Evaluation of advanced bread wheat lines for yield components during season 2019-2020

Evaluación de líneas avanzadas de trigo pan para los componentes del rendimiento durante la temporada 2019-2020

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José Luis Félix-Fuentes

M.S. in Natural Resources

INIFAP, Campo Experimental Norman E. Borlaug, Apdo. Postal 155, km 12 Norman E. Borlaug, entre 800 y 900, Valle del Yaqui, Cd. Obregón, Sonora 85000

E-mail: j_luis_ff@yahoo.com.mx

Guillermo Fuentes-Dávila

Ph.D. in Plant Pathology

INIFAP, Campo Experimental Norman E. Borlaug, Apdo. Postal 155, km 12 Norman E. Borlaug, entre 800 y 900, Valle del Yaqui, Cd. Obregón, Sonora 85000

E-mail: fuentes.davila@gmail.com

Ivón Alejandra Rosas-Jáuregui

M.S. in Parasitology

INIFAP, Campo Experimental Norman E. Borlaug, Apdo. Postal 155, km 12 Norman E. Borlaug, entre 800 y 900, Valle del Yaqui, Cd. Obregón, Sonora 85000

E-mail: ivonn1590@hotmail.com

Juan Manuel Cortés-Jiménez

Dr. in Management and Conservation of Natural Resources

INIFAP, Campo Experimental Norman E. Borlaug, Apdo. Postal 155, km 12 Norman E. Borlaug, entre 800 y 900, Valle del Yaqui, Cd. Obregón, Sonora 85000

E-mail: cortesjjm@hotmail.com

Alma Angélica Ortiz-Avalos

M.I. in Administration Engineering of Hydraulic Resources

INIFAP, Campo Experimental Norman E. Borlaug, Apdo. Postal 155, km 12 Norman E. Borlaug, entre 800 y 900, Valle del Yaqui, Cd. Obregón, Sonora 85000

E-mail: alma_aoa75@hotmail.com

José Eliseo Ortiz-Enríquez

M.S. in Irrigation

INIFAP, Campo Experimental Norman E. Borlaug, Apdo. Postal 155, km 12 Norman E. Borlaug, entre 800 y 900, Valle del Yaqui, Cd. Obregón, Sonora 85000

E-mail: eo.eliseo@gmail.com

ABSTRACT

A study was conducted with seven advanced bread wheat lines to determine grain yield, a thousand grain weight, grain length, grain weight per spike, number of grains per spike, spike length and spike weight, at the Norman E. Borlaug Experimental Station in the Yaqui Valley, Sonora, Mexico, during the 2019-2020 crop season. Plots were 100 m long on three beds, 0.80 m apart, with two rows, and three replications; seed density was 100 kg/ha. Sowing date was December 14, 2019. Experimental lines were generated by the Global Wheat Program from the International Maize and Wheat Improvement Center, and they are candidates for commercial release by the National Institute for Forestry, Agriculture, and Livestock Research in Mexico. Genotypes BORL14*2/5/ATTILA/3*BCN*2//BAV92/3/KIRITATI/WBLL1/4/DANPHE, BORL14*2//MUNAL#1/FRANCOLIN#1, and PREMIO/4/CROC_1/AE.SQUARROSA(205)//KAUZ/3/PIFED/5/BORL14, showed the highest grain yield with 7.1, 7, and 6.9 t/ha, respectively, which can compete with current bread wheat cultivars in southern Sonora, Mexico, like Borlaug 100. The third line also showed the highest a thousand grain weight, grain length, grain weight per spike, and spike weight.

