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CORN FORAGE PRODUCTION IN SANTIAGO DE ANAYA, HIDALGO

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Abstract: The production of corn forage in Santiago de Anaya, Hidalgo, was carried out with the objective of evaluating the yield of dry corn biomass in a rainfed area, with the purpose of supporting the agricultural sector of Alto Mezquital, Hidalgo. 8 commercial corn hybrids were evaluated and 15 plots of at least one hectare were used; In general, these properties are classified as moderately alkaline to strongly alkaline soils. Regarding the percentage of organic matter (% OM), a range between 1.30% to 2.65% is reported; The real density refers to loam soils (1.3 mg cm-3) and sandy soils (> 1.32 mg cm-3) with a minimum porosity of 27.12 %. It is worth mentioning that a randomized complete block experimental design with two repetitions was used; in addition to pointing out that the hybrids did not receive any type of fertilization. Due to this, the average height (Tukey, $p \leq 0.05$) for 404W was 62.90 cm, for AZ20 39.16 cm, for CRM-77 118.90 cm; for 31.7 cm Gladiator; for P2327 the height was 112.50 cm; for P3026W 69.95 cm, for UIG 86.30 cm and for UIGA 79.73 cm. The hybrids with the highest dry biomass production (Tukey $p \leq 0.05$) were: CRM-77 with 4,636 t ha-1, followed by U1GA and P3026W with 3,818 ha-1 and 3,599 t ha-1 correspondingly; same hybrids that generated profits by being economically viable and achieving a net profit per hectare of $17,189.33, $14,672 and $13,650 respectively.

INTRODUCTION

Corn is one of the most important crops because it is used for human and animal consumption. The production of this crop has a nutritional, economic, social and industrial impact (FAO, 2023). The United States occupies first place as a producer and exporter of corn worldwide, producing on average more than 291 million tons annually in the last ten years. A production of approximately 384 million tons of corn was obtained in 2021; China and Brazil were in second and third position respectively (Statista, 2023).

On the other hand, the Ministry of Agriculture and Rural Development reported that in Mexico in 2021, a growth of 2.6% was generated in corn grain production, with an estimated volume of 28 million 427 thousand 436 tons. In Mexico, corn is grown in the 32 states of the country; mainly in: Sinaloa, Jalisco, State of Mexico, Guanajuato, Michoacán and Hidalgo; The latter is one of the producers that is located in the first places nation wide. For Hidalgo, an area planted with corn of 201,292.52 hectares was reported in 2023, of which 24,270.66 hectares were harvested, with a production of 41,936.31 tons, and an average yield of 1.73 tons/hectare. (SADER, 2023).

Generally, animals consume this crop as dry forage or silage, as well as grain; it is also one of the most important cereals for human nutrition. It is worth mentioning that the cultivation of corn has a dual purpose, one is the production of grain of which about 50% is harvested and the rest is in the form of biomes that corresponds to various structures of the plant such as the leaf and its cob among others. The main biomass producers in the world are the United Kingdom, Finland, Poland and Florida (Montúfar et al., 2021). According to the Ministry of Agriculture and Rural Development, at the national level this had an increase with a margin of two million tons. In the state of Hidalgo, it was among the main producers of corn forage in the country, producing 32, 619.59 tons per year (SADER, 2023).

In addition to the above, the objective of this project is to evaluate the yield of corn forage in rainfed areas, to support the agricultural sector of Alto Mezquital, Hidalgo.

MATERIALS AND METHODS

LOCATION OF THE STUDY AREA

The experiment is located within the area of the upper Mezquital Valley; Hidalgo (See Table 1). Experimental plots from the ejidos of: El Porvenir, González Ortega and Vicente Guerrero were taken as study areas, which are located in the municipality of Santiago de Anaya; as well as the Palomo located in Actopan.

AVERAGE PROPERTY CHARACTERISTICS

It is worth mentioning that the type of soil in which the commercial hybrids were established presents different physicochemical characteristics and agricultural management. Table 2 shows the characterized parameters based on NOM-021-RECNAT-2000.

The type of soil in the high valleys of Santiago de Anaya is sandy loam and its climate is semi-dry temperate with an average annual precipitation of 50 mm. The area has an average annual temperature of 16 °C. It is worth mentioning that the conventional tillage practice for growing corn in rainfed areas is using animal traction.

Biomass sampling and grain yield calculation were carried out using the "Yield Determination Manual" (Verhulst et al., 2012).

EXPERIMENTAL DESIGN

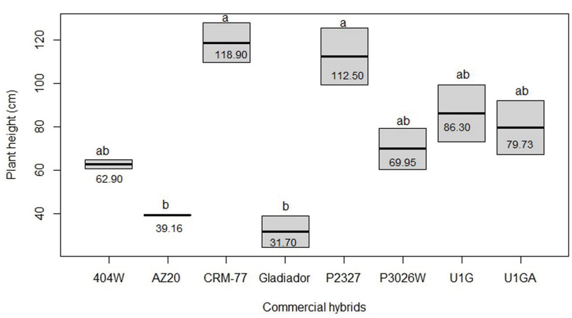
A randomized complete block experimental design with two repetitions was used. The data obtained were analyzed by analysis of variance (ANOVA) for each commercial hybrid, individually and in combination, using R Core Team version 2023. All parameters were tested for significance between hybrids ($p \leq 0.05$). When significant differences were found, the honest least significant difference (DMSH) was used to determine the difference between means.

