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GROWTH AND HARVEST INDEX OF LOCAL MAIZE VARIETIES (*Zea mays* L.) IN COMMUNITIES OF THE FRAILESCA REGION OF CHIAPAS, MEXICO

Crecimiento e índice de cosecha de variedades locales de maíz (*Zea mays* L.) en comunidades de la región frailesca de Chiapas, México

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ABSTRACT. In order to characterize the growth and harvest index of local maize varieties (*Zea mays* L.), field experiments through a randomized blocks were designed at the villages of "Agua Dulce Dos" and "24 de Febrero", in the Frailesca region of Chiapas, Mexico. All the varieties were selected following a Research-Action and Participatory Learning process (RAPL) and oriented to the Participatory Plant Breeding (PPB) and Conservation Agriculture (CA). In both villages, a similar pattern of plant growth was observed, excepting for plant height, being taller plants belonging to the Campeón variety in "Agua Dulce Dos" (236 cm at 60 days) and Z-30 and Morado in "24 de Febrero" (120 cm at 60 days). Both, leaves number and stem diameter were similar in all varieties ranging between 11 and 12 leaves per plant and 1,7 and 2 cm of stem diameter respectively. The harvest index in "Agua Dulce Dos" was higher for the Macho variety and negatively correlated with plant height. The Campeón, Negro and Jarocho varieties accumulated higher plant biomass, while the Jarocho variety accumulated a higher stem biomass and negatively correlated with the harvest index. In "24 de Febrero" village, the harvest index ranged between 18 and 23 %; it was higher for the Morado and Parraleño varieties and negatively correlated with plant biomass. The leaves and stem biomass significantly varied among varieties, and a correlation with the harvest index was not observed.

Key words: biomass, plant growth, harvest index

RESUMEN. Con el objetivo de caracterizar el crecimiento y el Índice de Cosecha (IC) de variedades locales de maíz (*Zea mays* L.), se diseñaron experimentos de campo en bloques al azar en las comunidades "Agua Dulce Dos" y "24 de Febrero" de la región Frailesca de Chiapas, México. Las variedades estudiadas se seleccionaron a partir de un proceso de Investigación-Acción y Aprendizaje Participativos (IAAP) entre investigadores y productores orientado hacia el Fitomejoramiento Participativo (FMP) y la Agricultura de Conservación (AC). Las variedades que mayor altura de la planta mostraron fueron la Campeón en "Agua Dulce Dos", con 236 cm a los 60 dds y Z-30 y Morado en "24 de Febrero" con 120 cm. El número de hojas por planta y el diámetro del tallo fueron similares en todas las variedades y oscilaron entre 11 y 12 hojas por planta y 1,7 y 2 cm de diámetro respectivamente. El IC de las variedades cultivadas en "Agua Dulce Dos" fue mayor en la variedad Macho y se correlacionó negativamente con la altura de la planta. Las variedades Campeón, Negro y Jarocho fueron las que mayor cantidad de biomasa por planta acumularon, mientras que la variedad Jarocho acumuló mayor cantidad de biomasa en el tallo en detrimento del índice de Cosecha. En la comunidad "24 de Febrero", el índice de cosecha osciló entre 18 y 23 %, siendo mayor en las variedades Morado y Parraleño y se correlacionó negativamente con la masa fresca de la planta. La acumulación de biomasa en hojas y tallo varió significativamente entre variedades y no se observó un patrón definido que mostrara correlación alguna con el índice de cosecha.

Palabras clave: biomasa, crecimiento, índice de cosecha

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INTRODUCTION

Maize (Zea mays L.) is a species domesticated in Mexico about 9,000 years ago (1, 2) and it is the third most important cereal after wheat and rice (3-6). Its grains represent the foodstuffs of Mexican indigenous peoples and food security of families living in rural areas depends on its production (7). Chiapas is the fifth largest maize producing state of the nation (8), with 1,700,000 t in 2011 and its production system constitutes the employment basis for three out of five field producers.