Keywords: Bread wheat, *Triticum aestivum*, yield components, advanced lines

RESUMEN

Se realizó un estudio con siete líneas avanzadas de trigo pan para determinar el rendimiento de grano, peso de mil granos, longitud de grano, peso de grano por espiga, número de granos por espiga, longitud de espiga y peso de espiga, en la Estación Experimental Norman E. Borlaug en el Valle del Yaqui, Sonora, México, durante la temporada de cultivo 2019-2020. Las parcelas tuvieron una longitud de 100 m en tres camas, separadas 0.80 m, con dos hileras y tres repeticiones; la densidad de semilla fue de 100 kg/ha. La fecha de siembra fue el 14 de diciembre de 2019. Las líneas experimentales fueron generadas por el Programa Global de Trigo del Centro Internacional de Mejoramiento de Maíz y Trigo, y son candidatas a ser liberadas comercialmente por el Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias de México. Los genotipos BORL14*2/5/ATTILA/3*BCN*2//BAV92/3/KIRITATI/WBLL1/4/DANPHE, BORL14*2//MUNAL#1/FRANCOLIN#1, y PREMIO/4/CROC_1/AE.SQUARROSA(205)//KAUZ/3/PIFED/5/BORL14, mostraron el mayor rendimiento de grano con 7.1, 7 y 6.9 t/ha, respectivamente, que pueden competir con los cultivares actuales de trigo pan en el sur de Sonora, México, como Borlaug 100. La tercera línea también mostró el mayor peso de mil granos, longitud de grano, peso de grano por espiga y peso de espiga.

Palabras clave: Trigo panificable, *Triticum aestivum*, componentes del rendimiento, líneas avanzadas.

1 INTRODUCTION

Bread wheats (*Triticum aestivum* L.) are cereals of great importance in Mexico, particularly for human consumption and the transformation industry (PEÑA et al., 2008). Currently, there is a great deficit in bread wheat production and therefore, wheat is imported from other countries (VILLASEÑOR et al., 2011). During the 2019-2020 fall-winter crop season, the area grown with wheat was 448,735 ha, which represents 11.1% less area than the previous crop season; the states of Sonora, Guanajuato, Michoacán, and Baja California comprise 80.4% of the total (SIAP 2021).

The preference of this cereal varies in each region (VALENZUELA-ANTELO et al., 2018); durum wheat is widely grown in northwest Mexico due its high grain yield, resistance to diseases, particularly to

karnal bunt, and its value in the international market (FUENTES- DÁVILA et al., 2014), while bread wheat for bread-making is preferred in the north (HUERTA-ESPINO et al., 2011). CAMACHO-CASAS et al. (2010) indicated that in the 90's, bread wheat was the most grown species in northwest Mexico; during the 1983-1984 to 1993-1994 crop seasons, it occupied more than 50% of the area grown with wheat in the state of Sonora. CAMACHO-CASAS et al. (2010) reported that the preference by farmers for certain wheat cultivars, primarily of durum wheat, since the middle of the 90's is due to the phytosanitary regulations established in the domestic quarantine No. 16 (SARH, 1987), the high grain yield potential, greater export market, resistance to karnal bunt, and tolerance to leaf rust (*Puccinia triticina* Eriksson). Under this context, the objective of this work was to evaluate seven bread wheat advanced lines for their grain yield potential, so that some may become candidates for commercial release as new cultivars for southern Sonora.

2 MATERIALS AND METHODS

The evaluation was carried out at the Norman E. Borlaug Experimental Station (CENEB) which belongs to the National Institute for Forestry, Agriculture, and Livestock Research of Mexico (INIFAP), located in block 910 of the Yaqui Valley in the State of Sonora, Mexico (27°22'3.01" N and 109°55'40.22" W; 37 masl), during the wheat season 2019-2020. This region of southern Sonora has a dry and warm climate (BW (h)) and extreme heat (BSO) according to Köppen's classification, modified by GARCÍA (1988). Average annual rainfall is around 280 mm; 75% occurs during the summer months (June to September) as torrential rains, and the other 25% during the winter (December to March) as intermittent rains (INIFAP, 2001).

Sowing was carried out on December 14, 2019; plots were 100 m long, on beds with two rows and separated by 0.80 m, and the seed density was 100 kg/ha (Figure 1). Four complementary irrigations were applied at 40, 70, 90, and 106 days after sowing. Fertilization was applied at pre-sowing with 100 kg/ha of monoammonium sulfate (11-52-00) and 100 of nitrogen (urea 46%); before the first complementary irrigation 100 kg of nitrogen were applied and 50 just before the second. For agronomic management, INIFAP's technical recommendations were followed (FIGUEROA-LÓPEZ et al., 2011).