RESULTS AND DISCUSSIONS

COMPARISON OF MEANS FOR TEMPORAL VARIABLES

The mean values observed for plant height determinations were significantly affected (Tukey, $p \leq 0.05$); Graph 1 shows the plant height obtained in the rainfed zone for each of the commercial hybrids.

In Graph 1 three groupings are displayed. In the first, the hybrid CRM-77 and P2327 are statistically equal, and are the hybrids with the greatest height, however; numerically CRM-77 is 6.4 centimeters more than P2327. For the second group; the hybrids U1G, U1GA, P3026W and 404W statistically do not present a significant difference (Tukey, $p \leq 0.05$); However, numerically the U1G hybrid is 20.4 centimeters longer than the 404W hybrid, therefore, it is convenient to establish U1G as a hybrid with an average height among all the hybrids evaluated.



Graph 1: Height of commercial corn hybrids in rainfed areas.

The third group is represented by hybrids with lower height; Although statistically AZ20 and Gladiator are equal, numerically the first hybrid is 7.4 centimeters more than Gladiator.

De la Cruz-Lázaro et al., 2009 evaluated the hybrid HS-3G and variety VS-536 under rainfed conditions in the humid tropics, with planting densities of 44, 289, 53,200 and 66 seeds per hectare, from which a average height 251 cm; This compared to the present project

Property location coordinates		msnm	Home
20.435626	-98.950021	2234	El Porvenir, Santiago de Anaya, Hgo; México.
20.435387	-98.950206	2229	El Porvenir, Santiago de Anaya, Hgo; México.
20.435716	-98.951059	2235	El Porvenir, Santiago de Anaya, Hgo; México.
20.435945	-98.951263	2243	El Porvenir, Santiago de Anaya, Hgo; México.
20.493532	-98.930678	2000	El Porvenir, Santiago de Anaya, Hgo; México.
20.362203	-98.993050	1967	González Ortega, Santiago de Anaya. CP. 42621 Hgo; México.
20.362201	-98.993048	1967	González Ortega, Santiago de Anaya. CP. 42621 Hgo; México.
20.377330	-98.996850	1981	Guerrero, Santiago de Anaya. Hgo; México.
20.377550	-98.996340	1981	Guerrero, Santiago de Anaya. Hgo; México.
20.364040	-99.007060	1952	Vicente Guerrero; Santiago de Anaya, CP. 42621 Hgo.México.
20.36380,	-99.008590	1948	Vicente Guerrero; Santiago de Anaya, CP. 42621 Hgo.México.
20.363322	-99.007544	1950	Vicente Guerrero Santiago de Anaya, CP. 42621 Hgo.México.
20.362468	-99.007949	1946	Vicente Guerrero; Santiago de Anaya, CP. 42621 Hgo.México.
20.363354	-99.006849	1951	Vicente Guerrero; Santiago de Anaya, CP. 42621 Hgo.México.
20.248009	-98.945357	2000	El Palomo, Actopan; Hidalgo México.

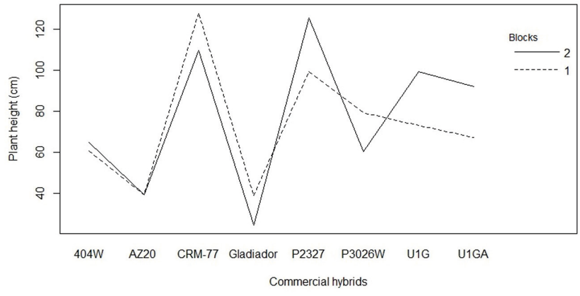
Table 1: Geographic location of the experimental plots.

Hybrid	pH	%MO	Real Density	Porosity (%)	Stubble management	Previous crop	Density (sem/ha)
Gladiator	8.8	1.3	1.3	51.5	Incorporated	Fruit	40 000
404W	7.9	1.4	1.9	45.7	Incorporated	Corn / beans	40 000
P3026W	7.9	1.4	1.9	45.7	Incorporated	Corn / beans	42 000
AZ20	8.6	2.55	1.87	56	None	None	20 000
U1GA	8.9	2.23	1.6	27.12	None	None	100 000
P2327	9.1	2.23	3.08	61.6	None	None	20 000
CRM-77	9.1	2.23	3.08	61.6	None	None	20 000
U1G	8.8	2.65	3.03	43.9	None	None	143 000

Table 2: Physicochemical parameters of the experimental plots and planting density.