Today, it is one of the most significant cereals in the world, due to its richness for human and animal nutrition (6, 9). In many countries, it is mainly obtained for forage, for its high stubble production (10, 11), that is a raw material of processed foods, ethanol production and human consumption[A]. In Mexico, there is a strong cultural and historical tradition, due to its uses, mainly for feeding (12).

Since its origin, maize has been grown and improved through selection processes based on man's needs and tastes, which has led this grass to have an enormous richness, considering local and improved varieties[B]. The former ones have a broad adaptive form that makes them favorable to multiple agroecological conditions, whereas the latter ones have more homogeneous characteristics and are created for a single purpose, that is, its adaptation to very specific conditions, such as drought, pest and disease resistance as well as higher yields.

At present, local maize has a high scientific interest, from the viewpoint of its preservation, management, culture, marketing and breeding. These studies are joined to those related with molecular characterization and potentialities of use in the Frailesca region of Chiapas[C]. Some early studies showed its great richness and ethnobotanical diversity (13). More recent studies, mainly in Chiapas, have been based on collections and characterizations reporting up to 11 races of local materials[D].

Chalqueño, Conico, Celaya, Bolita, Tuxpeño and Comiteco have been intensively used in breeding researches, so as to obtain improved varieties[E]. However, there is still a lack of information about local materials, its current genetics, environmental performance and different managements, as well as its relationship with their multiple uses they have or represent.

Results shown in this paper form part of a study conducted in several communities of the Frailesca region of Chiapas, aimed to generate and develop an Action-Research and Participatory Learning (IAAP) process to help rescue and improve local varieties, based on Participatory Plant Breeding (FP) and Conservation Agriculture (AC), mainly due to the need of having scientific evidence on local maize varietal characterization. Therefore, plant growth and harvest index of local varieties are described, as a criterion of production efficiency and its methodological value for comparing varieties with breeding purposes.

MATERIALS AND METHODS

Location

The study was conducted in "Agua Dulce Dos" and "24 de Febrero" communities, which belong to El Parral and Villa Corzo municipalities respectively, located in the Frailesca region of the state of Chiapas, from June to November, 2013.

"Agua Dulce Dos" Community

It is located in the Central Depression of El Parral municipality at 860 m above sea level. The climate is warm sub-humid with abundant rains in summer and mean annual rainfall of 1,248 mm, mean annual temperature of 25 °C and heat range of 8 °C (14).

Based on laboratory tests, it was shown that eutric Regosol is the predominant type of soil (15) with strongly acid pH (5,2), sandy loam texture, moderate salinity level, high organic matter, low hydraulic conductivity and mean level of available nitrogen. Phosphorus levels are moderately low, very low potassium and medium magnesium, whereas micronutrient availability, without apparent iron limitations. Zinc is present at a moderately low concentration, without apparent manganese limitations; copper is present at a moderately low concentration and boron at a very low concentration.

[A] Serratos, H. J. *El origen y la diversidad del maíz en el continente americano*. Ed. Review-Greenpeace, 2009, México, D. F, 33 p.

[B] Los autores adoptan el término de variedades locales y no criollas por la imprecisión que puede causar tal denominación producto del proceso de cruza o mejoramiento autóctono que se produce de manera espontánea o inducida por parte de los productores.

[C] Hernández, R. A. Maíces locales con potencial de uso múltiple en un área natural protegida de Chiapas. Master Thesis, Universidad Autónoma de Chiapas, 2014, México, 156 p.

[D] Perales, H. y Hernández, C. ''Diversidad de maíz en Chiapas''. En: eds. González E. M., Ramírez M. N., y Ruiz M. L., Diversidad biológica de Chiapas, Ed. Plaza y Valdés-ECOSUR-COCYTECH, México, D.F., 2005, pp. 337-355.

[E] Espinoza, C. A.; Taedo, R. M.; Sierra, M. M.; Gómez, M. N.; Coutiño, E. B. y Palafox, C. A. ''Mejoramiento genético y conservación de biodiversidad del maíz en México''. En: *XIII congreso nacional de Divulgación de la Ciencia y la Técnica Divulgación, agua, energía y Biodiversidad*, 2004.

