DEVELOPMENT OF TROPICAL MAIZE HYBRIDS FOR USE IN MULTIPLE CROPPING SYSTEMS

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ABSTRACT

The development of tropical maize *(Zea mays* L.) hybrids with insect and disease resistance is needed to improve maize silage and grain production in multiple cropping systems in the southeastern USA. Selection and development of inbred lines in Florida's spring and summer environments should produce materials with superior pest resistance and wide environmental adaptability. Two tropical maize inbred nurseries were initiated in 1988 using Caribbean lowland flint as base germplasm. Selection criteria were yield, earliness, husk tightness, reduced insect damage, stay green, and synchronous pollen shed-silk emergence. Hybrid yield tests of 55 inter-nursery single crosses of S_3 inbred lines were conducted in 1991. Additionally 64 crosses of S_5 inbred lines were tested in spring of 1992. Yield test plots, consisting of two rows 0.76 m apart and 3.04 m long, were arranged in a randomized complete block desgin with four replications. Two hybrid crosses (BM29 x SY60 and BY45 x SY60) produced grain yields of over 9.0 Mg ha" both years. The top 10 grain yielding crosses in 1991 and 1992 yielded comparably with commercial hybrid controls. Additional testing of elite hybrid materials will be conducted in the late spring and summer in 1993 in order to ascertain their potential for use in the multiple cropping systems of the southeastern USA.

INTRODUCTION

The long growing season in Florida allows farmers numerous multiple cropping system choices, many of which include maize as a spring- or summer-planted crop. Maize silage production has been reported to be economically advantageous compared with grain production, especially when planted in late spring or early summer (Gallaher et al., 1991). Due to the long growing season and mild winters, damage to maize can be severe by pests and diseases, i.e. fall armyworm *(Spodoptem frugiperda)* and foliar fungal pathogens *(Helminthosporium* ssp. and *Puccinia polysora).*

Research has shown that, in general, tropical maize germplasm is photoperiod sensitive, is prone to lodging, and has poor combining ability (Goodman, 1985). It has been reported to have resistance to many foliar diseases and ear-feeding insects (Brewbaker et al., 1989). The degree of resistance to ear-feeding insects by maize has been shown to be correlated with husk number (Brewbaker and Kim, 1979). Corn ears with tight husk cover and extended husk are known to better resist damage from weevils *(Sitophilus* spp.), but selection for tight husk cover increases grain moisture at harvest. In maize silage production, whole plant dry matter and grain concentration and, generally, not grain moisture are of concern.

Temperate USA maize hybrids yield well in Florida when planted in early spring, but perform poorly when planted in late spring or early summer due to susceptibility to pests and poor adaptability to high temperatures (Gonzalez, 1989). The objectives of this research were to develop tropical maize inbred lines with acceptable agronomic characteristics and to test the hybrids created from these inbred lines for performance against adapted commercial hybrids.

MATERIALS AND METHODS

Two inbred nurseries, designated B and S, were established in 1988. Nursery B was composed of materials from five populations (Table 1) that had undergone crossing in all combinations, followed by two cycles of mass selection before selling. Nursery S was composed of materials from four populations (Table 1) derived from a recurrent selection program for yield and insect resistance by Espaillat (1990). Original materials for the recurrent selection populations were a Costa Rican flint used as the female parent and USA temperate and tropical hybrids as male parents. Selfing began for both nurseries in 1988 by selecting plants for yield, earliness, husk tightness, reduced insect damage, stay green, and synchronous pollen shed-silk emergence.

Initial yield testing of inbred lines began using S_2 lines. A replicated yield test of S, hybrid crosses was conducted in spring of 1991 using 55 single, 35 three-way, and 17 double-cross hybrids. Only the single-cross

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Table 1. Genetic background of inbred nurseries B and S.

Nursery B		Nursery S	
Material	Origin	Material	Origin
White Flint	Costa Rica	FL Farmer	FL
Temp. Hybrids	USA	Droop Ear	FSRS-FL‡
Trop. Hybrids	USA	Upright Ear	FSRS-FL
Cenia-12	Dominican	Cenia-12	Dominican
Pool†	CIMMYT	Pool	CIMMYT

† Composite of seven CIMMYT open-pollinated cultivars.
‡ Fullsib recurrent selection (Espaillat, 1989).

hybrid results are presented here. Hybrid crosses were planted in two row plots of 3.04 m length; distance between rows was 0.76 m. Plant population was 64,000 plants ha^{-1}, and standard cultural practices were followed. Experimental design was a randomized complete block design with four replications. Data collected from the 1991 yield test included grain and stover yields, ear and plant heights, days to flowering and silking, percent lodging and smutty ears, grain moisture, and weevil damage to ears. Weevil damage was visually rated after manually dehusking ears in the remaining row 1 month after harvest.

Replicated yield testing of 64 single crosses of S_5 inbred lines was conducted in the spring of 1992 using the same cultural practices and experimental design of 1991. Included in the test were seven crosses that performed well in the 1991 yield test. Data collected from the 1992 yield test included grain and stover yields, days to pollen shed and mid-silk, ear and plant height, shuck length past the tip of the ear, and grain moisture.

Analyses of variance were conducted using the general linear models procedure of SAS (1984). The top 10 grain yielding crosses and their characteristics were compared with commercial hybrids using LSD means separation.

