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Data Article

Dataset of historic and modern bread and durum wheat cultivar performance under conventional and reduced tillage with full and reduced irrigation

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ABSTRACT

Conservation agriculture (CA) is an agronomic management system based on zero tillage and residue retention. Due to its potential for climate change adaptation through the reduction of soil erosion and improved water availability, CA is becoming more important in many regions of the world. However, increased bulk density and large amounts of crop residues may be a constraint for early plant establishment. This holds especially true under irrigated production areas with high yield potential. Genotype × tillage effects on yield are not well understood and it is unclear whether tillage should be an evaluation factor in breeding programs.
Fourteen CIMMYT bread (*Triticum aestivum*) and thirteen durum (*Triticum turgidum*) wheat genotypes, created between 1964 and 2011, were tested for yield and agronomic performance at CIMMYT's experimental station near Ciudad Obregon, Mexico, during nine seasons. The genotypes were subjected to different tillage and irrigation treatments which consisted of conventional and permanent raised beds with

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full and reduced irrigation. The dataset includes traits collected during the growing period (days to emergence, days to flowering, maturity, plant height, NDVI, days from flowering to maturity, grain production rate) and at harvest (yield, harvest index, thousand grain weight, spikes/m², grains/m², test weight) and weather data (daily minimum and maximum temperature, rainfall). Six years of data of 26 genotypes were published along with the Honsdorf et al. (2018) paper in Field Crops Research (DOI: s10.1016/j.fcr.2017.11.011). This updated dataset includes three additional seasons of data (harvest years 2016 to 2018) and an additional bread wheat genotype (Borlaug100).

Specifications Table

Subject	Agronomy and Crop Science
Specific subject area	Wheat genotype by tillage by irrigation interactions
Type of data	Table
How the data were acquired	Yield and agronomic performance data were acquired over nine years of field experiments. Normalized difference vegetative index (NDVI) data were obtained using a Green-Seeker™ Handheld Optical Sensor Unit (Trimble, USA). Yield data were obtained following the manual by CIMMYT (2013).
Data format	Raw
Description of data collection	Agronomically important traits were collected for 13 durum and 14 bread wheat genotypes. Data were collected over 9 consecutive years and with 3 field replicates. Data include: days to emergence, flowering and maturity, plant height, NDVI, grain production rate, thousand grain weight, test weight, spikes/m², grains/m², harvest index, grain yield, daily rainfall, minimum and maximum temperature.
Data source location	Institution: International Maize and Wheat Improvement Center (CIMMYT) City, State: Ciudad Obregón, Sonora Country: Mexico Latitude and longitude for collected data: lat. 27.33 N, long. 109.09 W, 38 masl
Data accessibility	Repository name: Dataverse (CIMMYT Research Data) Data identification number: 11529/10548636 Direct URL to data: https://hdl.handle.net/11529/10548636
Related research article	N. Honsdorf, M.J. Mulvaney, R.P. Singh, K. Ammar, J. Burgueño, B. Govaerts, N. Verhulst, Genotype by tillage interaction and performance progress for bread and durum wheat genotypes on irrigated raised beds, Field Crops Res. 216 (2018) 42–52. https://doi.org/10.1016/j.fcr.2017.11.011

Value of the Data

- The dataset provides information of agronomic performance and breeding progress of bread and durum wheat under conventional tillage and conservation agriculture with optimal and reduced irrigation.
- The data allow a direct comparison of historical and modern genotypes and breeding progress under contrasting production conditions.
- Agronomists and plant breeders working in the field of conservation agriculture may use these data as a basis for further investigation.

- These data could be reused for further genotype by management interactions and serve as validation dataset for crop modelling approaches.
- These data can be used to determine if current agronomic and breeding progress is on track to meet global production needs under various production scenarios.

1. Data Description

The data set consists of five tables, available at https://hdl.handle.net/11529/10548636. Table 1 contains the legend, units used, and explanations of abbreviations. Table 2 contains details about bread and durum wheat genotypes. Table 3 contains agronomic and yield data over nine seasons. Table 4 contains weather data. Table 5 contains NDVI data.

2. Experimental Design, Materials and Methods

Data were collected over nine seasons (November to May) during the years 2009/10 to 2017/18 at CIMMYT's experimental station near Ciudad Obregon, Sonora, in northwestern Mexico (lat. 27.33 N, long. 109.09 W, 38 masl). An arid climate with highly variable precipitation characterizes the conditions at the experiment station. Mean annual precipitation (1993–2015) was 308 mm. The annual reference evaporation is approximately 1800 to 2000 mm and the long-term mean annual temperature is 23.5 °C with monthly mean temperature ranging from 16 °C in January to 31 °C in July/ August. The soil is classified as a Hyposodic Vertisol (Calcaric, Chromic).