"24 de Febrero" community

It is located in Villa Corzo municipality, in the southeastern state of Chiapas, which is geographically called Central Depression. The climate is warm sub-humid with rains and heat waves in summer, with lower winter rain percentage than 5 %. Annual rainfall ranges between 1,200 and 2,000 mm. Mean annual temperature varies from 24 °C to 28 °C (14).

The type of soil is Leptosol (15), with strongly acid pH (5,2), loam texture with moderate salinity level, moderately high organic matter, moderately high hydraulic conductivity with medium level of available nitrogen, low phosphorus, very low potassium and medium magnesium. As for micronutrient availability, without apparent iron limitations, zinc is present at a low concentration, without apparent limitations of manganese and copper, as well as boron at a very low concentration.

Experimental design and measured variables

In both communities, field experiments were designed in randomized blocks with three replicates. Treatments consisted of four local maize varieties for both communities, whose origin, producers' preference and characteristics are presented in Table I, which provides relevant data, as varietal selection was carried out according to producers' interests. In those communities, experiments were seeded by hand at a space of 0,75 m between rows and 0,30 m between plants on June 23 and 25, 2013 respectively. Plot dimensions were 2159 m^2 in "24 de Febrero" and 1120 m^2 in "Agua Dulce Dos" community.

Agronomic management of both experiments was performed by combining traditional practices of each locality and applying chemical and organic products, as well as temporary production system. Seeding was done by hand and direct with minimum tillage, whereas chemical weed control with glyphosate applied twice at a rate of 2 L ha^{-1}.

Table I. Local maize varieties studied, their origin and main characteristics

Community	Variety	Community of origin	Reasons referred by producers for its seeding	Characteristics
"24 de Febrero"	Macho	"24 de Febrero"	Better adaptability to different types of soil, better taste	Plant 200-230 cm high, with cobs 15 cm long and 14 white grain rows. Resistant to adverse climatic conditions
	Morado	"24 de Febrero"	Better taste in tortilla, sweeter, it is destined for self-consumption	Plant 250-300 cm high, of purple color, thin cobs and 12 cream grain rows
	Z-30	"24 de Febrero"	Sweeter, it is destined for self-consumption for its better taste in tortilla	Plant 250-300 cm high, thin cobs 15 cm long and 14 cream grain rows
	Parraleño	"24 de Febrero"	Preferable for self-consumption and animal feeding	Plant 180-200 cm high, thin cobs 15 cm long and 16 white grain rows
"Agua Dulce Dos"	Campeón	"Agua Dulce Dos"	Highly accepted by animals, higher amount of protein	Plant 212 cm high, thin cobs 15 cm long and 14 yellow grain rows
	Negro	"Agua Dulce Dos"	More delicious for tamales, it is destined for self-consumption	Plant 239 cm high, thin cobs 15 cm long and 12 black grain rows and full to its tip
	Jarocho	"Agua Dulce Dos"	Preferable for self-consumption, sweet variety	Plant 273 cm high, thin cobs of 12 white grain rows
	Macho	"24 de Febrero"	Well adapted to different types of soils and its characteristics, higher pest and disease resistance	Plant 200-230 cm high, with cobs 15 cm long, resistant to adverse environmental conditions and white grains

In both locations, chemical and organic fertilizations based on urea ("24 de Febrero") and ammonium sulfate ("Agua Dulce Dos") were combined at a dose of 140 kg ha^{-1} N applied 20 days after seeding (das). The second fertilization was performed at 40 days with vermicompost at a rate of 250 g per plant. Besides, liquid humus was applied to foliage three times at a rate of 2 L $pump^{-1}$ at 20, 40 and 60 das.

Growth and harvest index

Plant height (AP, cm), leaf number per plant (NHP) and stem diameter (DT, cm) were measured 20 das and at the same interval of time, until completing three samplings in ten plants per treatment.