RESULTS AND DISCUSSION

In 1991, two of the top 10 yielding crosses, BM29 x SY60 and BY45 x SY60, were also top yielding crosses in 1992 (Tables 2 and 3). Both crosses yielded above 9.0 Mg ha^{-1} both years and produced plants that were tall with good husk cover. The top four yielding crosses in 1992 were all over 2 m in height, indicating the expression of tropical maize genetic effects with no evidence of inbreeding. In both 1991 and 1992, top yielding crosses were competitive with the yields of commercial hybrid checks.

Visual weevil damage ratings taken in the field 1 month after physiological maturity were not different among hybrids in 1991. High levels of smut-infested ears in 1991 were due to high incidence of insect damage and favorable weather conditions. Top yielding crosses in 1991 showed good resistance to smut. Percentage of lodged plants at harvest among hybrids was significant in 1991 and not significant in 1992 (not shown). Husk tip length of the top 10 yielding hybrid crosses in 1992 showed a wide range of tip lengths (0.16 to 2.85 cm).

Inbred lines with potential for crossing with opposite nursery inbred lines and temperate USA inbred testers include: BY45, BY20, BM29, SY60, and SY20. All inbred lines are now at the S_6 stage and kept in cold storage at the University of Florida. Additional testing of elite hybrid materials will be conducted in the late spring and summer in 1993 in order to ascertain their potential for use in the multiple cropping systems of the southeastern USA.

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REFERENCES

Brewbaker, J.L. and S.K. Kim. 1979. Inheritance of husk numbers and ear insect damage in maize. Crop Sci. 19:32-36.

Brewbaker, J.L., M.L. Logrono, and S.K. Kim. 1989. The MIR (maize inbred resistance) trials: Performance of tropical adapted maize inbreds. Hawaii Institute of Tropical Agriculture and Human Resources, Research Series 062, University of Hawaii.

Espaillat, J.R. 1990. Recurrent selection of tropical open pollinated corn for the subtropical conditions of fall planting in north-central Florida. M.S. Thesis, University of Florida, Gainesville.

Gallaher, RN., SA. Ford, R. McSorley, and J.M. Bennett. 1991. Corn forage and forage sorghum double cropping yield, economics, crop nutrient removal, and quality. Agron. Res. Rpt. AY-91-05, Agronomy Dept., Inst. Food and Agri. Sci., Univ. of Florida, Gainesville.

Goodman, M.M. 1985. Exotic maize germplasm: Status, prospects, and remedies. Iowa State J. Res. 59:4977-527.

Gonzalez, N 1989. The effects of cultivar, planting date, sampling date, and plant density on dry matter accumulation, and N concentration end content in maize *(Zea mays* L.). M.S. Thesis, University of Florida, Gainesville.

SAS Institute. 1985. SAS user's guide: Statistics. 5th ed. SAS Inst., Cary, NC.

Table 2. Means for yield, plant height, ear height, and percent smut infested ears of top 10 crosses and check hybrids in 1991.

Pedigree	Grain† Yield	Plant Height	Ear Height	Percent Smut
	Mg ha^{-1}	----------m-----------		----%----
BWl8x **SW08**	10.77	1.95	1.00	1.75
BY27 xSY60	9.57	1.67	**0.82**	1.75
BY07 x SY20	9.19	152	0.72	0.00
BY45 **x SY60‡**	9.16	1.92	1.00	**0.00**
BY01 x SY03	9.14	2.00	1.00	430
BW16 **x** SW50	9.11	1.90	1.00	225
BY16 **x** SYl1	9.03	1.85	0.95	3.75
BW16 x SW35	9.02	1.85	0.90	4.08
BM29 **x** SY60‡	9.02	1.95	0.85	3.00
BY16 x SY20	8.88	1.90	0.90	3.50
NK-508	**8.44**	2.10	1.00	24.75
P-3320	10.06	1.85	0.90	525
Mean	7.95	1.86	0.92	333
LSD (0.05)	0.88	021	0.12	7.11

† Grain yield at 15.5% moisture.
‡ Among top 10 yielding hybrids in both 1990 and 1991.

Table 3. Means for yield, plant height, ear height, and husk cover of top ten crosses and check hybrids in 1992.

Pedigree	Grain† Yield	Plant Height	Ear Height	Husk Cover
	Mg **ha^{-1}**	----------m-----------		--cm--
BM29 **x SY60‡**	1033	2.42	122	1.11
BY45 **x** SY16	10.13	2.45	1.40	2.85
BY20 x SY16	9.86	2.45	1.23	2.19
BY45 **x** SY60	9.47	2.50	130	2.54
BY11 **x** SY60	9.42	2.17	1.11	0.95
BY20 **x** SY30	939	226	1.00	0.16
BY45 **x SY60‡**	925	2.07	0.97	0.64
BY03 **x** SY68	9.15	2.47	1.15	238
BY20 **x** SY68	9.13	2.10	0.96	***0.47***
BM29 **x** SY20	9.12	2.17	1.03	032
P-X304C	8.01	2.10	1.00	127
P-3320	9.41	1.85	0.76	1.84
DK-XL678C	730	2.18	124	1.58
Mean	7.77	2.05	0.99	0.59
LSD **(0.05):**	2.14	0.23	0.17	028

† Grain yield at 15.5% moisture.
‡ Among the top 10 yielding hybrids in both 1990 and 1991.