

Performance of Twelve Corn Hybrids and Selections in Three Consecutive Crops on the Same Site in the Same Year¹

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ABSTRACT

Twelve corn (*Zea mays* L.) hybrids and selections were planted three times on the same site in the same year at Isabela, Puerto Rico, according to the following schedule: Nov. 5, 1975 (crop 1); April 21, 1976 (crop 2); and Aug. 13, 1976 (crop 3). Average time to milksilk for the 12 entries was similar in crops 1 and 3 (62.1 and 61.6 days, respectively) but was shorter in crop 2 (59.1 days). Average height to the base of the lowest ear for the 12 entries was 87.1, 106.3, and 99.0 cm for crops 1, 2, and 3, respectively. Average test weight was highest (81.2 kg/hl) in crop 1, decreasing to 72.4 and 55.0 kg/hl in crops 2 and 3, respectively. Average severity of leaf blight, caused by *Bipolaris maydis* (Nisikado) Shoemaker, was similar in crops 1 and 2. The best grain yield in all three crops was hybrid Pioneer 304 C, with yields of 5,975, 4,103, and 3,729 kg/ha in crops 1, 2, and 3, respectively. The average yield for the 12 entries was 4,598, 3,180, and 2,523 kg/ha in crops 1, 2, and 3, respectively.

Nematodes in plots were counted and identified after crop 3 was harvested. The nematode most commonly found in the rhizosphere was *Pratylenchus zeae*. Plots with Pioneer 304 C, the top yielder, had the second lowest nematode count, 480 per 250 cm³ of soil. Plots with PR-3 and the F₁ hybrid PRMo₂ × PR-3 had the highest nematode counts, 1040 and 1232 per 250 cm³ of soil, respectively. Although soil disinfestation might have resulted in higher yields, this study showed that three corn crops grown on the same site during the same year can produce grain yields of more than 13,000 kg/ha (205 bu/acre).

INTRODUCTION

Corn is an important component of animal feed in Puerto Rico, but most is imported. Imports of corn and corn products during 1975–76 were valued at more than \$33 million. If level land suitable for mechanization and irrigation were available, the production of corn in Puerto Rico would have a considerable economic potential.

Recent research indicates that with adequate management, excellent corn yields can be obtained in Puerto Rico. Talleyrand et al. (10) obtained a yield of 8.4 tons/ha (134 bu/acre) with Funk's G-795W on an Humatas soil fertilized with N at 200 kg/ha. They attributed a lower yield (only 5.4 tons/ha) with Funk's G-795W on a Bayamón clay to late planting and a moderate attack of leaf blight. Fox et al. (7) reported a maximum yield of about 6.3 tons/ha from hybrid Pioneer 306 during 1970–72.

Webster and Walker (11) tested 18 corn cultivars at Mayagüez, Puerto Rico, for resistance to earworm, *Heliothis zea* (Boddie); sugarcane borer, *Diatraea saccharalis* (Fabricius); corn silk maggot, *Euxesta stigmatias*

¹ Manuscript submitted to Editorial Board May 9, 1978.

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Loew; corn rust, caused by *Puccinia polysora* (Underw.); and corn leaf blight, caused by *Bipolaris maydis* (Nisikado) Shoemaker. They found significant differences in severity of pest infestation between sprayed and unsprayed plots, and they stressed the importance of controlling the armyworm, *Spodoptera ornithogalli* (Guenée) in seedlings for successful corn production in Puerto Rico.

This study was conducted to evaluate the yield potential and to measure selected characters of 12 corn hybrids and selections in three consecutive crops at the same site during the same year.

MATERIALS AND METHODS

The corn hybrids and selections tested were obtained in 1975 from commercial suppliers and from seedstock of the Mayaguez Institute of Tropical Agriculture (MITA), Mayaguez, Puerto Rico. Kernel types varied from small to large and from white and yellow to dent and flint. The 12 entries included six commercial hybrids—Pioneer 105A, 304B, 304C, and 306B, and DeKalb B-660 and B-666; four samples of populations with broad genetic bases, potential sources of resistance to rust and blight—PR-Mp4 (4), PRMo2 (5), PR-3 (release pending), and PR-Mo2 × PR-3; and two well-adapted local varieties—Mayorbela and Diente de Caballo.