At 60 das, a destructive sampling was performed to ten selected plants, for determining total fresh weight of plant aerial part (MFP, g), as a result of adding leaf fresh weight (LFW, g) and stem fresh weight (MFT, g). In addition, cob fresh weight without bracts (MFM, g), cob peduncle length (LPM, cm), cob length (LM, cm), cob diameter (DM, cm), stem node number (NNT) and spike fresh weight (MFE, g) were also determined. Harvest index was calculated by dividing cob fresh weight by the biomass of plant aerial part (16).

Statistical analyses

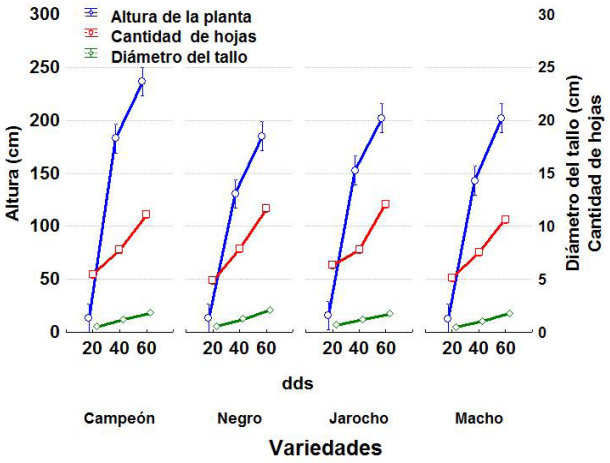
Variance analyses were performed and correlation matrices calculated for all variables evaluated per community, whereas means were compared through Tukey test ($p \leq 0,05$), after comparing variance homogeneity and normal data distribution. STATISTICA was the statistical program employed (17).

RESULTS AND DISCUSSION

"Agua Dulce Dos" community

Campeón variety reached the greatest plant height under "Agua Dulce Dos" community conditions, both at 40 and 60 das, with values of 183 and 236 cm respectively. The other varieties did not exceed 150 and 200 cm during those periods (Figure 1).

The amount of leaves per plant was statistically the same among varieties. This indicator ranged from 10 to 11 leaves per plant for all varieties at 60 das, which was lower than that reported in a study with local varieties at the communities from "La Sepultura" Biosphere Reserve Protected Natural Area (REBISE) of Chiapas, México[C], where Jarocho variety also showed higher growth.



Vertical bars represent mean standard error

Figure 1. Growth performance of local maize varieties under soil and climatic conditions of "Agua Dulce Dos" community, Chiapas, Mexico

Stem diameter ranged between 1,7 and 2 cm, providing some wind susceptibility to plants and consequently causing the characteristic lodging of local varieties in the region, which was one of the features that could be identified during IAAP process, as a key problem for producers of both localities. Hence, plant height reduction was considered one of the objectives of participatory plant breeding and conventional breeding programs[F], because landraces are precisely the varieties exceeding 250 cm high (18), compared to improved ones, which generally do not surpass 160 cm (19).

In a comparative study with Cacahuacintle landraces in Toluca Valley of Mexico, varieties exceeding 250 cm high were reported (18), meanwhile improved varieties obtained in INIFAP did not surpass 160 cm at 55-64 days to anthesis (19), which confirm the results shown over here related to height differences between local and improved maize plants.

Leaf fresh weight (MFH) did not differ significantly among varieties, with values ranging from 150 to 206 g. Significant differences were neither observed in stem node number (Table II).

[F] Ovando, C. J.; Rodríguez, L. L.; Marto, G. R. y Guevara, H. F. *Investigación Acción para el mejoramiento del sistema de producción de maíz con Agricultura de Conservación y Fito-mejoramiento Participativo en las regiones Centro y Frailesca de Chiapas, México*. Línea Base de Proyecto SAGARPA-CIMMYT-MasAgro-RED, A.C., 2013, p. 49.

