SILAGE EVALUATION OF TROPICAL CORN IN A STARTER-MINIMUM TILLAGE SYSTEM

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ABSTRACT

The greatest economic value from a corn (Zea mays L.) crop is obtained when it can be used as silage rather than for grain only. The objectives were to study tropical corn silage yield and quality in relation to starter fertilizer, planting date, corn hybrid, and fall armyworm stress. This study was conducted in the field at Quincy and Jay, Florida during 1991 and 1992. Results have shown the interaction of tropical corn silage to starter fertilizer and hybrids. Pioneer X304C was a positive changer, DeKalh DK 9101 was a no-changer, and Pioneer 3099 and Cargill X70lTR were negative changers. In 1992, the fall armyworm migrated to Quincy 1 month earlier than usual. Some hybrids were not as tolerant to the fall armyworm as others. Late-planted tropical corn resulted in high yields of corn silage. Feed quality 1% CP and in vitro organic matter digestibility (IVOMD)] of tropical corn grain and silage varied in relation to planting date and hybrid.

INTRODUCTION

The greatest economic value from a corn crop is obtained when it can be used as silage rather than only for grain. Recently, in the "Sunbelt" of this area, there has been a surging growth of population accompanied by increased sales of milk and milk products and significant growth in dairy farming. Increased dairying has been most notable in Florida, Georgia, and Texas, with a concomitant increase in the demand for corn silage of highly digestible dry matter (DM).

Most of the high yielding (temperate) corn hybrids in the U.S. produce silage in which nearly 50% or more of the DM is grain. Feeding silage, high in non-structural carbohydrates (starch), to ruminants, such as production stressed cows, can cause severe problems in the digestive tract unless the total feed is formulated to compensate for the high proportion of starch.

If corn silage with lower starch contents was used (no more than 40% of the DM as grain, i.e., tropical corn), it would be easier to maintain lactating cows with normal healthy digestive systems. Thus, corn silage containing lower proportions of grain would be more desirable for dairy farmers provided high digestibility could be maintained or increased without any reduction of silage intake by cows (Johnson, 1991).

Legislated disposal of dairy waste and the recycling of waste as fertilizer for the year-round production of dairy forage (sequential-cropping) may become the driving force for the use of tropical corn or pearl millet as a late summer-crop (Teare et al., 1991a) during the hot summer months in the southeast.

Struink (1982) showed that when harvested at similar maturities, the digestibilities within corn genotypes were fairly constant when grown in a wide range of environments. However, other plant characteristics, such as yielding ability, were strongly influenced hy differences in climatic conditions and associated cultural practices.

Tropical corn hybrids are most useful where prevailing environmental conditions usually are unfavorable for adapted domestic temperate cultivars (Teare and Wright, 1991). Tropical hybrids have been selected for their adaptation for short days, high temperatures, and high humidity; moderate yields at moderate fertility levels; and disease and insect resistance. In contrast, temperate hybrids have been selected for maximization of yields (high fertility rates and adequate soil moisture), early planting (cooler weather), and northern latitudes (longer days and lower humidity) (Wright and Rhoads, 1980; Wright et al., 1988). Thus, we have two corn hybrid groups that are used in different environments, depending on the planting date and degrees latitude. All tropical corn hybrids may not perform well under Southeastern conditions. Pioneer X304C is tolerant to fall armyworm and southern rust (Puccinia polysora) invasion (Teare et al., 1990), hut some tropical hybrids have been noted to have no more tolerance than temperate. hybrids. Therefore, tropical corn hybrids must be evaluated for each area/use before reliable recommendations can be made.

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Tropical corn hybrids can be no-till planted and multiple-cropped after winter grains, vegetables, or early-planted temperate corn harvested for silage (Wright et al., 1990). Early-May planting of tropical corn allows the escape of heavy infestation of fall armyworm [Spodoptera frugiperda (J. E. Smith)] that can devastate tropical corn planted after 10 June (Teare et al., 1991b).

Much of the "Sunbelt" of the southeastern United States is suitable for sequential-cropping (Wright et al., 1988) because silage crops do not require full maturity. It is possible to produce on the same land in the southeast: one winter crop of cereal grains, followed by an early-spring temperate corn crop, then a mid-summer planted tropical corn crop.

The objectives were to: 1) study tropical corn silage yields in relation to starter fertilizer and no-starter, 2) observe tropical corn silage yield in relation to planting date and fall armyworm stress, and 3) measure grain and silage quality in relation to grain and silage yields, planting date, and corn hybrids.

