Article

Forage evaluation of maize from various origins of Mexico in the semi-arid region

Marco Antonio Rivas Jacobo[1]
Sergio Iban Mendoza Pedroza[2§]
Dora Ma. Sangerman-Jarquín[3]
Miguel Ángel Sánchez Hernández[4]
Camelia Alejandra Herrera Corredor[1]
Adelaido Rafael Rojas García[5]

[1]UASLP Faculty of Agronomy and Veterinary Medicine. Highway San Luis-Matehuala km 14.5, Ejido Palma de la Cruz, Soledad de Graciano Sánchez, San Luis Potosí. CP. 78321. (marco.rivas@uaslp.mx). [2]Postgraduate College-Montecillo *Campus*. Mexico-Texcoco highway km 36.5, Montecillo, Texcoco, State of Mexico. CP. 56230. [3]Valle de México Experimental Field-INIFAP. Los Reyes-Texcoco km 13.5, Coatlinchán, Texcoco, State of Mexico. AP. 10. CP. 56250. Tel. 01 800 0882222, ext. 85353 (sangerman.dora@inifap.gob.mx). [4]Papaloapan University-Loma Bonita Campus, Oaxaca, Mexico. (msanchez@unpa.edu.mx). [5]Faculty of Veterinary Medicine and Animal Husbandry no. 2-Autonomous University of Guerrero. Cuajinicuilapa, Guerrero. CP. 41940. (rogarcia-05@hotmail.com).

[§]Corresponding author: sergiomp@colpos.mx.

Abstract

The aim was evaluating the productive behavior of 21 genotypes of forage maize of different origins and seeing their adaptation in semi-arid areas in Soledad de Graciano Sanchez, SLP, at 22.22° north latitude and 100.85° west longitude at 1 835 masl. In temperate dry climate with an average temperature of 17.1 °C and precipitation of 362 mm. In 21 corn genotypes of different regions, the Plant Height (PHeight), Number of leaves per plant (NLeaves), Stem diameter (Diameter), Height of the first corn (EHeight), Foliar area of the corn leaf (FACL), Number of corn (NCorn), Yield of dry matter of the plant (YDMP), of leaf (YDML), of stem (YDMS) and of corn (YDMC), Relationships Leaf: Plant (RLP), Stem: Plant (RSP), Corn: Plant (RCP); Neutral Detergent Fiber (NDF) and Acid (ADF). The experimental design was completely randomized with six replications. The Tlaha2 genotype showed the highest value of PHeight with 2.5 m and EHeight with 1.4 m. Tampiqueño1 showed the highest NLeaves with 13.6. Chalqueño showed the largest diameter with 4.1 cm and the greater FACL with 775.97 cm^2. Papjalb/a, AS948-2 and Gdelfin showed the highest number of corns with 1.5 pl^{-1} corn. Chalqueño and Tampiquelo1 showed the highest YDM values with 46 246 and 42 947 kg DM ha^{-1}, respectively. It is concluded that there are genotypes from other regions that adapt to the dry climate of semi-arid areas and produce higher RMS and with better morphological components than other creoles and that the recommended improved varieties.

Keywords: *Zea mays* L., creoles, forage, morphological components.

Reception date: January 2020
Acceptance date: April 2020

Introduction

The genetic diversity of maize in Mexico is wide, as 59 breeds distributed throughout the country are recognized, from which 1 000 creoles or more are derived in the various localities of the national territory (CONABIO, 2012) material that is protected in different Germplasm Banks in various parts of Mexico by the National Institute of Research, Forestry, Agriculture and Livestock (INIFAP), state universities and in greater numbers by the International Center for Improvement of Maize and Wheat (CIMMYT), with the aim of safeguard the genetic diversity of this species.

The genetic variability of corn constitutes a wealth for the world population and can be the basis for achieving food sovereignty in Mexico, especially in the face of climatic changes (Preciado and Montes, 2011). The evaluation of this diversity is important for genetic improvement programs, due to its potential as a source of new, exotic and favorable characteristics (Vigouroux *et al*., 2008). There is little information on the usefulness of these breeds and creoles for other regions, so the study of local varieties is important to define their productivity and profitability for forage.

