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Felicitas Vignati
Kansas State University

Lucas Lingua
Kansas State University

W. E. Brown
Kansas State University

See next page for additional authors

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Authors

Felicitas Vignati, Lucas Lingua, W. E. Brown, and Ignacio Antonio Ciampitti

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F. Vignati, L. Lingua, W.E. Brown, I.A. Ciampitti

Summary

Dual-purpose corn (*Zea mays L.*) hybrids are capturing the attention of farmers due to their versatility, as their final use can be decided for either grain or silage. This study compared eight dual-purpose corn commercial hybrids. During the 2023 growing season, a dryland field experiment was conducted in Manhattan, KS (US). We analyzed grain yield differences and the numerical and physiological yield components between hybrids. Furthermore, we assessed the hybrids' grain dry-down rates, which are crucial to optimize harvest time and minimize post-harvest losses. Grain yield ranged from 141.5 to 182 bu/a, and the grain number explained more of this variation than grain weight. The harvest index values varied narrowly between 0.46 and 0.51. Hybrids with higher yields also exhibited greater biomass. Additionally, the study uncovered three distinct patterns in the rate of kernel moisture loss, clarifying the dry-down process.

Introduction

Corn (*Zea mays L.*) is a versatile multi-purpose crop that plays a key role in global agri-food systems, including food for humans and feed pathways for animal-sourced foods (Erenstein et al. 2022). Roughly one-third of the global corn production is concentrated in the United States (U.S.) (USDA, 2023). Corn is the leading cereal in use as livestock feed, with over half of the global corn production used as feed for monogastric and ruminant livestock. In line with this global trend, the U.S. also allocates approximately 40% of its corn for livestock feed use, mirroring the pattern of using corn as a fundamental component in animal agriculture (USDA, 2022).

Located in the Central Great Plains of the United States, Kansas stands out for its significant contributions to national agriculture, securing the sixth spot nationwide in corn production and beef cow inventory (USDA, 2022). However, this success brings its own set of challenges, especially in meeting the surging demand from the cattle feeding sector (Kansas Department of Agriculture, 2021). This context emphasizes the importance of evaluating the performance of dual-purpose (grain and silage) corn hybrids in Kansas. This study aimed to (1) compare the differences in grain yield, (2) grain yield numerical and physiological components, and (3) evaluate the rate of kernel moisture loss among the hybrids. Additionally, it aims to (4) determine the differences in quality characteristics. This report is the first part of a series, with the following segment comparing grain quality characteristics before and after ensiling.

For more information, please read “Dual Purpose Corn Hybrids (Grain-Silage) Performance Assessment in Northeastern Kansas. II. Quality.”

Procedures

Field procedures

A field experiment was conducted during the 2023 growing season at the Kansas State University Experimental Field located in Manhattan, KS, U.S. (39°13'04.5" N; 96°35'55.6" W). The experimental design was a Randomized Complete Block Design (RCBD) with four replicates and eight treatments, which consisted of eight commercial double-purpose hybrids (6278SX, 6241Q, 6256Q, 6152D1, 6219wx, 5963SX, 6219 and 6235D1) from Beck's company. The hybrids do not differ in terms of cycle length (~112 CRM, Comparative Relative Maturity). The experiment's arrangement consisted of eight rows per hybrid in a 20ft by 65-ft plot. The hybrids were sown on April 17, 2023, with a plant density of approximately 30,000 plants per acre on a silty clay loam soil (Table 1). The crop remained free from pests and weeds with herbicide application and manual removal. Nutrient availability was not a limiting factor. The experiment was managed without irrigation.

To determine grain yield, an area of 2.5 from the central rows of each plot was harvested after physiological maturity (i.e., R6, visible black layer; Ritchie et al., 1986). The number of ears per plant was determined, and the ears were harvested, threshed, and dried until constant weight was reached. Then the kernel number and weight were determined. Grain yield was adjusted to a standard moisture content of 15.5%. To determine the harvest index, three plants from each plot were harvested. These plants were subjected to a controlled drying process for one week. After the drying period, the plants were partitioned, and the harvest index was calculated as the ratio between the weight of the grains and the total weight of the respective plant.

The dry-down pattern was determined during the seven weeks after R3 growth stage (milk stage). For that purpose, the upper apical ear was collected weekly from a plant per plot previously tagged to the accurate silking stage (R1 growth stage) date records. Dry kernel weights were determined weekly from ten kernels taken from the center of each collected ear. Grain moisture content was calculated using the measurements of wet and dry weight, obtained after seven days in a forced air oven at 70°C.

