eighty five elite bread wheat lines were evaluated for resistance to karnal bunt (*Tilletia indica*) during the crop season fall-autum 2015-2016 at the Norman E. Borlaug Experimental Station which belongs to the Mexican National Institute for Livestock, Agriculture and Forestry Research (INIFAP). The station is located in block 910 in the Yaqui Valley, Sonora, Mexico at 27º22´3.01" N and 109º55´40.22" W. Sowing dates were November 12, 19, and 26, 2015, using 8 g of seed for a row 0.7 m long on a bed with two rows in a clay soil with pH 7.8. For the agronomic management, INIFAP´s technical recommendations were followed (Figueroa-López *et al*., 2011). For the inoculations, inoculum was prepared by isolating teliospores from infected grains, followed by centrifugation in a 0.5% sodium hypochlorite solution and plating on 2% water-agar Petri plates. After teliospore germination, fungal colonies were transferred and multiplied on potato-dextrose-agar. Inoculations were carried out by injecting 1 mL of an allantoid sporidial suspension (10,000/mL) during the boot stage in five heads from each line. High relative humidity in the experimental area was provided by an automatic mist spray-irrigation system five times a day for 20 min each time. To avoid bird damage, an anti-bird net system was installed in the area used for evaluation of the wheat lines. Harvest was done manually, and the counting of healthy and infected grains was done visually to determine the percentage of infection. Evaluated lines originated from the collaborative project between the Global Wheat Program of the International Maize and Wheat Improvement Center (CIMMYT) and INIFAP.

RESULTS

The range of the percentage of infection of the advanced lines in the first date was 0-37.9%, with an average of 10.2; 0-57.7% for the second, with an average of 12.2; and 0-50.5% for the third, with an average of 11.9. The percentage of infection of lines in each date and the average infection of the three dates are shown in Figure 1. Three lines did not show infected grain in the first date (FRANCOLIN#1/3/PBW343*2/KUKUNA*2//YANAC/4/KINGBIRD#1//INQALAB91*2/TUKURU, SUP152*2/3/TRCH/SRTU//KACHU, and BAVIS/8/BOW/VEE/5/ND/VG9144//KAL/BB/3/YACO/4/CHIL/6/CASKOR/3/CROC_1/AE.SQUARROSA(224)//OPATA/7/PASTOR//MILAN/KAUZ/3/BAV92), 21 lines presented a resistant reaction (0.1-5.0% infection) (Fuentes-Dávila and Rajaram, 1994), and the line FRET2/KUKUNA//FRET2/3/TNMU/5/FRET2*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ/6/ATTILA*2/PBW65//TNMU/7/FRET2*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ/5/TNMU/6/FRET2*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ presented a susceptible reaction with 37.9% infection. In the second date BECARD#1*2/3/PBW343*2/KUKUNA//PBW343*2/KUKUNA did not show any infected grain, 17 lines presented a resistant reaction (0.1-5.0% infection), and lines SUP152/7/TUKURU//BAV92/RAYON/6/NG8201/KAUZ/4/SHA7//PRL/VEE#6/3/FASAN/5/MILAN/KAUZ,PBW343*2/KUKUNA//SRTU/3/PBW343*2/KHVAKI/4/WBLL1/KUKUNA//TACUPETOF2001, and WHEAR/SOKOLL/3/TRCH/SRTU//KACHU showed a susceptible reaction; the last line with 57.7% infection. In the third date, four lines did not show any infected grains (SAUAL/MUTUS*2//PICAFLOR#1, BECARD#1*2/3/PBW343*2/KUKUNA//PBW343*2/KUKUNA, NELOKI/4/MARCHOUCH*4/SAADA/3/2*FRET2/KUKUNA//FRET2/5/PBW343*2/KUKUNA*2//FRTL/PIFED, and WAXWING/KIRITATI/6/PVN//CAR422/ANA/5/BOW/CROW//BUC/PVN/3/YR/4/TRAP#1/7/SERI.1B//KAUZ/HEVO/3/AMAD*2/4/KIRITATI/8/ATTILA*2/PBW65*2/4/BOW/NKT//CBRD/3/CBRD), 15 lines showed a resistant reaction (0.1-5.0% infection), and lines C80.1/3*BATAVIA//2*WBLL1/3/PBW343*2/KUKUNA*2/8/SHA7//PRL/VEE#6/3/FASAN/4/HAAS8446/2*FASAN/5/CBRD/KAUZ/6/MILAN/AMSEL/7/FRET2*2/KUKUNA,TRCH/SRTU//KACHU/3/WAXWING/PARUS//WAXWING/KIRITATI/4/TRCH/SRTU//KACHU, WBLL1/KUKUNA//TACUPETOF2001/3/UP2338*2/VIVITSI/4/HUW234+LR34/PRINIA*2//KIRITATI and WHEAR/SOKOLL/3/TRCH/SRTU//KACHU showed a susceptible reaction; the last one with 50.5% infection. Lines that showed the lowest average percentages of infection of the three dates were: NELOKI/4/MARCHOUCH*4/SAADA/3/2*FRET2/KUKUNA//FRET2/5/PBW343*2/KUKUNA*2//FRTL/PIFD with 0.60%, BAVIS/8/BOW/VEE/5/ND/VG9144//KAL/BB/3/YACO/4/CHIL/6/CASKOR/3/CROC_1/AE.SQUARROSA(224)//OPATA/7/PASTOR//MILAN/KAUZ/3/BAV92 with 0.61%, BECARD#1*2/3/PBW343*2/KUKUNA//PBW343*2/KUKUNA with 1.27%, SUP152*2/3/TRCH/SRTU//KACHU with 1.62%, WHEAR/KUKUNA/3/C80.1/3*BATAVIA//2*WBLL1*2/8/NG8201/KAUZ/4/SHA7//PRL/VEE#6/3/FASAN/5/MILAN/KAUZ/6/ACHYUTA/7/PBW343*2/KUKUNA with 2.18%, MUNAL#1*2//SOKOLL/WBLL1 with 2.23%, and SAUAL/MUTUS*2//PICAFLOR#1 with 2.39%. Lines with the highest average percentage of infection of the three dates were: WBLL1/KUKUNA//TACUPETOF2001/3/UP2338*2/VIVITSI/4/HUW234+LR34/PRINIA*2//KIRITATI with 28.56% and WHEAR/SOKOLL/3/TRCH/SRTU//KACHU with 39.31%.