In such a way, that they have a broad knowledge of their productive behavior in order to define a better performance (Muñoz-Tlahuiz *et al*., 2013), in addition to considering their nutritional quality and effect on animals; thus, producers and technicians will have information and alternatives to supply food and supplements in the production units to counteract nutritional deficiencies in times of greater forage shortage.

Studies carried out by Rivas *et al*. (2019) where they compared a local creole from Santa Cruz Ajajalpan, Tecali, Puebla against 12 experimental hybrids and one commercial; observed that the creole outperformed more than half of the improved varieties and was equal to the national average with 21 772 t DM ha^{-1}, higher than the yields of other improved varieties studied by other researchers such as Borroel *et al*. (2014) for the hybrids Caiman, Occorn, AN-423 and Berentsen 302 with 23.83, 20.17, 19.39 and 19.11 t DM ha^{-1}; respectively, Núñez *et al*. (2005), with 20 t DM ha^{-1}, Núñez *et al*. (2007), observed values from 21.64 to 16.21 t DM ha^{-1} in commercial genotypes, Yescas *et al*. (2015), in the AN-447 hybrid of corn with 14.78 t DM ha^{-1} and those of Gaytan-Bautista *et al*. (2009) for 22 hybrids from 89 to 11.8 t DM ha^{-1}.

This shows that some creoles respond better than some improved varieties, offering alternatives for their production, but for many other creoles some information is unknown. In the particular case of San Luis Potosí, there is little information on local or improved corn varieties specifically for the production of forage for ensiling, used by dairy cattle producers in the central, middle and huasteca areas of the state, which improve the systems of production and lower production costs.

Therefore, the objective of this research was to evaluate the productive behavior of 21 genotypes of forage maize of different origin and their adaptation to semi-arid zones in order to offer alternatives to forage maize producers for ruminant feeding, in such a way so that there is availability of genetic material that guarantees a higher dry matter yield to lower production costs.

Materials and methods

The research was carried out at the UASLP Faculty of Agronomy and Veterinary Medicine, located in the Common Palma de la Cruz, Municipality of Soledad de Graciano Sánchez, SLP, at 22° 13' 39.8” north latitude and 100° 50’ 58.3” west longitude and 1 835 masl. The climate is dry temperate with an annual average temperature of 17.1 °C and a rainfall of 362 mm (García, 2004). 21 maize genotypes from different regions and environments were used (Table 1).

Table 1. List of genotypes of different origin and environment used as treatments.

Genotype	Origin	Region
Forrajala	Local fodder yellow corn from the Jala valleys, Nayarit	Semi-warm
Tampiqueño1	Local tampiqueño white corn from the Jala valleys, Nayarit	Semi-warm
Stafejal	Local white corn from the mountain areas of Jala, Nayarit	Temperate
AS948-1	Commercial white corn with an inter-regression generation of the Jala breed	Warm
Papjalb/a	Local white corn of Papantla, Ver. with interregression of the Jala race	Warm
Ojitalct	Local white corn from Castillo de Teayo, Ver.	Warm
Feuze	Selected white corn introduced to Uzeta, Ahuacatlan, Nayarit	Semi-warm
Gdelfin	Yellow corn recommended for commercial downtown area of San Luis Potosi	Semi-arid
Stiburon	Yellow corn recommended for commercial downtown area of San Luis Potosi	Semi-arid
H-311plus	Yellow corn recommended for commercial downtown area of San Luis Potosi	Semi-arid
AS948-2	Commercial white corn of two generations with interregression of the Jala race	Semi-arid
Tlaha1	Local yellow corn from Tlanchinol, Hidalgo	Warm
Tlaha2	Local yellow corn from Tlanchinol, Hidalgo	Warm
Tlaha4	Local yellow corn from Tlanchinol, Hidalgo	Warm
Tlaha6	Local yellow corn from Tlanchinol, Hidalgo	Warm
Tlaha7	Local yellow corn from Tlanchinol, Hidalgo	Warm
Rojo	Local red corn from Paso de Mata, Querétaro	Temperate
Chalqueño	Chalqueño-type creole white corn, Texcoco, Mexico	Temperate
Cerritos	White Corn local from Cerritos, San Luis Potosi	Semi-warm
Mexqui	Local white corn from Mexquitic, San Luis Potosí	Semi-warm
Hueha2b/a	White corn with local yellow from Huehuetla, Hidalgo	Temperate