Statistical analysis

The effect of genotype on grain yield and harvest index was determined by analysis of variance and multiple comparisons among maize hybrids. All the analysis was performed using R software (R Core Team, 2023).

Results

The average yield of the trial was 164 bu/a, with a minimum yield of 141 bu/a for hybrid 6219 and a maximum yield of 182 bu/a for hybrid 5963SX, representing a 23% yield difference between the highest and lowest yielding hybrids. Despite this variation, statistical analysis indicated no differences in yield among hybrids ($P > 0.05$). However, it is noteworthy that five of the eight hybrids studied (5963SX, 6256Q, 6219WX, 6241Q and 6278SX) surpassed the five-year average yield for Riley County, which stands at 155.12 bu/a (Figure 1). Furthermore, aligning with the yield results, the

hybrids with higher yield also presented higher biomass (Figure 2a). This correlation did not extend to the harvest index, which varied within a narrower range between 0.46 and 0.51 (Figure 2b). Additionally, the grain number explained more yield variation than grain weight (Figure 3).

The results of the grain dry-down showed differences among the hybrids (Figure 4a). A pattern of three categories was observed regarding the rate of kernel moisture loss rate. The hybrids 6278SX, 6241Q, 6256Q, 6152D1, and 6219wx fell into the “Slow” category, 5963SX and 6219 were in the “Intermediate” category, and finally, the hybrid 6235D1 was in the “Fast” category (Figure 4b).

Conclusion

This study showed a great adaptability of dual-purpose corn hybrids, which were not bred for the Kansas region, yet they out yielded the five-year Riley County average under dryland conditions. For the numerical components, grain number explained more yield variation than grain weight, while for the physiological components, biomass accounted for more yield variation than harvest index. As a future step, more data on the adaptability of other dual-purpose hybrids should be gathered in this region.

Acknowledgments

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Table 1. Pre-sowing soil characterization (pH, organic matter (OM), Mehlich phosphorus, potassium (K), magnesium (Mg), sodium (Na), cation exchange capacity (CEC), N-NO⁻, N-NH⁺, sand, silt and clay) of corn experiments in the Kansas State University Experimental Field (Manhattan, KS, U.S.).

	Depth inches	pH	OM %	P-M ppm	K ppm	Ca ppm	Mg ppm	Na ppm	CEC meq/100g	N-NH4	N-NO3	Sand %	Silt %	Clay %
Block-1	0-6	7	2.4	11	285	2767	372	26	17.8	8.2	11	13	59	28
Block-2	0-6	7	2.4	15	192	1933	188	13	11.8	27.8	12	13	59	28
Block-3	0-6	6.8	2.6	23	219	2304	240	18	14.2	10.7	11.8	13	59	28
Block-4	0-6	6.7	2.8	26	259	2564	267	19	15.8	11.2	12.2	13	59	28
Block-1	0-24									13.7	10.9			
Block-2	0-24									7.5	15			
Block-3	0-24									8.8	4.3			
Block-4	0-24									10.6	5.4			