No statistically significant differences were found between variables that morphologically characterized maize cob (Table III). Cob fresh weight (MFM) ranged from 130 to 200 g, whereas length and diameter showed less variability, ranging from 15 to 20 cm long and from 4,20 to 4,80 cm diameter. Peduncle length ranged between 6,77 and 11,33 cm. Spike fresh weight was significantly higher in Jarocho, Negro and Macho varieties, compared to Campeón, which only reached 16,67 g fresh weight (Table III).

Similar results regarding the growth characteristics of local varieties in this research were obtained in a recent study that compared local maize varieties with multiple use potentiality for rural areas of Chiapas[C].

Harvest index (IC) was significantly higher in Macho variety, followed by Campeón and Negro varieties. Jarocho variety showed the least IC, indicating its poor efficiency due to the lower cob fresh weight proportion per plant fresh weight unit, unlike 23 % IC of Macho variety (Table III).

The most correlated growth variables with IC were plant height and stem fresh weight, both in a negative sense, as well as cob fresh weight, which was positively correlated with IC (Table IV); however, due to its concomitance with IC, it is worthless to reach a conclusion, either methodologically or physiologically. Nevertheless, these variables are involved in the matrix, so as to find possible correlations with other non-concomitant and interesting variables for varietal characterization.

Other interesting correlations were observed between node number and leaf fresh weight, as well as between the latter one and cob fresh weight (Table IV).

Results of this analysis confirm that the greatest plant height shown by local varieties is not a desirable indicator in maize crop. Hence, stem biomass accumulation is one of the largest influencing factors on IC reduction under soil and climatic conditions of "Agua Dulce Dos" community.

In connection with these results and because of IC significance, some authors report a series of evidence about its usefulness to model maize varietal growth (20). Others suggest that this indicator behaves relatively constant within the economically interesting fields where fertilizers are used, as well as types of hybrid varieties and landraces, which does not correspond to the results shown over here. Moreover, these same authors confirm that landraces are higher, but have lower grain yield potential. In a study where different sowing dates were compared, IC ranged from 0,37 to 0,44 (21).

Table II. Growth parameters of local varieties grown in "Agua Dulce Dos" community

Variety	Plant fresh weight (g)	Leaf fresh weight (g)	Stem fresh weight (g)	Node number
Campeón	1140 [a]	196,67	423,33 [b]	14,00
Maíz negro	1140 [a]	206,33	450,66 [b]	14,33
Jarocho	1160 [a]	126,67	763,33 [a]	15,33
Macho	760 [b]	150,00	293,33 [b]	14,33
Standard mean error	0,06 *	41,74 ns	61,44 *	0,58 ns

* Different letters in superscripts mean that there is significant difference for p≤0,05

ns: no significant differences

Table III. Harvest Index and growth parameters of cob and spike of maize varieties grown in "Agua Dulce Dos" community

Variety	Harvest index	Cob weight (g)	Spike fresh weight (g)	Peduncle lenght (cm)	Cob length (cm)	Cob diameter (cm)
Campeón	0,17 [b]	200	16,67 [b]	6,83	18,33	4,80
Maíz negro	0,18 [b]	210	28,00 [a]	11,33	20,00	4,57
Jarocho	0,11 [c]	130	28,33 [a]	6,67	17,00	4,37
Macho	0,23 [a]	180	26,67 [a]	7,57	15,00	4,20
Standard error	0,05 *	0,02 ns	9,50 *	1,86 ns	2,11 ns	0,26 ns

* Different letters in superscripts mean that there is significant difference for p≤0,05

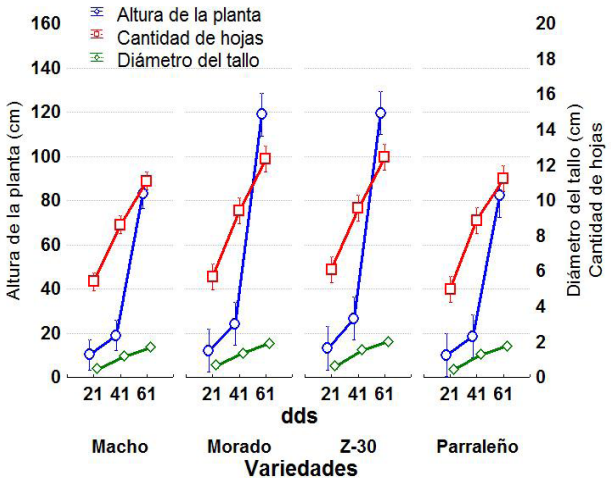
ns: no significant differences

Table IV. Correlation matrix between growth variables, harvest index and some cob morphological characteristics in maize landraces of "Agua Dulce Dos" community