MATERIAIS AND METHODS

All tropical corn studies reported herein were conducted under a medium-energy-input system defined by Wright et al. (1990) as a no-till planting system following wheat harvest, fertilized with < 134 kg N ha^{-1} and grown under natural-rainfall conditions. The experiments were conducted at two locations: 1) North Florida Research and Education Center on a Norfolk sandy loam soil (fine-loamy, siliceous, thermic, Typic Kandiudult) and 2) Agricultural Research Center, Jay, FL on a Orangeburg sandy loam. The plot sizes were 7.6 m long by 6 m wide (eight rows). Row spacing was 0.76 m. The previous crop in each experiment was Fla 303 winter wheat, harvested in mid-May.

Fourteen tropical corn hybrids were compared in a starter vs no-starter silage yield experiment. Experimental design was a randomized complete block with four replications. It was planted on 18 June and harvested for silage on 16 Sept. Interactions are illustrated according to the technique of Teare and Wright (1990).

Fourteen tropical corn hybrids were planted no-till into the small grain stubble with a Brown-Harden Ro-Til planter (Brown Co., Ozark, AL 32630) at a population density of 20,000 plants ha^{-1}. The experimental design of was a randomized complete block with four replications (Table 2). Planting, silage harvest, and grain harvest dates were 19 May, 18 June, and 5 Oct, respectively.

The late-planted tropical corn experiment was planted on 17 June and 6 July at Jay, FL, 1992. Both planting dates were fertilized with 134 kg N ha^{-1} and a population density of 20,000 plants ha^{-1}. The rows were 7.6 m long by 3 m (four rows) with 0.76 m between rows. The previous crop was winter wheat harvested in late May. The experimental design was split plot with four replications. Whole plots were the planting dates. The sub-plots were 14 tropical hybrids (Table 3). Tropical corn grain yield and grain crude protein (CP) % [dry matter basis (DM)] comparison was conducted as a measure of grain quality of 27 tropical corn hybrids in 1991 (Table 4). Planting date was 1 July and harvest date was 31 Oct. The experiment was a completely randomized block with four replications.

Silage yields from five hybrids in the 31 May planting of the previous experiment were measured on 5 Sept (four replications) and subsampled for IVOMD analysis (Table 5). This harvest was badly damaged by fall armyworm and the other hybrids were not harvested.

In vitro organic matter digestibility and silage yield were also studied to compare two tropical corn hybrids and one high yielding temperate corn at four planting dates at Quincy, 1991. Planting and harvest dates are shown in Table 6.

RESULTS AND DISCUSSION

The interaction of temperate corn hybrid grain yields in relation to small amounts of starter fertilizer application at time of planting was described by Teare and Wright (1990). This explained the highly variable temperate corn yield results from starter fertilizer experiments reported throughout the United States (Wright, 1989). It also provided another management tool for farmers to consider in their selection of seed corn for optimization of yield (Rhoads, 1993). In 1992, a starter fertilizer experiment was conducted on tropical corn hybrids for the first time in relation to silage yield. Silage yields of 14 tropical hybrids are shown in relation to starter and no-starter application at planting (Table 1). The interactions are shown in Figure 1. Pioneer X304C showed the greatest range as the "positive changer" and Pioneer 3099 and Cargill X701TR, the greatest ranges, as the "negative changers." DeKalb DK 9101 showed the least change as a "non-changer."

Table 1. Silage yield of 14 tropical corn hybrids in relation to starter fertilizer, Quincy, Florida, 1992. Planting and silage harvest dates were 18 June and 16 September, respectively.

Hybrid	Starter at planting	Ton/A (35%DM)
Cargill **X701TR**		l2.6
Pioneer **3099**		**113**
Pioneer **X304C**	+	**11.2**
Pioneer **3069**	+	**11.1**
Cargill **X70lTR**	+	**10.9**
Pioneer **3072**	+	**10.8**
DeKalb DK **X9052**		**10.8**
Pioneer **3069**		**10.5**
Pioneer **3072**		**105**
DeKalb DK **X9152**		**10.4**
Dekalb DK **X9052**	+	**103**
Pioneer X304C	-	**9.9**
Dekalb DK **X9152**	+	**9.7**
Pioneer **3099**	+	**9.7**
Pioneer **4098**	+	**9.5**
Pioneer **3098**		**9.2**
Dekalb DK **XL510**		**8.9**
Dekalb DK **XL510**	+	**8.5**
DeKalb DK **XL678C**		**8.0**
DeKalb DK **XL678C**	+	**7.6**
DeKalb DK **XL520**	+	**7 5**
DeKalb DK **XL520**		**6.8**
Cargill **C955**		**4.1**
DeKalb DK **9101**	+	**3.9**
DeKalb DK **9101**		**3.8**
Cargill **C955**	+	**3.6**
Cargill **9197**		**3.0**
Cargill **9197**	+	**2.7**
MD.,		**1.7**

Table 2. Grain and silage yield[1] of 14 tropical corn hybrids, Quincy, FL, 1992. Planting, silage, and grain harvest dates were 19 May, 18 June, and 5 Oct, respectively.