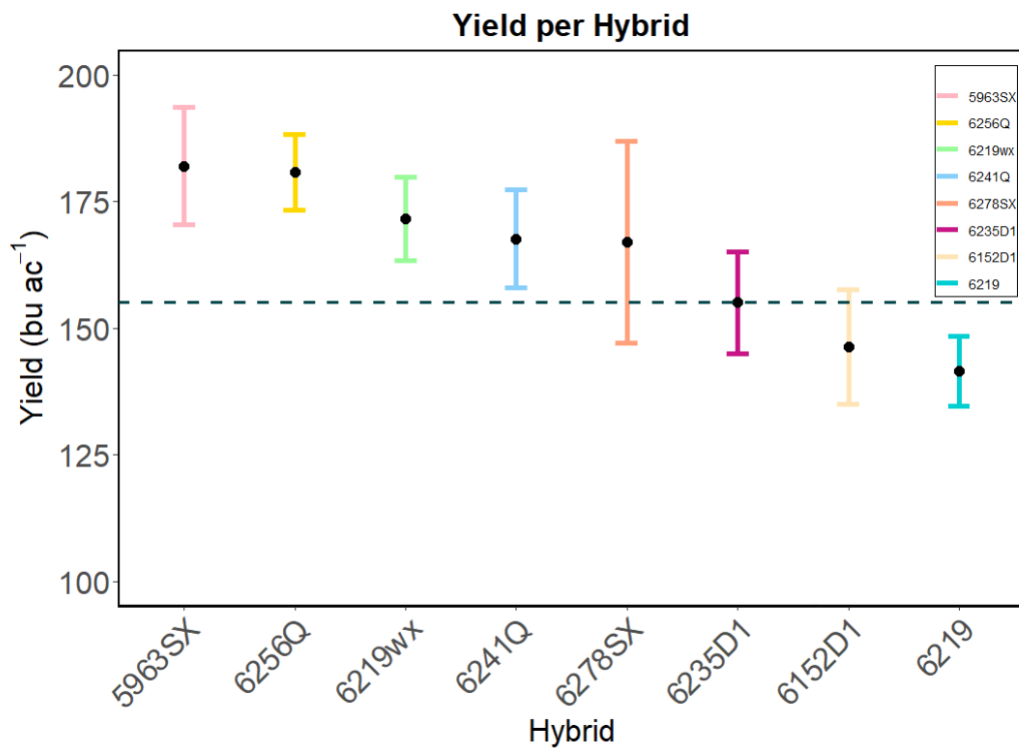


Figure 1. Yield in bu/a as a function of the hybrids. The hybrids are arranged in decreasing order according to their mean yields. The black point is the mean yield, and the bars are the standard error. The dashed line represents the mean yield of the last five years in Riley County, KS (USDA).