Field work

Sowing was carried out in humid sandy soil in May, in rows 95 cm apart and one seed was deposited every 15 cm at a depth of 7 cm (70 000 pl ha^{-1}). 126 plots 3.8 m wide by 6 m long were traced, in which the treatments were randomly distributed. Fertilization was performed with diammonium phosphate (18-46-00) and urea (46-00-00) to cover the dose of 115-46-00 (NPK), applying all the phosphorous and one third of the nitrogen to the sowing, the remaining N (60%) was divided into two applications, at 45 and 60 DDS.

Weed control was performed at 25 DDS with Gesaprin Cal. 90® herbicide at a rate of 2 kg ha^{-1}, when the weeds had a height of 5 to 10 cm, and a second one at 15 days later. And mechanically at 60 and 85 DDS.

Irrigation was applied on average every 21 days by gravity. No pest or disease control was performed. The harvest was made when the plants showed the corn in a milky state with approximately ½ of the milk line, observing the maturity state of the corn visually for each variety, which corresponded between 144 to 157 DDS. For this, ten plants were selected and marked at random in complete competition within each experimental plot (Sánchez-Hernández *et al*. 2011), which were harvested at ground level, weighed with a hanging 20 kg Gamo® manual scale. Subsequently, the morphological components, leaf, stem and corn were separated and weighed individually on a Torrey® brand digital scale model EQ-5/10 with a capacity of 5 kg and an approximation of 1 g.

Each morphological component was chopped in a green forage blaster with Noguera Dpm 2® blades and hammers, with a 2 Hp gasoline engine. A subsample of the minced material was taken from 100 g of the leaf and 300 g for stem and corn, which were deposited in brown paper bags number 7, they were taken to a forced air stove to dry them for 120 h at 55 °C.

Once dry, they were weighed on an Ohaus CS200 brand digital scale with a capacity of 200 g and an approximation to 0.1 g, and the percentage of dry matter and the percentage of each component of the subsample was determined and then applied to the green matter obtained per hectare and calculate by conversion the yield of total dry matter and of each component.

The variables evaluated were

Plant height (PHeight): it was measured with a tape measure from the base of the stem at ground level to the point of insertion of the last leaf; number of leaves per plant (NLeaves): the leaves of each marked plant were counted, stem diameter (Diameter): it was measured with a manual vernier in the center of the first internode, height of the first corn (EHeight): it was measured with a tape measure from the base of the stem to where the corn is inserted, foliar area of the corn leaf (FACL): the width and length of the leaf where the upper corn is inserted was measured with a tape measure and multiplied by the factor 0.75, number of corn (NCorn): the corn that had grains formed from each marked plant were counted; Complete plant dry matter yield (YDM), was measured taking into account the weight of the 10 green plants randomly harvested, from which a subsample of 100 g for leaf and 300 g for stem and corn was taken and it determined the dry matter percentage, data that served to calculate the total dry matter of the ten plants and later per hectare, as well as for each morphological component; leaf dry matter yield (YDML), stem (YDMS) and corn YDMC.

Relationships Leaf: Plant (RHP): the dry matter yield of the leaf was divided by the dry matter yield of the entire plant, relationships stem: plant (RSP): the dry matter yield of the stem was divided by the material yield dry the entire plant; relationships corn: plant (RCP): the dry matter yield of corn was divided between the dry matter yield of the entire plant, neutral detergent fiber (NDF) and acid detergent fiber (ADF): they were calculated using the modified fractionation methodology of Van Soest fibers.