Hybrid	Grain yield[2] (bu/A)	Silage yield[3] (ton/A)
Pioneer 3099	136.9 A	10.5 B
Pioneer 3069	124.5 AB	10.8 AB
Pioneer 3072	119.9 ABC	10.6 AB
Pioneer 3098	106.7 BCD	9 3 CD
DeKalb XL678C	105.2 BCD	7.8 EF
Pioneer X304C	99.4 CD	10.5 B
Cargill C955	96.8 D	3.9 G
DeKalb XL510	96.7 D	8.7 DE
Cargill X701TR	93.9 D	11.8 A
DeKalb X9052	93.2 D	10.6 B
DeKalb 9101	91.9 D	3.8 G
DeKalb X9152	90.7 D	10.0 BC
Cargill 9197	88.4 D	2.8 G
DeKalb XI520	87.2 D	7.1 F

[1] Yield in columns followed by the same letter are not significantly different at the 5% level of probability.
[2] Corrected to 15.5% moisture.
[3] Corrected to 35% DM.
[4] Comparison for 35% DM.

Table 3 Grain yield[1] of late-planted' tropical corn hybrid trials at two planting dates at Jay, FL., 1992.

Hybrid	Planting Date June 17	Planting Date July6
	(bu/A)	(bu/A)
Pioneer 3072	114.1	115.4
Pioneer 3099	98.5	109.5
Pioneer 3069	95.3	100.5
DeKalb X9152	77.1	89.5
Cargill X701TR	78.4	81.0
Pioneer 3098	80.4	79.1
DeKalb X9052	62.9	77.1
Pioneer X304C	50.6	70.7
DeKalb XL678C	50.6	609
DeKalb XL510	382	42.8
DeKalb XL520	32.4	35.7
Cargill C955	18.1	169
DeKalb 9101	14.9	13.0
Cargill 9197	12.3	11.0
Means	59.0	64.2
$LSD_{.05}$	18.8	169

1 Correct to 15.5% moisture.

2 **Rainfall Distribution (Inches)**

June	9.10
July	8.71
August	7.99
September	6.91
October	2.08
November	10.73
TOTAL	4552

Table 4. Tropical corn grain yield and percentage grain crude protein (DM) for 27 hybrids at Quincy, Florida, 1991. Planting and harvest dates were 1 July and 31 October, respectively.

Hybrid	Grain yield (bu/A)	% CP (DM)
Pioneer 3078	16.6	11.7
Pioneer 3098	39.8	11.6
Cargill C525	6.9	11.4
Cargill C381	19.7	11.3
Gallaher FL5-1990	21.5	11.3
Asgrow A6798	15.7	11.3
Cargill C511-A	10.0	11.2
Cargill T-321	5.0	11.1
Gallaher FL1-41-1990	13.8	11.0
Pioneer 3086	21.6	11.0
Cargill C606	16.2	10.9
Pioneer 3214	17.0	10.9
Cargill C801	2.9	10.9
Asgrow XM7759	35.3	10.9
Pioneer 6875	9.0	10.8
Cargill Semiden 5	--	10.8
Cargill C901	21.3	10.8
DeKalb XL678C	28.9	10.6
Pioneer 3292	8.4	10.5
Pioneer X304C	16.3	10.5
Cargill c633	21.5	10.5
Cargill C385	18.2	10.5
Pioneer 3210	14.7	10.4
Cargill C701	30.1	10.2
Cargill C33	20.8	10.0
Asgrow A667	5.1	10.0
Cargill C905	21.6	9.9
$LSD_{.05}$	10.9	0.9

Early (May) planting of tropical corn has been shown to be an escape management tool for evading fall armyworm damage (Teare et al., 1990 and 1991). Planting date studies in 1992 show unique weather influences not observed in the previous 8 years of tropical corn research. Weather during the winter of 1992 was very mild and spring temperatures and rainfall were higher than normal. As a result, fail armyworm migrations north from Puerto Rico and southern Florida were about a month earlier than usual. This was the first time significant fall army-worm damage occurred to grain yield in May planted tropical corn at this location. Grain and silage yields of 14 tropical corn hybrids are shown for the 19 May planting at Quincy in Table 2. Grain yields were good, but some silage yields were low showing the effect of fall armyworms on some low tolerance tropical hybrids. The low silage yielding hybrids for the May planting was what would be expected for June planting dates.

