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Title: Three-way maize (Zea mays L.) hybrids, alternative for producing and using improved seed

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Introduction

Three way maize hybrids present the advantage of the heterosis (López et al., 2021; Ramírez et al., 2019); This hybrids represent agronomic and economic advantages in certified 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 and general combining ability (Tadeo et al., 2021; Sierra et al., 2019; Sierra et al., 2018; Ramírez et al., 2019; Gómez et al., 2017).

Objectives

The objective of this research was to know the yield and agronomic characterístics of three way maize hybrids for the humid tropic

Methodology

Localization. ***This research was carried out during the spring summer season in 2021 at Cotaxtla Experiment Station in Veracruz. The clime conditions are Aw1 subhumid warm, García (2004),***

Germplasm used. ***The germplasm used in this research were 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 were included the commercial checks H-562, H-565 and H-520.***

Results

Table 1. Mean square and significance for yield and agronomic characteristics of maize hybrids. Cotaxtla. CIRGOC. INIFAP. 2021B

Source of Variation	Degree Free	Grain Yield	Days to tassel	Days to silk	Plant height	Ear height	Plant aspect[1/]	Ear aspect[1/]	Plant sanity[1/]	Ear sanity[1/]
Hybrids	29	2.05*	2.178	2.192	449.79*	326.8*	0.166*	0.3085*	0.0536	0.305*
Blocks	2	1.18	17.678*	18.43*	19.21	142.81	0.21	0.71	0.019	0.1
Error	58	1.06	1.39	1.387	113.94	65.13	0.0588	0.113	0.0367	0.1287
Total	89									
CV (%)	15.78		2.09	2.05	6.08	10.6	11.42	15.26	9.65	15.71

[1/] = Qualification scale from 1 to 5 where, 1 correspond to plants and ears with the best phenotypic expression and 5 for the worst; *= Statistical Signifficance for the Sources of Variation at 0.05 of probability of error; B= Spring Summer season; CV= Coefficient of Variation.

Table 2. Grain yield and agronomic characteristics of three way maize hybrids. Cotaxtla 2021B. CIRGOC INIFAP

Entry	Genealogy	Grain Yield t ha-1	Relative %	Days to tassel	Days to silk	Plant height	Ear height	Plant aspect1/	Ear aspect1/	Plant sanity1/	Ear sanity1/
19	(LT155xT48)xCLWN247	7.46*	112	56	57	180	87	2.17	2.17	2	2.33
6	(LT156xCML549)xT49	7.42*	111	56	57	180	64	2.5	2.33	2	2.5
20	(CML311xT48)xCLWN247	7.39*	111	56	57	180	84	2.17	2.17	2	2.33
14	(CML549xT49)xCLWN247	7.34*	110	58	59	189	84	2	1.5	1.5	1.83
25	(CML549xLT154)xT48	7.32*	110	57	58	175	67	1.83	2.33	2	2.33
17	(LT156xLT154)xCLWN247	7.30*	109	55	56	178	74	1.83	2.33	2	2.33
1	(CLWN247xLT154)xT49	7.29*	109	56	57	178	73	2	2	2	2.17
18	(T48xT49)xCLWN247	7.22*	108	58	59	179	84	2.17	2.17	1.83	2.5
11	(T47xLT156)xLT154	7.18*	108	57	58	195	84	2	1.83	1.83	2
22	(T47xLT156)xCLWN247	7.18*	108	57	58	182	85	2	2.17	1.83	2
21	(T47xCML549)xCLWN247	7.12*	107	57	58	205	98	1.83	1.83	2	1.83
10	(T48xCLWN247)xLT154	7.03*	105	56	57	183	85	1.83	1.83	1.83	1.83
3	(CML550xCLWN247)xT49	7.01*	105	55	56	165	73	2	2	2	2.17
5	(CML549xLT154)xT49	6.75**	101	57	58	166	65	2.33	2.5	2	2.67
8	(CLWN247xT48)xT49	6.71	101	55	56	178	77	2.33	2.33	2	2.5
30	H-520	6.67	100	54	55	190	81	1.67	1.83	1.83	2
2	(LT156xLT154)xT49	6.64	100	56	57	194	96	2	1.83	1.83	2
29	H-562	6.54	98	56	57	159	71	2.33	2.5	2.17	2.33
28	H-565	6.39	96	57	58	171	76	2	2.5	2	2.33
13	(CLW247xCML549)xLT154	6.29	94	57	58	158	66	2.17	2.17	2	2.17
15	(CML549xLT154)xCLWN247	6.27	94	57	58	182	83	2	1.67	1.67	1.67
26	(CML549xT49)xT48	6.20	93	57	58	164	65	2.17	2.5	2.17	2.83
24	(CML550xCLWN247)xT48	6.13	92	55	56	168	72	2.33	2.33	2	2.33
23	(CML311xCLWN247)xT48	6.00	90	56	57	165	74	2.17	2.17	2	2.5
4	(CML311xCLWN247)xT49	5.94	89	56	57	166	70	2.33	2.5	2	2.33
27	(T47xLT154)xT48	5.69	85	56	57	161	66	2.17	2.83	2	2.83
12	(CML549xT49)xLT154	5.17	77	57	58	158	57	2.17	2.17	1.83	2.33
16	(T47xLT154)xCLWN247	5.13	77	56	57	187	91	2	2.5	2	2
9	(T47xT49)xLT154	5.06	76	57	58	169	66	2.33	2.33	2	2.5
7	(B49xB47)xT49	4.30	64	57	58	160	63	2.83	2.83	2	3
	Average	6.54		56.38	57.37	175.49	76.08	2.12	2.21	1.94	2.28
	MSE	1.065		1.39	1.39	113.94	65.13	0.059	0.113	0.037	0.129
	CV (%)	15.78		2.09	2.05	6.08	10.61	11.43	15.27	9.85	15.71
	SMD 0.05	0.53									
	SMD 0.01	0.71									

** and **= Significance of the treatments at 05 and 0.01 of probability; 1/ = Qualification scale from 1 to 5, where, 1 correspond to plants and ears with the best expression and 5 for the worst; MSE= Mean square of error; CV= Coefficient of Variation; SMD= Significant Minimum Difference*

Conclusions

The best 13 three way maize hybrids, registered grain yield 5 to 12% over the commercial check H-520.

In agreement with the yield and agronomic characteristics the best hybrids were: (LT155xT48)xCLWN247, (LT156xCML549)xT49, (CML311xT48)xCLWN247, CML549x T49)xCLWN247, CML549xLT154)xT48, LT156xLT154)xCLWN247, (CLWN247x LT154) xT49.

In the best hybrids participate as parentals, inbred lines from Campo Cotaxtla, Ver., and Iguala, Gro., INIFAP, and lines from CIMMYT.

The inbred lines LT156, LT154, CLWN247, CML549 and T49 participate in several of the best hybrids and suggest that these lines are characterized with Good General Combining Ability

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