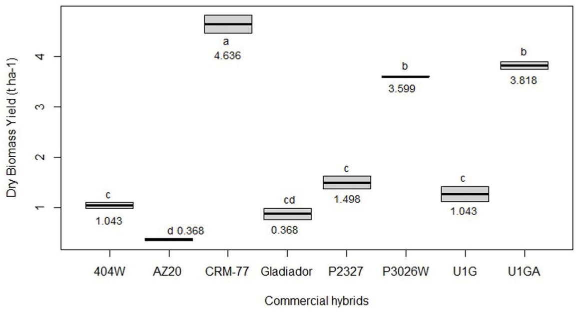
denotes that the height obtained by CRM-77 is lower than that reported by Cruz-Lázaro, however, it is important to mention that in CRM-77 it was established in a strongly alkaline soil based on NOM-021 -RECNAT-2000 and with a density three times less than what was established by the author.

The genotypes with the greatest height, CRM-77 and P2327, presented a height of 118.9 cm and 112.5 cm respectively, which leaves a minimal difference between them.



Graph 2: Comparación de bloques en la evaluación de altura de planta en zona de temporal.

In the comparison of the two replicates shown in Graph 2, there is homogenization in the majority of hybrids, with the exception of U1G and U1GA where there was a standard deviation of 18.5 cm and 17.4 cm respectively between both blocks.



Graph 3: Dry biomass yield in each commercial hybrid in rainfed areas.

Graph 3 shows the biomass yield, where for its estimation the plants were cut at ground level above the first aerial node in flowering and at physiological maturity.

Significant differences were recorded (Tukey, p ≤ 0.05); among the genotypes evaluated, unlike the three groups reported in height; When analyzing dry biomass, four groups were estimated, positioning the CRM-77 hybrid again in first place with 92.06% more production compared to the AZ20 hybrid; which was the lowest recommended to establish in biomass.

The second group for the dry biomass variable is made up of the hybrids U1GA and P3026W, both genotypes report a minimum difference of 0.2195 t ha-1 and both hybrids were part of the second group of plant height in the previous section.

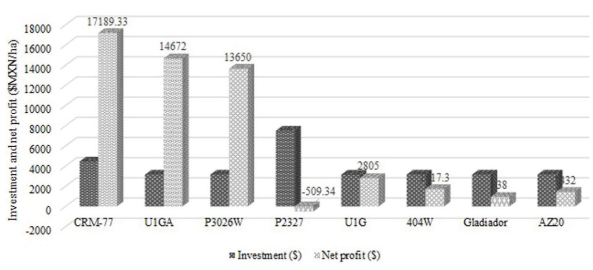
In this sense, it is important to highlight that the genotype called P2327, which presented the second largest plant height, for the dry biomass variable is positioned in fourth place, contrary to the hybrid P3026W which occupied fifth place in plant height and third place in dry biome performance. With the above, a better development is inferred for genotype P3026W.

The third grouping for dry biomass reported in Graph 3, positions P2327, U1G and 404W; Although they are statistically equal (Tukey, p ≤ 0.05), the 404W hybrid is the only one that remains in sixth place in plant height (62.90 ± 2.96) and in sixth place in dry biomass yield (1.04 ±0.08).

The Gladiator and AZ20 hybrids maintain the lowest plant heights and dry biomass yields among the genotypes evaluated. These hybrids are poorly adaptable to strongly alkaline soils; nor did the established planting densities favor the analyzed variables.

Corn, due to its photosynthetic system (C4), is more efficient than winter cereals (C3) to convert radiation into biomass (Seiler, 2010). It must be noted that low temperatures during the early stages of the PV 2023 production system and severe droughts with greater frequency and intensity have compromised the results obtained.

The production of forage or dry corn biomass as feed for livestock under rainfed conditions is a secondary activity for producers in the upper Mezquital area. Chart 4 shows the summary of production costs for the rainfed zone. It is worth mentioning that this graph does not include seed costs, because these were donated by each of the seed companies. The P2327 genotype reports greater economic investment with an average dry biomass yield of 1,498 t ha-1; On the other hand, the CRM-77 hybrid presents $3,050.00 less investment with an average biomass yield of 4,636 t ha-1. The above reaffirms the adaptability of this hybrid to strongly alkaline soils, also considering the low planting density established.



Graph 4: Summary of investment and net profit of temporary dry biomass.

Despite the different agroclimatic conditions, the CRM-77 and U1GA genotype could be alternatives for producers interested in generating dry biomass for their livestock. It is important to consider that in the upper Mezquital region, dry biomass (stubble) is sold in the form of bales of approximately 15 kg at a price of $70.00, therefore, the genotypes with the highest net profit would be CRM-77 ($17,189.33), U1GA ($14,672.00) and P3026W ($13,650.00).

In this sense, producers look for more efficient alternatives for their production systems or change their crops for others that can offer them greater profitability; However, in the case of traditional farmers, planting corn is part of their culture, considering that when grain is not available, the dry biomass obtained is used to feed their cattle or sheep mainly.

CONCLUSIONS

However, the CRM-77 genotype is an excellent proposal to obtain dry biomass in strongly alkaline soils. It is suggested to evaluate this hybrid in an irrigation area (in the upper Mezquital, Hidalgo) to assess and estimate the grain yield, as well as to know the nutritional quality of the grain to promote agri-food security in the region.

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