Experimental design

The experimental design was a completely randomized one with six replications, where the experimental plot was 3 m long and 3 m wide and was made up of 4 furrows. The data obtained was analyzed using the SAS® statistical package version 9.3. and the tukey test was performed at 0.05, to compare the means of the treatments.

Results and discussion

Table 2 shows the comparison of means in PHeight, NLeaves, Diameter, EHeight, FACL, NCorns of 21 corn genotypes from different environments, which showed statistical differences ($p < 0.05$).

Table 2. Statistical significance of means for morphological variables of 21 corn genotypes from different environments.

Genotype	PHeight (m)	NLeaves	Diameter (cm)	EHeight (m)	FACL (cm^2)	NCorn
AS948-1	1.9 defg	9.7 hij	2.3 hi	1.35 bcde	625 efg	1.2 abcde
AS948-2	1.8 gh	10.6 efgh	2.9 fg	1.26 defg	678.6 cde	1.5 ab
Cerritos	1.6 j	9.4 ij	3.9 ab	1.02 h	536.5 hi	1.2 abcde
Chalqueño	2.2 b	12.3 bc	4.1 a	1.39 abc	776 a	0.8 f
Feuze	1.6 ij	11.7 cd	2.8 g	1.2 g	527.2 i	1 def
Forrajal	1.9 def	13.1 ab	3.9 b	1.22 fg	723.7 abcd	1.4 abc
Gdelfin	1.2 k	11.6 cde	3 efg	0.53 i	543 hi	1.5 ab
H311plus	1.8 gh	10.9 defg	3.8 b	1.21 fg	579.8 ghi	1 ef
Mexqui	1.8 fgh	9.2 j	3.8 b	1.27 defg	556.6 ghi	1.3 abcde
Ojitalct	1.9 cde	10.9 defg	2.1 hi	1.31 cdef	698.1 bcd	1 cdef
Papjalb/a	2 c	10.7 defgh	3.5 c	1.45 a	763.5 ab	1.5 a
Rojo	1.7 h	10.3 ghi	2 i	1.3 cdefg	658.2 def	1 ef
StFACLjal	1.9 efg	11.6 cde	3.2 cde	1.25 efg	734.3 abc	1.1 cde
Stiburon	1.2 k	10.7 defgh	2.3 h	0.48 i	518.7 i	1.1 cde
Tampiqueño1	1.9 efg	13.6 a	3.1 def	1.38 abcd	708 abcd	1.2 bcde
Tlaha1	1.7 hi	10.4 fgh	3.3 cd	1.19 g	567.6 ghi	1 ef
Tlaha2	2.5 a	11.2 defg	3.2 def	1.49 a	706.4 abcd	1.3 abcd
Hueha2b/a	1.9 def	10.6 efgh	3 efg	1.30 cdefg	603.9 fgh	1 cdef
Tlaha4	1.9 cdef	11.4 cdef	3.8 b	1.25 efg	757.4 ab	1.1 cde
Tlaha6	1.9 efg	9.1 j	3 efg	1.25 efg	663.6 cdef	1 cde
Tlaha7	2 cd	10 ghi	3.1 def	1.34 bcde	759.7 ab	1.4 abc
Mean	1.8	10.9	3.2	1.2	651.7	1.2
MSD	0.1	1.0	0.3	0.1	72.0	0.3

a, b, c= different letters in the same column are statistically different. Tukey at 0.05. PHeight= plant height; NLeaves= number of leaves; EHeight= height of the first corn; FACL= Leaf area of the sheet which is inserted the first corn; NCorn= number of corns per plant. MSD= minimal significant difference.

In PHeight the Tlaha2 genotype showed the highest value with 2.5 m, followed by Chalqueño with 2.2 m. and those with the lowest height were the improved Gdelfin and Stiburon varieties with 1.2 m. This shows that the creoles had the highest height and the improved ones the lowest. Results similar to those observed by Parra (1996) who for 23 genotypes of creole corn observed a height range of 2.45 to 1.69 m. in 1991 and 2.39 to 1.75 in 1992, as well as those observed by Sánchez-Hernández *et al*. (2011) for creole corn with 2.44 and 2.16 m in height of a warm humid region. This height is similar, since the creoles that showed a higher height in this investigation come from warm and semi-warm regions.