The experimental unit for each genotype consisted of 1.0 m²; three replications per genotype were harvested manually with a sickle and threshed with a Pullman stationary thresher. The genetic material for evaluation corresponded to seven bread wheat advanced lines (Table 1), generated by the Global Wheat Program from the International Maize and Wheat Improvement Center (CIMMYT), and later by the selection as advanced line by INIFAP at CENEB. The variables evaluated were: grain yield, a thousand

grain weight, grain length, grain weight per spike, number of grains per spike, spike length and spike weight. Contrasts and comparisons were made through histograms and a graph.

Figure 1. Evaluation of seven advanced bread wheat lines, evaluated at the Norman E, Borlaug Experimental Station, in the Yaqui Valley, Sonora, Mexico, during the crop season 2019-2020.

Table 1. Bread wheat genotypes evaluated during the 2019-2020 crop season, at the Norman E. Borlaug Experimental Station in the Yaqui Valley, Sonora, Mexico.

No.	Pedigree	Selection history
1	WBLL1*2/BRAMBLING*2//BAVIS/3/BORL14	CMSS13B00376S-099M-0SY-30M-0WGY
2	PREMIO/4/CROC_1/AE.SQUARROSA(205)//KAUZ/3/PIFED/5/BORL14	CMSS12B00456S-099M-099NJ-099NJ-44Y-0WGY
3	KATERE/BORL14/MANKU	CMSS13B01850T-099TOPY-099M-099Y-1M-0RGY
4	BORL14*2//MUNAL #1/FRANCOLIN #1	CMSS12B00629T-099TOPY-099M-0SY-15M-0WGY
5	BORL14*2/5/ATTILA/3*BCN*2//BAV92/3/KIRITATI/WBLL1/4/DANPHE	CMSS13B01137T-099TOPY-099M-0SY-11M-0WGY
6	BORL14*2/3/KBIRD//WBLL1*2/KURUKU	CMSS12B00630T-099TOPY-099M-0SY-11M-0WGY
7	BORL14*2/3/WBLL1*2/TUKURU//CROSBILL #1	CMSS12B00631T-099TOPY-099M-0SY-4M-0WGY

3 RESULTS AND DISCUSSION

The average grain yield of the group of lines was 6.63 t/ha with a range of 5.8 to 7.10 (Graph 1), a difference of 22.41% between the contrasting yields. BORL14*2/5/ATTILA/3*BCN*2//BAV92/3/KIRITATI/WBLL1/4/DANPHE showed the highest grain yield followed by BORL14*2//MUNAL#1/FRANCOLIN#1 with an average of 7.0 t/ha. These lines as well as PREMIO/4/CROC_1/AE.SQUARROSA(205)//KAUZ/3/PIFED/5/BORL14 (6.9 t/ha), can compete with current cultivars grown in southern Sonora, like Borlaug 100 which previous to its commercial release, showed a grain yield average of 7.0 t/ha with four complementary irrigations (CHAVEZ-VILLALBA et

al., 2021). Lines with the lowest grain yield were BORL14*2/3/KBIRD//WBLL1*2/KURUKU and BORL14*2/3/WBLL1*2/TUKURU// CROSBILL#1 with 5.80 and 6.20 t/ha, respectively. MARTI and SLAFER (2014) made a worldwide study that allowed them to confirm that in the last few years, bread wheats produce similar or even greater grain yield than durum wheats.

Graph 1. Grain yield of seven advanced bread wheat lines, evaluated at the Norman E, Borlaug Experimental Station, in the Yaqui Valley, Sonora, Mexico, during the crop season 2019-2020.

The weight range of a thousand grains was 48.40 to 69.60 g with an average of 58.86 (Graph 2). There was a 30.4% difference between the contrasting weights. The genotype with the highest weight was PREMIO/4/CROC_1/AE.SQUARROSA(205)//KAUZ/3/ PIFED/5/BORL14, which carries in its pedigree a synthetic. Although in this evaluation ethylene production was not quantified, according to HAYS et al. (2007), the reduction of grain number per spike and the thousand grain weight, is caused by a greater production of this compound when genotypes are exposed to stress. Greater production of ethylene causes shriveled seed and greater flower abortion as a consequence of early aging. LOPES et al. (2012) reported that grain yield of CIMMYT bread wheats is directly correlated to the a thousand grain weight.