	IC	AP	NN	NH	MFP	MFH	MFT	MFE	MFM	LPM	LM
AP	**-0,62**										
NN	-0,44	0,42									
NH	0,20	-0,05	-0,03								
MFP	-0,46	0,28	0,09	0,18							
MFH	0,46	-0,45	**-0,61**	0,11	0,32						
MFT	**-0,76**	0,56	0,55	-0,20	0,55	-0,42					
MFE	-0,15	0,47	0,58	-0,10	-0,11	-0,65	0,17				
MFM	**0,71**	-0,43	-0,41	0,42	0,29	**0,74**	-0,45	-0,22			
LPM	-0,03	0,23	-0,28	0,40	0,03	-0,09	0,01	0,06	-0,01		
LM	-0,10	0,17	0,22	0,28	0,42	0,19	-0,03	0,39	0,27	0,13	
DM	-0,13	-0,30	-0,14	0,13	0,42	0,48	-019	-0,41	0,24	-0,04	0,34

"24 de Febrero" community

The highest varieties were Z-30 and Morado in this community at 61 das, with 120 and 40 cm more than Parraleño and Macho varieties (Figure 2). Regardless that experiments were not designed for comparative purposes between communities, it is striking that Macho variety, the only one seeded in both locations, showed lower height under the soil and climatic conditions of "24 de Febrero" community, which indicates a possible genotype-environment effect previously recorded by other authors (2), whose results are also added to others in Mexico (18, 22-24).



Vertical bars represent mean standard error

Figure 2. Growth performance of maize landraces under soil and climatic conditions of "24 de Febrero" community, Chiapas, Mexico

However, this performance was not the same for leaf number per plant, as results were similar to those observed in "Agua Dulce Dos" and ranged between 11 and 12 leaves per plant at 61 das for all varieties, suggesting that plant height is more easily modified than leaf number, depending on the prevailing soil and climatic conditions. Similar results were obtained for stem diameter. At 61 das, the four varieties developed stems with diameters ranging from 1,7 to 2 cm.

Biomass accumulation in leaves and stem was significantly different among varieties. Z-30 and Parraleño showed the highest values of leaf fresh weight, while Z-30 and Morado accumulated higher stem biomass. As for node number, it was significantly higher in Macho and Morado varieties (Table V).

According to correlation matrix results (Table VI), higher plants produced smaller cobs, whereas stem fresh weight increased with node number. Cob fresh weight increased significantly when stem fresh weight also increased. Besides, a negative correlation was observed between cob fresh weight and peduncle length.

Cob growth parameters did not show significant differences among varieties. Only spike fresh weight was statistically higher in Morado variety and Parraleño showed the lowest spike fresh weight (Table VII).

Table V. Growth parameters of local varieties grown in "24 de Febrero" community

Variety	Plant fresh weight (kg)	Leaf fresh weight (g)	Stem fresh weight (g)	Node number
Macho	1150 [b]	196,67 [b]	516,67 [b]	15,00 [a]
Morado	1110 [b]	173,33 [b]	540,00 [a]	15,00 [a]
Z-30	1330 [a]	320,00 [a]	576,67 [a]	14,67 [ab]
Parraleño	970 [c]	273,00 [a]	297,33 [c]	13,33 [c]
Standard error	0,03*	14,06*	28,44*	0,37*

* Different letters in superscripts mean that there is significant difference for p≤0,05

ns: no significant differences

Table VI. Correlation matrix between growth variables, harvest index and some cob morphological characteristics in maize landraces of "24 de Febrero" community, Chiapas, Mexico