In NLeaves Tampiqueño1 and Forrajal they showed the highest values with 13.6 and 13.1, respectively, and the lowest value were Mexqui and Tlaha6 with 9 leaves, average. Values slightly lower than those observed by Rivas *et al*. (2011) for trilinear hybrids of maize and similar to hybrids and creole ranging from 14.9 to 12.3 leaves plant^{-1}. In the Chalqueño diameter it showed the highest value with 4.1 cm and the smallest diameter were Ojitalct with 2.1 and Red with 2.0. Values higher than those observed by Rivas *et al*. (2011) with 2.71 to 2.62 cm and those of Montemayor, *et al*. (2006) with values from 2.12 to 1.97 cm.

The highest EHeight was for Tlaha2 and Papjalb/a with 1.4 m and the lowest values were for Gdelfin and Stiburon 0.5 and 0.4 m, respectively. This shows the variability in terms of the height of the corn on the plant, a character that can be selected in case of requiring varieties with corn located at a lower height.

For the variable FACL, Chalqueño showed the largest area with 776 cm^2, and the lowest was Stiburon with 519 cm^2. Character that is observed to be variable between genotypes and that can be selected to improve the FACL in some varieties for a better and greater interception of sunlight, since some researchers have observed that the leaf area index (LAI) is an important biophysical parameter to analyze the amount of photosynthetically active radiation. An increase in the LAI provides increased biomass production; but, due to the self-shading of the plant on the basal leaves, the average photosynthetic rate per unit of leaf area decreases, so special interest is placed on the upper leaves (Montemayor *et al*., 2006).

Regarding NCorn per plant Papjalb/A, AS948-2, Gdelfin showed the highest number of corns per plant (1.5 corn plant^{-1}) and the lowest values were for Chalqueño with 0.8 and Rojo and Tlaha1 with 1 corn, respectively. Values higher than the hybrids studied by Rivas *et al*. (2011) who observed maximum values of 1.33 corns planta^{-1}. Characteristic that should matter a lot in the selection or formation of a forage maize, since by showing a greater number they promise a greater amount of grain (corn), which in turn would ensure a greater amount of metabolizable energy for the development of a good silage, since the grain content is one of the main characteristics of corn hybrids associated with the energy value of forage (Allen *et al*., 1991).

Table 3 shows the statistical significance of the variables total dry matter yield, stem, leaf and corn. With the exception of this last component (YDMC), in the rest of them significant differences were observed between phenotypes (p< 0.05), where Chalqueño and Tampiqueño1 showed the highest values of YDM with 46 246 and 42 947 kg DM ha^{-1}, respectively in Stiburon change showed the lowest value with 17 300 kg DM ha^{-1}.

Table 3. Statistical significance of means for dry matter yields and their morphological components of 21 corn genotypes from different environments.

Genotype	YDM	YDML	YDMS	YDMC
AS948-1	35 032 abc	8 680 ab	19 242 abc	7 110 a
AS948-2	29 009 abc	7 787 ab	14 486 abcd	6 737 a
Cerritos	27 503 abc	5 736 ab	15 295 abcd	6 472 a
Chalqueño	46 246 a	9 781 a	25 951 a	10 513 a
Feuze	30 865 abc	8 031 ab	16 725 abcd	6 110 a
Forrajal	29 548 abc	6 999 ab	14 626 abcd	7 923 a
Gdelfin	20 493 bc	4 676 b	11 115 cd	4 702 a
H311 plus	25 890 abc	7 686 ab	11 121 cd	7 085 a
Mexqui	37 546 abc	7 300 ab	25 374 a	4 872 a
Ojitalct	31 459 abc	7 852 ab	16 098 abcd	7 510 a
Papjalb/a	39 354 ab	8 690 ab	23 279 ab	7 385 a
Rojo	34 625 abc	6 925 ab	21 764 abc	5 936 a
StFACLjal	25 554 abc	6 682 ab	13 396 bcd	5 475 a
Stiburon	17 300 c	4 921 b	6 883 d	5 496 a
Tampiqueño1	42 947 a	9 528 a	24 312 ab	9 107 a
Tlaha1	32 238 abc	7 312 ab	16 610 abcd	8 317 a
Tlaha2	29 593 abc	6 947 ab	16 765 abcd	7 840 a
Hueha2b/a	31 429 abc	6 870 ab	20 101 abc	4 459 a
Tlaha4	29 450 abc	7 568 ab	15 187 abcd	6 696 a
Tlaha6	30 775 abc	7 892 ab	15 354 abcd	7 528 a
Tlaha7	35 043 abc	7 336 ab	20 364 abc	7 343 a
Mean	31 519	7 390	17 336	6 886
MSD	21 140	4 569	11 937	8 312