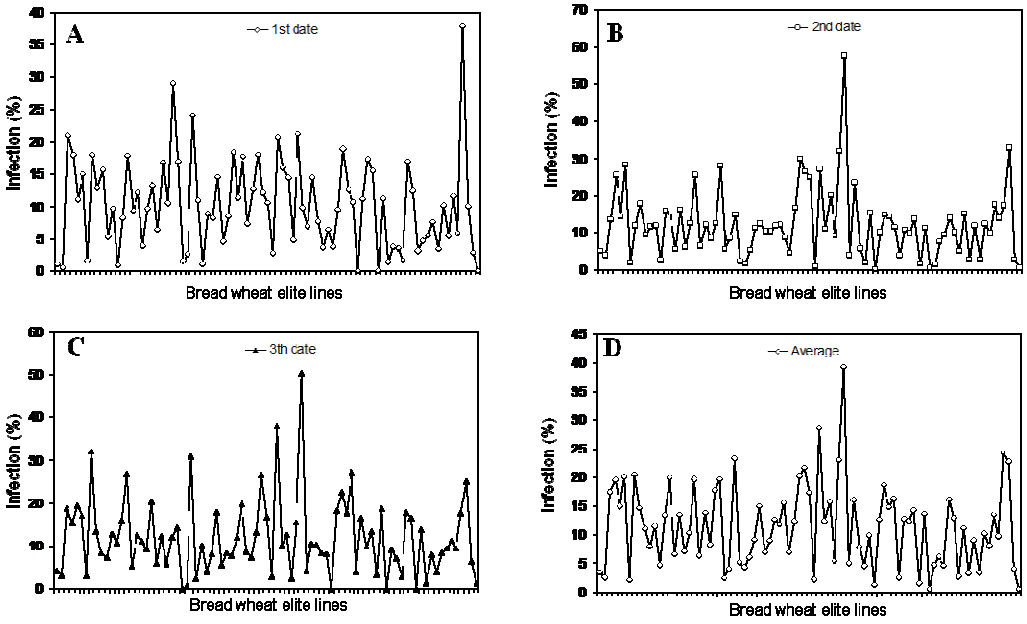

Figure 1. Infection (%) of 85 bread wheat elite lines artificially inoculated with *Tilletia indica* in the field in three sowing dates, during the crop season 2015-2016, at the Norman E. Borlaug Experimental Station in the Yaqui Valley, Sonora, Mexico.