All genotypes were tested under conventional and conservation agriculture practices with full or reduced irrigation [1]. All treatments involved sowing on raised beds and irrigation was applied as furrow irrigation. The combination of tillage and irrigation treatments resulted in four agronomic environments: (1) conventionally tilled beds with full irrigation (CB-FI), (2) conventionally tilled beds with reduced irrigation (CB-RI), (3) permanent beds with full irrigation (PB-FI), and (4) permanent beds with reduced irrigation (PB-RI). Permanent beds and conventionally tilled treatments were located in adjacent blocks. Each of the two blocks was divided into two subblocks with full or reduced irrigation treatment. All wheat genotypes were tested in in each subblock in a randomized complete block design with three replications. Prior to experiment initiation, the PB area had been under zero tillage for three years. When necessary, permanent beds were reshaped, but the top of the beds were not tilled. In conventionally tilled environments soil was tilled after harvest and again before sowing with a disk plough to 20 cm and new beds were formed before planting. The trial was irrigated prior to planting in order to germinate weeds and volunteers, which were controlled using glyphosate under PB and using tillage under CB.

The trials were sown between end of November and beginning of December. Each plot had a size of 8 m^2, consisting of two 80 cm wide and 5 m long beds sown twin-row wheat with 26 cm distance between rows at a sowing density of 250 seeds m^{-2}. A seeding irrigation was applied in all agronomic systems. The FI treatments received three or four additional irrigations (approximately 520 mm water per season) to avoid moisture stress; RI treatments received one additional irrigation near heading (approximately 240 mm per season). In most years, the pre-sowing irrigation was applied two to three weeks before sowing. In the season 2010/11, seeding irrigation was applied three days after sowing. In 2011/12 due to an atypical rainfall event, the experiment was sown into residual moisture.

At the start of the season, 103 kg N ha^{-1} as granular urea and 23 kg P ha^{-1} was applied as a band application in the center of the beds. At first node, a sidedress N application was banded in the furrow as granular urea. The RI treatment received an additional 100 kg N ha^{-1} at sidedress and the FI treatment received 175 kg N ha^{-1} because of increased N demand under FI systems. Weeds, pests, and diseases were controlled chemically as needed. Fungicides against rusts (*Puccinia* sp.) were applied preventively. The experiments were harvested between end of April and beginning of May.

During the nine growing seasons 14 agronomically relevant traits were collected for all genotypes. The traits recorded during the growing period were: Days to emergence (EMER), days from emergence to flowering (FLO), plant height (HEI), and days to maturity (MAT). Around the time of emergence each plot was assessed visually in daily field revisions. The date when 50% of plants had emerged was recorded and expressed as days between date of sowing and date of emergence. Days to flowering were calculated as days between emergence and the date when 50% of the plants in a plot showed their anthers and shed pollen. Days to maturity were calculated as days between date of emergence and date when the plants had reached hard dough stage (EC 87) and at least 75% of the spikes/panicles and the peduncles had lost their green color.

Plant growth was approximated using normalized difference vegetative index (NDVI) with a Green-Seeker^{TM} Handheld Optical Sensor Unit (Trimble, USA). The unit senses a 0.6 m by 0.01 m spot when held at a distance of approximately 0.6 m from the illuminated surface. It takes readings at approximately 1000 measurements per second and averages measurements between readings. Travel velocities were at a slow walking speed (approximately 1 m s^{-1}), resulting in NDVI readings averaged over approximately 0.1 m [2]. The measurements were taken over the center of the raised beds and over the furrows.

After the crop reached maturity 50 stems were collected by randomly cutting five bundles of stems and then randomly selecting ten stems from each bundle to calculate harvest index (HI) [3]. After drying the stems at a temperature of 75 °C for 48 h their total dry weight was determined. The grain was separated from the straw in an individual plant thresher and then dried again for 24 h at a temperature of 75 °C and weight to determine the grain dry weight.

Each plot was mechanically harvested using a plot combine. Grain weight was recorded and moisture content was determined, by taking a subsample of approximately 200 g, determining the fresh weight and the dry weight after drying in the oven at a temperature of 75 °C for 48 h. Yield was adjusted to 12% moisture content (YLD). After harvest, thousand grain weight (TGW) was determined by counting 200 grains, weighing them after drying in the oven at a temperature of 75°C for 24 h and multiplying by five to obtain TGW. Test weight (TWT) was measured by evenly filling a 1 L cup with grain and weighing the grain [3]. Grain filling was determined as days from flowering to maturity (DaGr), grain production rate as yield divided by the days from flowering to maturity (GPR), expressed in kg ha^{-1} day^{-1}. The number of grains per m^2 (Grm2) was calculated by dividing dry yield by TGW. Spikes per m^2 (Spm2) were calculated by dividing biomass per m^2 (grain yield * HI) by the stem weight. Grains per spike (GrSp) were calculated as ratio of number of grains per m^2 and number of spikes per m^2 [3].

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Nine years of data on genotype by tillage interaction and performance progress for 14 bread and 13 durum wheat genotypes on irrigated raised beds in Mexico (Original data) (Dataverse).

CRediT Author Statement

Nora Honsdorf: Investigation, Data curation, Writing – original draft; **Michael J. Mulvaney:** Investigation, Writing – review & editing; **Ravi P. Singh:** Investigation; **Karim Ammar:** Investigation; **Bram Govaerts:** Conceptualization, Investigation; **Nele Verhulst:** Conceptualization, Investigation, Data curation, Writing – review & editing.

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