a, b, c= different letters in the same column are statistically different. Tukey al 0.05. YDM= dry matter yield; YDML= dry matter yield in leaf; YDMS= dry matter yield on stem; YDMC= dry matter yield in corn. MSD= minimal significant difference.

Results greater than those reported by Parra (1996) with 33 900 to 18 130 kg DM ha^{-1}, Rivas *et al*. (2019) reports 32 800 to 25 000 kg DM ha^{-1} for trilinear hybrids, those of Elizondo-Salazar (2011) with 11 000 kg DM ha^{-1} for improved corn and 15 300 kg DM ha^{-1} for corn creole, Amador and Boschini (2000) 15 200 kg of DM ha^{-1} and those of Núñez *et al*. (2005), who obtained average dry matter yield results from three maturity stages of 20 000 kg DM ha^{-1}.

However, values similar to those of Rivas *et al*. (2011), who evaluated 12 experimental hybrids, one commercial released and one creole in San Salvador El Seco, Puebla with the highest fertilizer of 206-69-60 (NPK) and at a density of 100 000 pl ha^{-1}, under minimal tillage and YDM observed from 47 215 to 34 250 kg DM ha^{-1}, to those of Sánchez-Hernández, *et al*. (2011) with 44 300 kg of DM ha^{-1}, for a first cycle and in the second cycle 36 600 kg DM ha^{-1}, and those of Elizondo and Boschini (2011) with values of 49 203 and up to 38 408 kg DM ha^{-1}.

In contrast, lower than those of Parra (1996) for 23 genotypes of creole maize and two commercial varieties, who observed values in the year 1992 of evaluation in a range of 54 100 to 23 000 kg DM ha^{-1}, with a density of 62 thousand pl ha^{-1}. An aspect that shows that the yields that can be obtained vary according to the variety, the fertility of the soil, the cutting age and the planting density, among other factors (Aldrich and Leng 1974). If the variety is considered, it can be said that any type of corn can be cultivated for forage, but those that produce higher biomass yields are those tall varieties. For their part, hybrids, being small, generally produce less forage per unit area.

For the YDML, the data showed the highest values for Chalqueño and Tampiqueño1 with 9 781 and 9 528 kg DM ha^{-1}, respectively, while Gdelfin and Stiburon showed the lowest values with 4 676 and 4 921 kg DM ha^{-1}, respectively. For YDMS, the data showed that Chalqueño and Mexqui had the highest values with 25 951 and 25 374 kg DMS ha^{-1}; respectively, however, Stiburon showed the lowest value with 6 883 kg DMS ha^{-1}, respectively.

If we consider the components of leaves and stems together, it can be seen that the results of this research are much higher than those obtained by Rivas, *et al*. (2018) with 5 700 to 4 800 kg DMSL ha^{-1} and 19 000 to 13 600 kg DMS ha^{-1} and Elizondo and Boschini (2001) with 2 594 to 1 709 kg DM ha^{-1} and 3 327 to 2 802 kg DMSL ha^{-1}. Although there were no significant differences in the YDMC, the mean of 6 886 kg DMC ha^{-1} was higher than that of Elizondo and Boschini (2001) who observed values of 432 to 667 kg DM of corn ha^{-1} and lower than those of Rivas *et al.* (2018) with 8 900 to 8 500 kg DMC ha^{-1}.