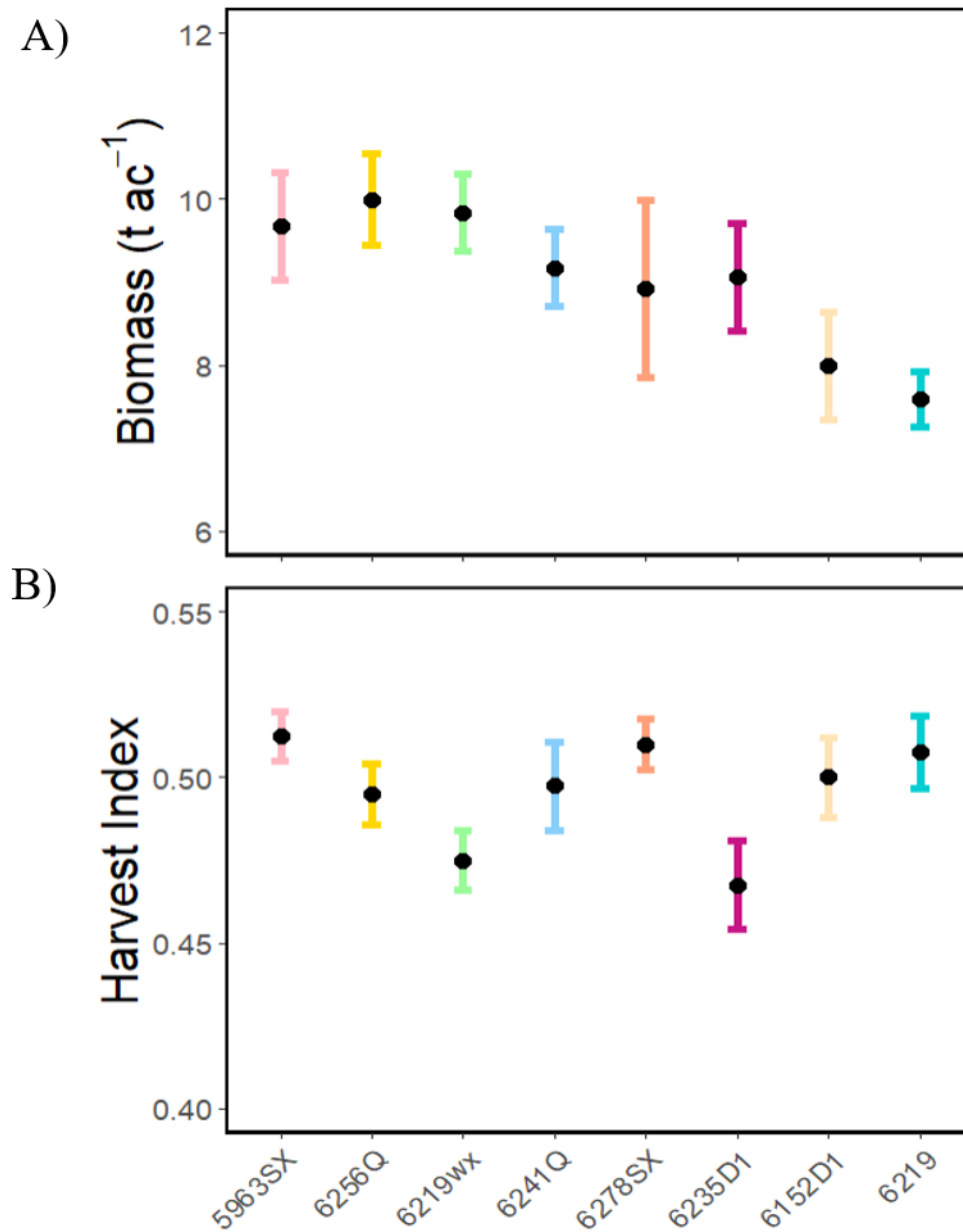


Figure 2. Yield physiological components. A) Biomass (t/a) as a function of hybrids. The hybrids are arranged in decreasing order according to their mean yield. B) Harvest Index as a function of hybrids. The hybrids are arranged in decreasing order according to their mean yield.

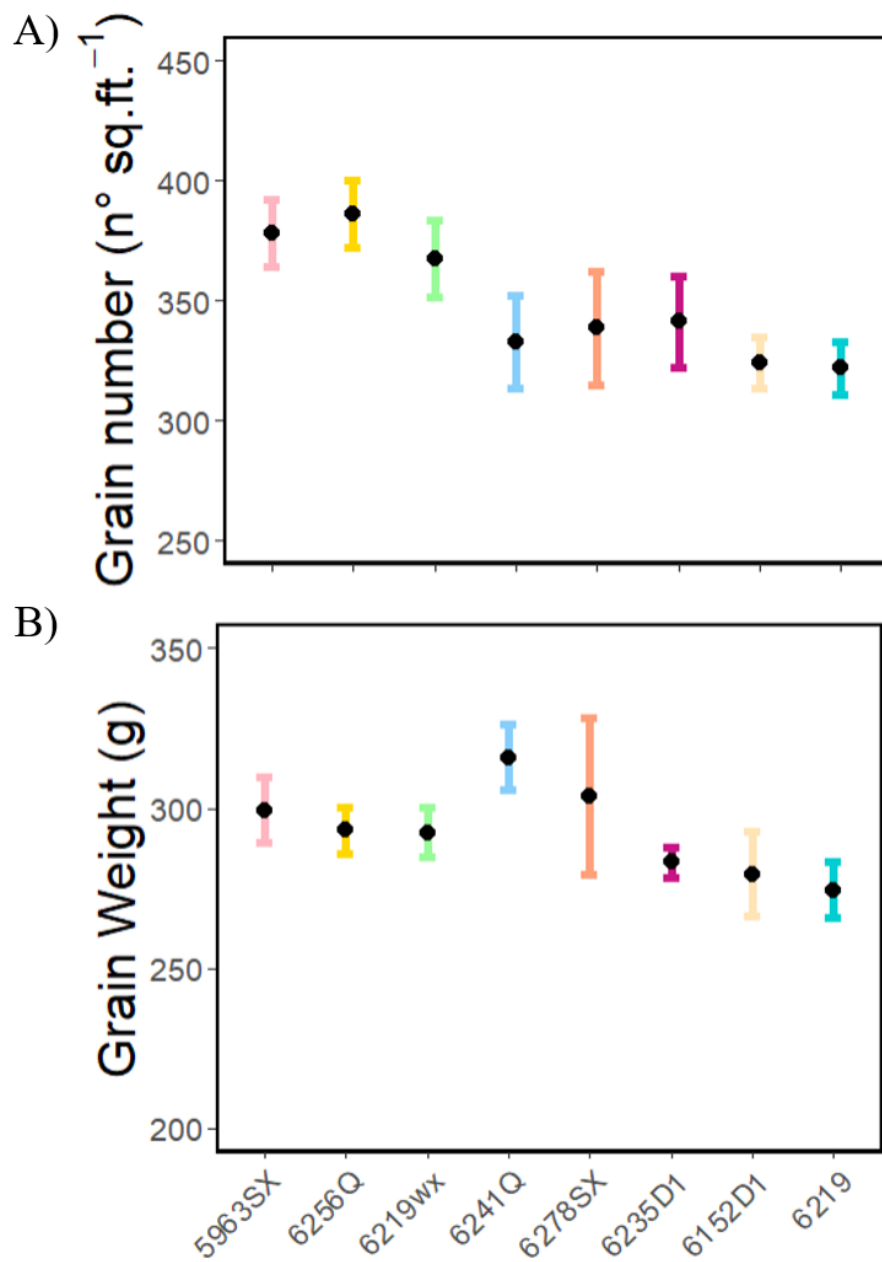
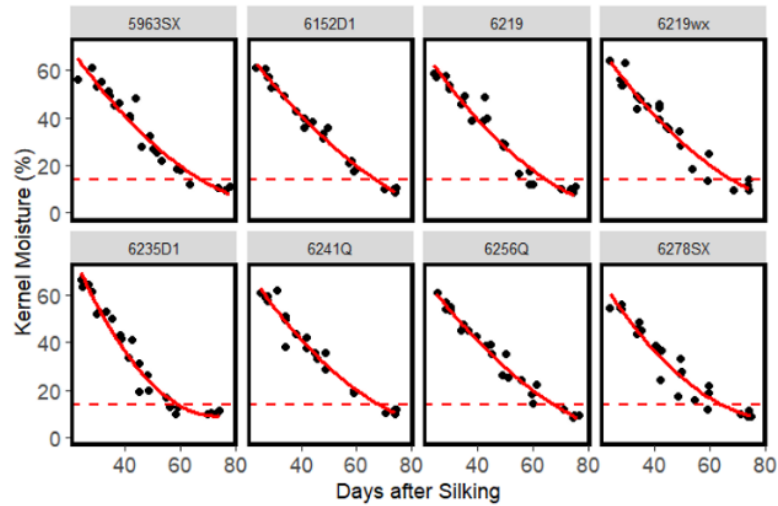