	IC	AP	NN	NH	MFP	MFH	MFT	MFE	MFM	LPM	LM
AP	-0,16										
NN	-0,37	0,36									
NH	-0,02	0,52	-0,24								
MFP	**-0,76**	0,41	0,46	0,16							
MFH	-0,52	0,22	-0,39	0,54	0,34						
MFT	-0,42	**0,61**	**0,74**	0,16	**0,81**	-0,10					
MFE	0,15	0,23	0,48	-0,31	-0,05	**-0,65**	0,30				
MFM	0,32	0,33	0,20	0,14	0,37	-0,33	**0,59**	0,19			
LPM	0,08	0,06	-0,32	0,15	-0,50	0,26	-0,52	-0,35	**-0,62**		
LM	0,09	**-0,59**	-0,50	-0,25	-0,28	0,18	-0,48	-0,49	-0,30	0,26	
DM	0,23	0,35	0,32	0,34	0,11	-0,16	0,42	0,27	0,49	-0,42	-0,52

Table VII. Harvest index and growth parameters of cob and spike of maize varieties grown in, "24 de Febrero" community

Variety	Harvest index	Cob fresh weight (g)	Spike fresh weight	Peduncle length (cm)	Cob length (cm)	Cob diameter (cm)
Macho	0,21 [bc]	250	15,00 [b]	6,17	19,67	4,83
Morado	0,23 [a]	250	16,67 [a]	5,33	18,50	5,17
Z-30	0,18 [c]	240	15,00 [b]	6,17	19,00	4,83
Parraleño	0,23 [a]	222	9,67 [c]	7,67	20,50	4,70
Standard error	0,01*	0,01 ns	5,11 *	0,88 ns	0,78 ns	0,23 ns

* Different letters in superscripts mean that there is significant difference for p≤0,05

ns: no significant differences

Morado and Parraleño varieties showed the highest IC, with significant differences with Macho and Z-30, the latter with only 18 %. Plant fresh weight was greater in Z-30, while Parraleño had the lowest accumulated biomass per plant (Table VII).

Although high CI values presumably indicate higher yields, available data in this research do not allow deepening on the productive performance of local varieties. Subsequent studies under the same conditions with emphasis on yield would provide further evidence upon the productive potential of these varieties.

However, despite the questioning of local varieties due to their low yield potential, results of this study demonstrate a stable behavior of vegetative and cob growth among all varieties in both locations. It is true that CI values are low and variable among varieties, compared with improved ones; however, producers' selection, seeding and preservation of local varieties follow a logic that rarely is part of scientists' interests (25).

In addition, so as to change this logic by introducing improved materials, we must take into account that the presence of hybrids and transgenics in agricultural production systems has raised a warning about the risky loss of a worldwide important germplasm, which has resulted in approaching strategies for its preservation[G].

CONCLUSIONS

♦ Local maize varieties grown in "Agua Dulce Dos" and "24 de Febrero" communities show similar growth patterns, except plant height. Leaf number and stem diameter ranged from 11 to 12 leaves per plant and 1,7 to 2,0 cm diameter respectively.

♦ Harvest index did not exceed 23 % in all varieties of both communities and it was higher in Macho variety of "Agua Dulce Dos" community, meanwhile it was negatively correlated with plant height. In "24 de Febrero" and considering IC values, the most efficient varieties were Parraleño and Morado. Maize leaf and stem biomass accumulation in "24 de Febrero" varied significantly among varieties, without any definite pattern showing correlation with harvest index.

♦ Varietal diversity and its differences between plant height and harvest index show that there is genetic potential at the studied areas, so as to start a Participatory Plant Breeding process focused towards those morphological parameters leading to increase its agro-productive efficiency, without forgetting its potentialities of multiple use and cultural tradition. This breeding process could consider introducing new improved and local maize genes from other regions, adaptable to the agro-climatic conditions studied and with desirable traits according to producers' perceptions involved in the process.

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