Statistical differences in RHP, RSP and RCP are shown in Table 4, where H311plus showed the highest value at 0.29, followed by Stiburon at 0.28 for RHP. Those with the lowest value were Tlaha7 and Mexqui with 0.21 and 0.19, respectively. The highest RSP occurred in Mexqui with 0.67, and the lowest ratio were H311plus with 0.42 and Stiburon with 0.4. On the other hand, in the RCP the highest relationships were obtained in Stiburon and H311plus with 0.31 and 0.28, and those with the lowest ratio were Hueha2b/a with 0.14 and Mexqui with 0.13.

The results obtained are lower than those observed by Rivas *et al.* (2006), who report values between 0.28 and 0.53 as well as those obtained by Reta *et al*. (2000), from 0.45 to 0.5 and to those of Peña *et al*. (2002), which yielded values from 0.32 to 0.4.

Table 4. Statistical significance of means for leaf, stem and corn relations against the entire plant of 21 corn genotypes from different environments.

Genotype	RHP	RSP	RCP
AS948-1	0.25 abcd	0.55 i	0.19 n
AS948-2	0.27 abc	0.49 s	0.23 f
Cerritos	0.21 cd	0.55 j	0.23 f
Chalqueño	0.21 cd	0.56 h	0.22 h
Feuze	0.26 abcd	0.53 m	0.2 m
Forrajal	0.23 abcd	0.49 r	0.26 c
Gdelfin	0.22 bcd	0.53 l	0.24 e

Genotype	RHP	RSP	RCP
H311 plus	0.29 a	0.42 t	0.28 b
Mexqui	0.19 d	0.67 a	0.13 s
Ojitalct	0.25 abcd	0.51 q	0.23 f
Papjalb/a	0.22 bcd	0.59 d	0.18 o
Rojo	0.2 cd	0.63 c	0.16 p
StFACLjal	0.26 abcd	0.52 n	0.21 k
Stiburon	0.28 ab	0.4 u	0.31 a
Tampiqueño1	0.22 bcd	0.56 g	0.21 i
Tlaha1	0.23 abcd	0.51 o	0.24 d
Tlaha2	0.25 abcd	0.59 e	0.16 q
Hueha2b/a	0.22 bcd	0.63 b	0.14 r
Tlaha4	0.25 abcd	0.53 k	0.2 l
Tlaha6	0.26 abcd	0.51 p	0.23 g
Tlaha7	0.21 cd	0.58 f	0.21 j
Mean	0.24	0.54	0.21
MSD	0.06	0	0

a, b, c= different letters in the same column are statistically different. Tukey at 0.05 RHP= leaf plant ratio; RSP= plant stem ratio; RCP= corn plant ratio. MSD= minimal significant difference.

The NDF in leaves, stem and corn did not show statistical differences ($p > 0.05$; Table 5), where the mean was 62.7, 74.9 and 66.7% of NDF for leaves, stem and corn, respectively. Values similar to those observed by Elizondo and Bochini (2001), who observed NDF values for leaf from 71.6 to 69.2%, for stem from 68.0 to 65.4% and for corn from 64.9 to 64.1%.

Table 5. Statistical significance of means for NDF and ADF of 21 corn genotypes from different environments.