Table 3 shows the grain yields of two late plantings of the same tropical corn hybrids at Jay. The high grain yields for the mid-June and early-July planting dates (the highest in our 9 years of tropical corn research) indicated that the fall armyworm migrated north earlier than usual and allowed the tropical corn hybrids to express their grain yield potentials late in the growing season without heavy insect damage. Early-July planted tropical corn grain yields for 27 hybrids in 1991 (Table 4) are shown as the more "normal" low grain yields from later migrating fall armyworms to compare with Table 3.

Grain and silage feeding quality for ruminant animals is estimated by measurements of percent crude protein on a dry matter basis and IVOMD (Moore and Mott, 1974). Table 4 shows the percent crude protein of 27 tropical corn hybrids grown at Quincy in 1991 along with corresponding grain yields.

In vitro organic matter digestibility and silage yields are shown in Table 5 for five tropical corn hybrids at Quincy in 1991.

In vitro organic matter digestibility and silage yield are shown for another study that compared two tropical corn hybrids and one high yielding temperate corn variety from four planting dates at Quincy, 1991. The May planting was in a very vulnerable vegetative stage when the fall armyworm invaded in June, which resulted in the decision to harvest early and reduced the silage yields of the May-planted silage crop of all hybrids. *In vitro* organic matter digestibility was also reduced because of the reduced leaves and grain.

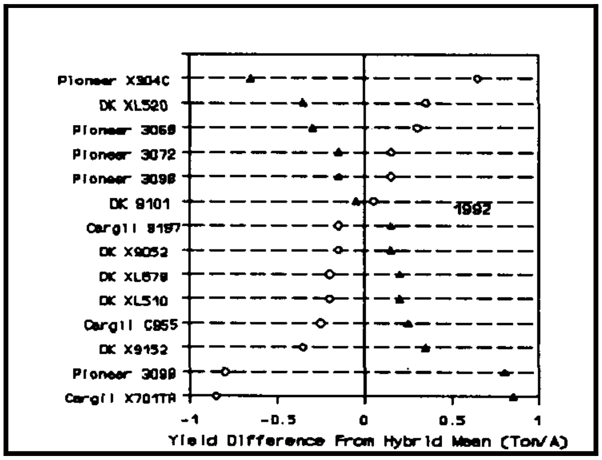

Figure 1. Silage yield difference from hybrid mean (ton/A) showing interaction with starter (0) and no-starter (A) during 1992 for 14 tropical corn hybrids (listed on y-axis). Hybrid mean is the sum of the silage yields of starter and no-starter treatments for each corn hybrid divided by two and is represented here by 0, so that silage yield differences from hybrid means can be shown, illustrating the interaction curves and the range of silage yield for starter and no-starter.

Table 5. *In vitro* organic matter digestibility and silage yields of five tropical corn hybrids, Qulncy, 1991. Planting date 1.

Hybrid	Yield[1] (ton/A)	IVOMD[1] (%)
Pioneer 3098	9.2 A	38.8 A
Pioneer 3214	7.4 A	38.7 A
Pioneer X304C	8.8 AB	38.6 A
Pioneer 3210	6.0 B	37.2 A
Pioneer 6875	6.4 B	35.5 A

[1] Means in row or columns followed by the same letter are not significantly different at the 5% level of significance.

Table 6. In vitro organic matter digestibility and silage yields of two tropical' corn hybrids and one hlgb yielding temperate[2] corn at four planting dates at Quincy, Florida, 1991.

Planting Date	Harvest Date	Pioneer 3098[1] Silage (ton/A)	Pioneer 3098[1] NOMD (%)	Pioneer X304C' Silage (ton/A)	Pioneer X304C' NOMD (%)	Sunbelt 1876[2] Silage (ton/A)	Sunbelt 1876[2] NOMD (%)	Mean[3] Silage (ton/A)	Mean[3] NOMD (%)
22 April	13 Aug	14.9	62.1	143	60.9	22.9	53.3	17d a	58.8 b
15 May	13 Aug	10.9	61.6	10.1	58.5	10.6	45.5	105 c	553 c
14 June	23 Sept	14.7	56.6	13.1	553	16.9	45.4	14.9 b	52.1 c
22 July	6 Nov	14.8	68.9	18.2	67.0	18.9	61.9	173 a	65.9 a
	Mean[3]	13.8 b	62.3 x	13.9 b	60d x	173 a	51s y		

[1] Tropical corn.
[2] Temperate corn.
[3] Means in row or columns followed by the same letter are not significantly different at the 5% level of significance.

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