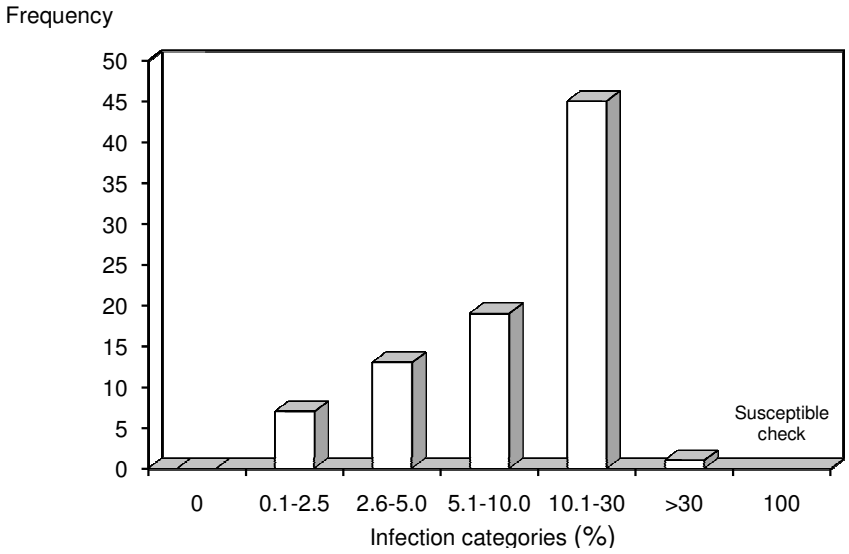

Figure 2. Infection categories for 85 bread wheat elite lines artificially inoculated with *Tilletia indica* in the field in three sowing dates, during the crop season 2015-2016, at the Norman E. Borlaug Experimental Station in the Yaqui Valley, Sonora, Mexico. The percentage of infection of the susceptible check is the average of the three highest percentages of infection recorded in this evaluation.

The distribution of lines within the average infection categories was as follows: seven lines within the 0.1-2.5%, 13 within 2.6-5.0%, 19 within 5.1-10.0%, 45 within 10.1-30%, and one line with more than 30% infection (Figure. 2). The average of the three highest percentages of infection of the susceptible check was 100%.

In northwest Mexico, bread wheat and durum wheat cultivars are released for commercial cultivation based on their resistance/tolerance to leaf, stripe rust and karnal bunt, as well as their performance in grain yield and quality. This region is important for the country, since out of almost 600,000 ha of wheat grown (SIAP, 2017a), 69.8% is produced in the region (SIAP, 2017b). Given the predominant susceptibility of bread wheats to karnal bunt, it is necessary that progenies of more interest as well as advanced lines from the collaborative project between

CIMMYT and INIFAP are evaluated each year, so that new commercial cultivars with tolerance/resistance (Fuentes-Dávila *et al*., 2014) to this disease and to the rusts can be generated, that comply with the expectations of the industry.

REFERENCES

Agarwal VK, Verma HS, Khetarpal RK (1977). Occurrence of partial bunt on triticale. Plant Protection Bulletin 25:210-211.

Bedi SKS, Sikka MR, Mundkur BB (1949). Transmission of wheat bunt due to *Neovossia indica* (Mitra) Mundkur. Indian Phytopathology 2:20-26.

Chona BL, Munjal RL, Adlakha KL (1961). A method for screening wheat plants for resistance to *Neovossia indica*. Indian Phytopathol. 14:99-101.

CIMMYT (2011). Training to beat karnal bunt in Afghanistan. http://blog.cimmyt.org/tag/karnal-bunt/. Accessed March 1, 2014.

Crous PW, Van Jaarsveld AB, Castlebury LA, Carris LM, Frederick RD, Pretorius ZA (2001). Karnal bunt of wheat newly reported from the African continent. Plant Disease 85:561.

Da Luz WC, Mendes MAS, Ferreira MASV, Urben AF (1993). *Tilletia indica* on wheat in the south of the state of Rio Grande do Sul, Brazil and measures for eradication. Fitopatologia Brasileira 18:S329.

Durán R (1972). Further aspects of teliospore germination in North American smut fungi. II. Can. J. Bot. 50:2569-2573.

Figueroa-López P, Fuentes-Dávila G, Cortés-Jiménez JM, Tamayo-Esquer LM, Félix-Valencia P, Ortiz-Enríquez E, Armenta-Cárdenas I, Valenzuela-Herrera V, Chávez-Villalba G, y Félix-Fuentes JL (2011). Guía para producir trigo en el sur de Sonora. Folleto para productores No. 39. INIFAP-CIRNO, Campo Experimental Norman E. Borlaug. Cd. Obregón, Sonora, México. 63 p.

Fuentes-Davila G, Rajaram S, Pfeiffer WH, Abdalla O (1992). Results of artificial inoculation of the 4th Karnal Bunt Screening Nursery (KBSN). Annu. Wheat Newsl. 38:157-162.

Fuentes-Davila G, Rajaram S, Pfeiffer WH, Abdalla O, Van-Ginkel M, Mujeeb-Kazi A, y Rodríguez-Ramos R (1993). Resultados de inoculaciones artificiales del 5o. vivero de selección para resistencia a *Tilletia indica* Mitra. Revista Mexicana de Micología 9:57-65.