Graph 2. A thousand grain weight of seven advanced bread wheat lines, evaluated at the Norman E, Borlaug Experimental Station, in the Yaqui Valley, Sonora, Mexico, during the crop season 2019-2020.

Minimum differences were detected in grain length which had a range of 0.66 to 0.74 cm, with an average of 0.70 (Graph 3). The same line PREMIO/4/CROC_1/AE. SQUARROSA(205)//KAUZ/3/PIFED/5/BORL14 which had the highest a thousand grain weight, showed the longest grain length, followed by WBLL1*2/BRAMBLING*2// BAVIS/3/BORL14 with 0.72 cm. The variation in grain size between and within the genotypes evaluated in this work, as well as those reported by other authors, is due to genotype effect, environment and their interactions (BRESEGHELLO and SORRELS, 2006).

Graph 3. Grain length of seven advanced bread wheat lines, evaluated at the Norman E, Borlaug Experimental Station, in the Yaqui Valley, Sonora, Mexico, during the crop season 2019-2020.

The grain weight per spike had a range of 2.92 to 3.96 g with an average of 3.47. PREMIO/4/CROC_1/AE.SQUARROSA(205)//KAUZ/3/PIFED/5/BORL14 showed the highest weight, while BORL14*2/3/KBIRD//WBLL1*2/KURUKU showed the lowest (Graph 4). The number of grains per spike ranged from 53 to 65 with an average of 60.14 (Graph 5). KATERE/BORL14//MANKU showed the highest grain number per spike and BORL14*2/3/WBLL1*2/TUKURU//CROSBILL#1 the lowest.

Genotypes with the longest spike had the highest spike weight, 11.08 cm with 4.5 g and 10.80 with 4.6, for KATERE/BORL14//MANKU and PREMIO/4/CROC_1/AE.SQUARROSA(205)//KAUZ/3/PIFED/5/BORL14, respectively (Graph 6); however, they were 7.04 and 2.81% below BORL14*2/5/ATTILA/3*BCN*2//BAV92/3/KIRITATI/ WBLL1/4/DANPHE which was the line with the highest grain yield.

Graph 4. Grain weight per spike of seven advanced bread wheat lines, evaluated at the Norman E, Borlaug Experimental Station, in the Yaqui Valley, Sonora, Mexico, during the crop season 2019-2020.

Graph 5. Number of grains per spike of seven advanced bread wheat lines, evaluated at the Norman E, Borlaug Experimental Station, in the Yaqui Valley, Sonora, Mexico, during the crop season 2019-2020.

Graph 6. Spike length (cm) and weight (g) of seven advanced bread wheat lines, evaluated at the Norman E, Borlaug Experimental Station, in the Yaqui Valley, Sonora, Mexico, during the crop season 2019-2020.

HEWSTONE (2003) reported that the grain yield could be increased as the phenotypic expression could be favored with greater number of plants per m², greater grain number per spike, greater number of spikelets per spike, greater number of spikes per plant, and greater grain weight. However, it is more reliable to measure grain yield, since it is the outcome of all the biotic and abiotic factors that might be present since the time of sowing to harvest. Also, yield components frequently show negative correlations, therefore, the yield potential of a particular cultivar will be reached when environmental factors do not interfere with the maximum expression of the yield components.

4 CONCLUSIONS

Genotypes BORL14*2/5/ATTILA/3*BCN*2//BAV92/3/KIRITATI/WBLL1/4/DANPHE, BORL14*2//MUNAL#1/FRANCOLIN#1, and PREMIO/4/CROC_1/AE.SQUARROSA (205)//KAUZ/3/PIFED/5/BORL14, showed the highest grain yield, 7.1, 7, and 6.9 t/ha, respectively, which can compete with current bread wheat cultivars in southern Sonora, Mexico, like Borlaug 100. The third line also showed the highest a thousand grain weight, grain length, grain weight per spike, and spike weight.

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