Genotype	Neutral detergent fiber			Acid detergent fiber		
	Leaves	Stems	Corns	Leaves	Stems	Corns
AS948-1	59.1 a	69.7 a	70.3 a	81.7 a	97.8 ab	98.5 a
AS948-2	59.8 a	69.5 a	63.1 a	84.9 a	98.5 ab	96.4 a
Cerritos	62.3 a	76.8 a	62.5 a	89.4 a	96.7 ab	96.5 a
Chalqueño	65.6 a	74.3 a	56.4 a	77.2 a	97.2 ab	95.4 a
Feuze	59.5 a	73.4 a	62.1 a	77 a	97.4 ab	91.4 a
Forrajal	62 a	75.9 a	75.5 a	74.7 a	98.1 ab	98.1 a
Gdelfin	62 a	72.8 a	71.8 a	64.8 a	97.9 ab	98.6 a
H311plus	62.6 a	74.8 a	67.4 a	85.5 a	95.4 b	96.4 a
Mexqui	61.4 a	74.1 a	68.5 a	78.3 a	97.8 ab	97.4 a
Ojitalct	66.7 a	72.8 a	62.2 a	84.2 a	97.4 ab	95 a
Papjalb/a	64.3 a	72 a	65.4 a	72.9 a	97.6 ab	95.9 a

Genotype	Neutral detergent fiber			Acid detergent fiber		
	Leaves	Stems	Corns	Leaves	Stems	Corns
Rojo	65.9 a	73.4 a	58.6 a	70.1 a	97.8 ab	96.1 a
StFACLjal	64.7 a	75.5 a	75.3 a	64.6 a	96.5 ab	82.1 a
Stiburon	60.7 a	78.7 a	71.9 a	80.2 a	97.5 ab	99.5 a
Tampiqueño1	65.5 a	76.4 a	70.6 a	63.4 a	96.7 ab	95.6 a
Tlaha1	63.7 a	77.1 a	69.6 a	69.5 a	96.5 ab	96.9 a
Tlaha2	65.4 a	79.5 a	81.2 a	79.8 a	97.7 ab	92.4 a
Hueha2b/a	60.2 a	76.1 a	59.1 a	72.2 a	97.8 ab	97.2 a
Tlaha4	61 a	76.1 a	65.2 a	64.8 a	97.7 ab	96.8 a
Tlaha6	61.3 a	71.8 a	69.5 a	61.8 a	99.4 a	97.7 a
Tlaha7	62.6 a	81.8 a	54.5 a	63.2 a	97.2 ab	86.5 a
Mean	62.7	74.9	66.7	74.3	97.5	95.3
MSD	13.8	13.4	33.1	33.4	3.9	27.8

a, b, c…= different letters in the same column are statistically different. Tukey at 0.05. NDF= neutral detergent fiber; ADF= acid detergent fiber. MSD= minimal significant difference.

Although the NDF values were by morphological component, it can be seen that the values were lower than those observed by Rivas *et al*. (2006), for silage dry matter that considered the complete plant for the milky state of the corn with 73.4% against 81.4% of NDF in the mass state. Instead, Núñez *et al*. (2005) observed lower values with 47 to 60.9% NDF in grain in 1/3 of milk line advance for the complete plant, while with 1/4 of grain milk line, they obtained on average 57.6 to 60.7% of NDF for the entire plant.

The ADF showed significant differences only for stem ($p< 0.05$; Table 5), where Tlaha6 showed the highest ADF value with 99.6%, while H311plus showed the lowest value with 95.4%. The mean ADF for leaves was 74.3 and for corn it was 95.3%. The results obtained are greater than those obtained by Rivas *et al*. (2006) in six corn genotypes harvested in two states of maturity of the corn under minimum tillage, observed that the lowest ADF of 39.1% in the corn harvest in the milky state. In contrast, in the mass state, the average ADF values were 46.42%. On the other hand, Peña *et al*. (2004) observed values of 26.4 ADF. In contrast, Elizondo and Boschini (2001) obtained much lower values with 39.7 to 37.4% for leaf, 44.9 to 42.6% for stem and 34.7 to 25.2% for corn.

Conclusions

The outstanding genotypes in total dry matter yield were two creoles, Chalqueño and Tampiqueño1, which corresponds to the temperate and semi-warm environment. It is concluded that there are creole genotypes from other regions that adapt to the dry climate of semi-arid zones and produce higher YDM and with better morphological components than other creoles in the region and that the recommended improved varieties. The results showed that there are genotypes from different regions and environments, with productive potential for semi-arid areas, so they can be used for production and breeding programs for forage.

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