Fuentes-Davila G, Rajaram S **(**1994). Sources of resistance to *Tilletia indica* in wheat. Crop Protection 13:20-24.

Fuentes-Dávila G, Tapia-Ramos E, Toledo-Martínez JA, y Figueroa-López P (2005). Evaluación de efectividad biológica de folicur 250 EW (Tebuconazol) para el control del carbón parcial (*Tilletia indica*) del trigo (*Triticum aestivum*), en el valle del Yaqui, Sonora, México, durante el ciclo de cultivo 2003-2004. Resúmenes, XIII Congreso Latinoamericano de Fitopatología, III Taller de la Asociación Argentina de Fitopatólogos. 19-22 de Abril, 2005. Villa Carlos Paz, Córdoba, Argentina. Resumen HC-29, página 271. 640 p.

Fuentes-Dávila G, Figueroa-López P, Camacho-Casas MA, Chávez-Villalba G, y Félix-Fuentes JL (2014). 'Quetchehueca Oro C2013', nueva variedad de trigo cristalino para el noroeste de México. Revista Fitotecnia Mexicana 37(4): 399-401.

Fuentes-Dávila G, Félix-Valencia P, Ayón-Ibarra CA, Figueroa-López P, Camacho-Casas MA, Félix-Fuentes JL, Chávez-Villalba G, Rosas-Jáuregui IA (2016). Biological effectiveness of several fungicides for control of karnal bunt (*Tilletia indica*) of wheat, in the field. Annual Wheat Newsletter 62:28-31.

Krishna A, Singh RA (1982). Effect of physical factors and chemicals on the teliospore germination of Neovossia indica. Indian Phytopathology 35(3):448-455.

Mitra M (1931). A new bunt of wheat in India. Annals of Applied Biology 18:178-179.

Mitra M (1935). Stinking smut (bunt) of wheat with a special reference to *Tilletia indica* Mitra. Indian J. Agric. Sci. 5:1-24.

Munjal RL (1975). Status of Karnal bunt (*Neovossia indica*) of wheat in Northern India during 1968-1969 and 1969-1970. Indian Journal of Mycology and Plant Pathology 5(2):185-187.

Salazar-Huerta FJ, Figueroa-Lopez P, Smilanick JL, Fuentes-Davila G (1997). Evaluation of foliar fungicides for control of Karnal bunt of wheat during 1986-1989 in northwestern Mexico. Revista Mexicana de Fitopatología 15:73-80.

SARH (1987). Cuarentena interior No. 16 contra el Carbón Parcial del trigo. Secretaría de Agricultura y Recursos Hidráulicos. Diario Oficial, (jueves) 12 de Marzo de 1987, México.

SIAP (Servicio de Información Agroalimentaria y Pesquera). (2017ª). http://infosiap.siap.gob.mx:8080/agricola_siap_gobmx/AvanceNacionalSinPrograma.do;jsessionid=87A1C284CC91C8C8C9AF4B82169FB91A. Accessed August 20, 2018.

SIAP (Servicio de Información Agroalimentaria y Pesquera). 2017b. http://infosiap.siap.gob.mx:8080/agricola_siap_gobmx/AvanceNacionalCultivo.do. Accessed August 20, 2018.

Singh DV, Joshi LM, Srivastava KD (1986). Varietal suceptibility and spread of Karnal Bunt of wheat in India. Rachis 5:40-42.

Singh DV, Dhaliwal HS, Metzger RJ (1988a). Inoculum and time for screening against Karnal bunt disease of wheat. Indian Phytopathology 41(4):632-633.

Singh A, Singh KP, Tewari AN (1988b). Salient findings of Karnal bunt research at Pantnagar. Department of Plant Pathology, G.B. Pant University of Agriculture and Technology, Pantnagar 263 145.

Singh DV, Agarwal R, Shrestha KJ, Thapa RB, Dubin HJ (1989). First report of *Tilletia indica* on wheat in Nepal. Plant Disease 73:273.

Smilanick JL, Hoffmann JA, Royer MH (1985). Effect of temperature, pH, light, and desiccation on teliospore germination of *Tilletia indica*. Phytopathology 75:1428-1431.

Smilanick JL, Hoffmann JA, Secrest LR, Wiese K **(**1988). Evaluation of chemical and physical treatment to prevent germination of *Tilletia indica* teliospores. Plant Disease 72:46-51.

Zhang Z, Lange L, Mathur SB (1984). Teliospore survival and plant quarantine significance of *Tilletia indica* (causal agent of Karnal bunt) particularly in relation to China. Eur. Plant Prot. Bull. 14:119-128.

APHIS (1996). Karnal bunt: situation report update (March 29). USDA-APAHIS, Plant Protection and Quarantine (http://www.aphis.usda.gov/oa/bunt).