Figure 3. Yield numerical component. A) Grain number (n/sq. ft.) as a function of the hybrids. B) Grain weight (g) as a function of the hybrids.

A)



B)

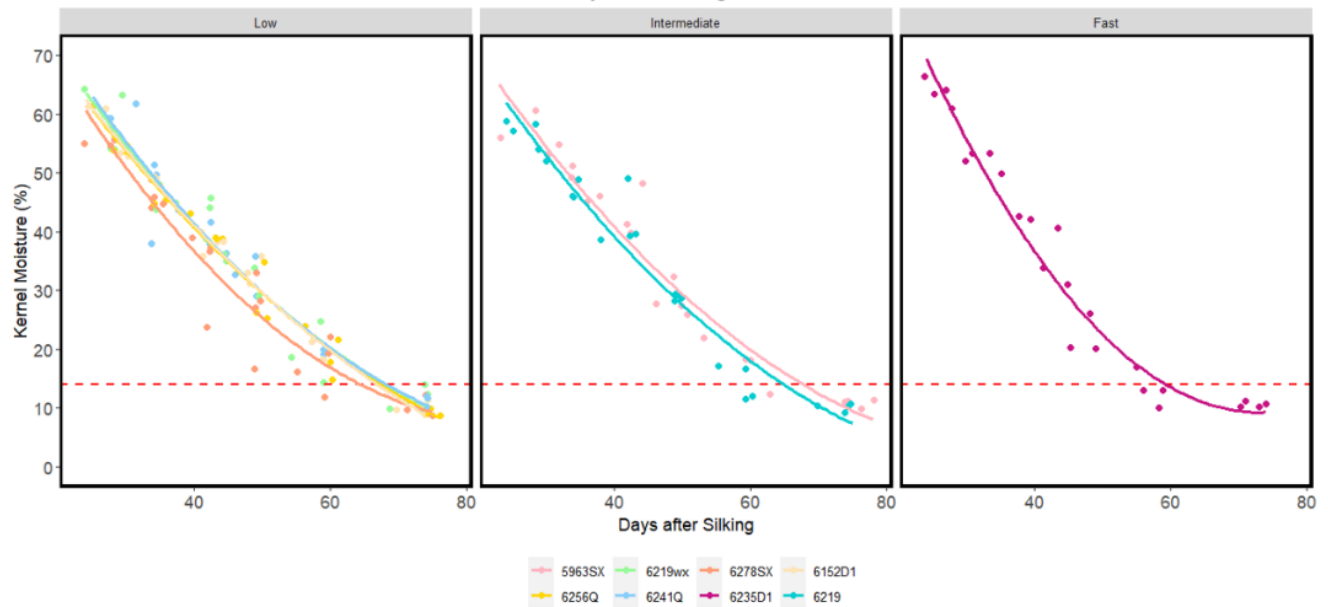


Figure 4. Kernel dry-down pattern. A) Kernel moisture (%) as a function of the days after silking. The dashed line refers to 15% moisture content. B) Kernel moisture (%) as a function of the days after silking is divided into three categories (“Slow,” “intermediate” and “fast”) based on the moisture loss rate.