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Title: Genotype environment interaction for maize (Zea mays L.) hybrids for the humid tropic of México

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Introduction

Three way maize hybrids present the advantage of the heterosis (López et al., 2021; Ramírez et al., 2019;); In the maize commercial production, besides, they represent agronomic and economic advantages in certificated seed production because they use a single cross as a female parent with high yield and complete vigor and as a male parent an inbred line with very good per se behaviour, general combining ability (Tadeo et al., 2021; Sierra et al., 2019; Sierra et al., Sierra et al., 2018; Ramírez et al., 2019).

Objectives

The objectives of this research were to know the yield and agronomic characteristics of the experimental maize hybrids and to know the interaction of these hybrids across the three environments in Veracruz and Tabasco states

Methodology

Localization. ***This research was carried out during the spring summer season in 2021 at Cotaxtla Experiment Station INIFAP, Carlos A. Carrillo in Veracruz and Huimanguillo, Tabasco state locations; The clime conditions are Aw1, Aw2 and Am for each location respectively and correspond to humid and subhumid warm conditions.García (2004).***

Germplasm used. ***The germplasm used in this research were 12 three way maize hybrids which were formed with inbred lines selected through the per se grain yield and their General Combining Ability (GCA), and they belong to the Tuxpeño race. These lines were generated in the maize breeding program of Cotaxtla, Ver., and Iguala, Gro., experimental stations of the National Institute of Agricultural, Forestry and Livestock Research (INIFAP) in México and inbred lines from CIMMYT Int; Besides, there was included the commercial check H-520.***

Results

Table 1. Combined Analysis of Variance for grain yield in Three way maize hybrids across three environments in Veracruz and Tabasco states. CIRGOC INIFAP 2021B.

Source of Variation	*DF*	*SS*	*MS*
Varieties (V)	*11*	*22.84*	*2.076**
Environments (E)	*2*	*5.46*	*2.73NS*
Interaction VxE	*22*	*39.74*	*1.806**
Error	*99*		*1.016*
CV (%)			*14.39*

DF=Degree of freedom; SS=Square Sum; MS=Mean Square; *=Significance for source of variation at 0.05 of probability

Table 2. Grain yield in experimental maize hybrids across the three environments. CIRGOC INIFAP 2021B.

Entry	Genealogy	Grain yield t ha^{-1}				Rel
		Huim 21B	Carr 21B	Cot 21B	Mean	%
11	(T35xT10)xLT154	7.60	6.74	8.46	7.60*	113.4
3	(T35xT10)xLT-156	6.66	7.78	7.98	7.47*	113.4
10	(CML500xCML498)xLT155	7.68	6.67	8.06	7.47*	114.3
5	(CML264xCML311)xLT-156	7.11	7.82	6.94	7.29*	113.4
4	(LT-164xLT-165)xLT-156	7.42	7.5	6.79	7.24*	107.9
2	(LT-169xLT-170)xLT-156	7.02	7.63	6.97	7.21*	109.3
1	(LT-169xLT-170)xLT-155	6.60	7.44	6.24	6.76**	103.5
6	(CML500xCML498)xLT-166	6.96	6.87	6.44	6.76**	100.8
9	H-520	6.64	6.97	6.5	6.70**	100.0
12	(LT164xLT165)xX LT154	6.88	7.09	5.8	6.59**	98.3
7	(LT-169xLT-170)xLT-166	7.62	6.7	5.29	6.54**	97.5
8	(LT164xLT165)xLT166	7.22	6.77	5.29	6.43	95.9
	Mean	7.116875	7.165	6.73	7.004	
	CV	18.52	11.7	11.48	14.39	
	MSE	1.753958	0.702	0.596	1.016	
	SMD0.05				0.8156	
	SMD0.01				1.0802	

** and **= Significance of the treataments al 05 and 0.01 of probability; B= Spring Summer season; Cot= Cotaxtla Experimental Station; Carr= Municipality of Carlos A. Carrillo, Ver., ; Huim= Huimanguillo, Tab.; MSE= Mean Square Error; CV= Coefficient of Variation; SMD= Significant Minimum Difference Rel % = Relative percent in relation with the commercial check*

Table 3. Agronomic characteristics of three way maize hybrids. Cotaxtla CIRGOC INIFAP 2021B

Entry	Genealogy	Days to tassel	Days to silk	Plant height	Ear height	Plant aspect[1/]	Ear aspect[1/]	Ear sanity[1/]	% Lodging	% husk cover	% Ear rot
1	(LT169xLT170)xLT155	52	53	238	70	2.30	2.03	2.00	2.95	3.62	1.82
2	(LT169xLT170)xLT156	54	55	243	77	2.05	1.95	1.83	2.83	6.47	2.85
3	(T35xT10)xLT-156	52	53	243	76	2.13	2.18	2.01	6.45	4.79	3.03
4	(LT164xLT165)xLT156	52	53	230	71	2.33	2.37	2.05	3.59	7.62	0.86
5	(CML264xCML311)xLT156	52	53	236	74	2.00	2.06	1.94	13.45	2.74	3.26
6	(CML500xCML498)xLT166	53	54	235	75	2.53	2.35	2.39	0.80	6.09	3.89
7	(LT169xLT170)xLT166	53	54	234	71	1.95	2.14	2.20	3.80	3.97	3.30
8	(LT164xLT165)xLT166	52	53	232	73	2.33	2.33	2.00	2.20	6.80	1.88
9	H-520	52	53	245	79	2.15	1.93	1.83	1.72	7.16	4.04
10	(CML500xCML498)xLT155	52	53	243	77	2.38	2.28	2.63	3.85	7.26	2.45
11	(T35xT10)xLT154	54	55	263	75	2.18	2.17	1.86	2.21	4.39	1.47
12	(LT164xLT165)xX LT154	54	55	250	72	2.43	2.54	2.15	0.50	1.64	1.65
	Mean	52.54	53.49	240.83	74.19	2.21	2.20	2.08	3.71	4.24	2.54
	MSE	2.40	2.52	270.92	66.88	0.28	0.21	0.10	0.74	0.68	0.35
	C.V %	2.94	2.96	6.83	11.02	23.94	20.05	14.54	39.08	38.48	33.78

B= Spring Summer season; [1/] = Qualification scale from 1 to 5, where, 1 correspond to plants and ears with the best phenotypic expression and 5 for the worst; MSE= Mean square of error; CV= Coefficient of Variation

Conclusions

There were found experimental three way maize hybrids with grain yield above the comercial check H-520.

In the best hybrids, are participating inbred lines of the maize breeding program of Cotaxtla, Veracruz, and Iguala, Guerrero, from INIFAP and inbred lines from CIMMYT.

The best experimental hybrids for grain yield and agronomic característics were: (T35xT10)xLT154; (T35xT10)xLT156 and (CML264xCML311)xLT-156.

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