All 12 entries were planted on the same site three times in the same year, according to the following schedule: November 5, 1975, first planting; April 21, 1976, second planting; and August 13, 1976, third planting. The three plantings were at the Isabela experiment farm of the MITA, in northwestern Puerto Rico. The farm is 128 m above sea level and the temperature ranges from 18° to 31° C. The soil is a Coto clay (an Oxisol), pH 5.0 to 5.5. Before each planting, a complete fertilizer (15-5-10) was applied to all plots at about 560 kg/ha. For control of soil nematodes and insects, carbofuran³ (2,3-dihydro-2,2-dimethyl-7-benzofuranyl methylcarbamate) was band applied with the fertilizer at about 6 kg/ha to all rows. Immediately after planting, propazine [2-chloro-4,6-bis(isopropylamino)-s-triazine] was applied to all plots at 2 to 3 kg of active ingredient per hectare. Methomyl (*S*-methyl *N*-[(methylcarbamoyl)oxy]thioacetimide) was sprayed at 0.27 kg of active ingredient per hectare every 10 to 14 days to control insects.

A randomized block design with five replications was used for each experiment. Each plot included four rows spaced 101 cm apart and about 6 m long. Plants were spaced about 25 cm apart in the rows. A 4-m² area

³ Trade names are used in this publication solely for the purpose of providing specific information. Mention of a trade name does not constitute a guarantee or warranty of equipment or materials by the Agricultural Experiment Station of the University of Puerto Rico or an endorsement over other equipment or materials not mentioned.

from the two inner rows of each plot was used for grain-yield sampling. The samplings were made on March 8, 1976; July 27, 1976; and November 29, 1976, for the first, second and third crops, respectively. Ears were harvested and dried to a uniform moisture content before shelling. Yields of shelled grain were adjusted to 15.5% moisture. In addition to yield, data were collected on time to midsilk, height to the base of the lowest ear (measured on four plants/plot), and test weight. In the first two plantings, leaf blight severity by row was evaluated on a scale of 0 (no lesions) to 4 (75 to 100% of leaf area covered with lesions). Data were subjected to analysis of variance, and significant differences were identified with Duncan's multiple range test.

TABLE 1.—Yield and other characters of 12 corn entries planted on November 5, 1975, at Isabela, P. R.¹

Entry	Time to midsilk	Height to lowest ear	Test weight	Leaf blight rating ²	Yield
	<i>Days</i>	<i>Cm</i>	<i>Kg/ht</i>		<i>Kg/ha</i>
Pioneer 304C	60.4 e	78.0 e	82.0 bc	1.4 h	5975 a
Pioneer 306B	64.8 cd	93.0 bc	80.6 cd	1.6 fgh	5734 a
Pioneer 105A	64.6 cd	80.6 cde	82.0 bc	1.7 efgh	5593 a
DeKalb B-666	67.4 ab	100.7 ab	81.8 bc	2.0 cdef	5331 a
Diente de Caballo	62.8 d	92.3 bcd	79.0 ef	1.8 efgh	5223 a
PR-Mp4	63.6 d	84.2 cde	80.6 cd	1.5 gh	4870 ab
DeKalb B-660	68.6 a	109.4 a	80.0 de	2.4 bc	4099 bc
Mayorbela	56.2 f	77.5 e	84.8 a	2.1 cde	3886 bc
PR-Mo2 × PR-3	57.4 f	77.4 e	80.2 de	2.8 ab	3872 bc
Pioneer 304B	66.2 bc	83.4 cde	82.2 b	1.9 defg	3813 bc
PR-Mo2	56.0 f	79.3 de	82.4 b	2.3 cd	3784 bc
PR-3	57.0 f	89.4 bcde	78.2 f	2.9 a	2992 c
\bar{X}	62.1	87.1	81.2	2.0	4598
C.V., %	2.8	10.5	1.4	16.2	17.1

¹ Data are means for five replicate plots. In each column, means followed by one or more letters in common do not differ significantly ($P = 0.05$) according to Duncan's multiple range test.

² Rating scale: 0 (no lesions) to 4 (75 to 100% of leaf area covered with lesions).

Because plants of the third planting seemed to be less vigorous than those of the previous two plantings and showed symptoms of nematode infestation, a study was begun to obtain information about the nematodes involved. A 250-cm³ soil sample was collected from the two center rows of each plot after harvest. The nematodes were extracted from the soil samples by a combination of the sieving-decanting and Baermann funnel methods (3). Nematodes were identified, and analyses of covariance and correlation were performed on total nematode counts and grain yields (third crop).

RESULTS AND DISCUSSION

FIRST CROP

Table 1 shows means for the various characters in the 12 entries grown under the short days of the first planting.

Time to midsilk ranged from 56.0 to 68.6 days. DeKalb B-660 and DeKalb B-666 reached midsilk last (in 67.4 and 68.6 days, respectively). These times were significantly different from those of most of the other entries.

Height to the base of the lowest ear ranged from 77.4 to 109.4 cm. The greatest ear height in DeKalb B-660 was significantly different from that in other entries except in DeKalb B-666.

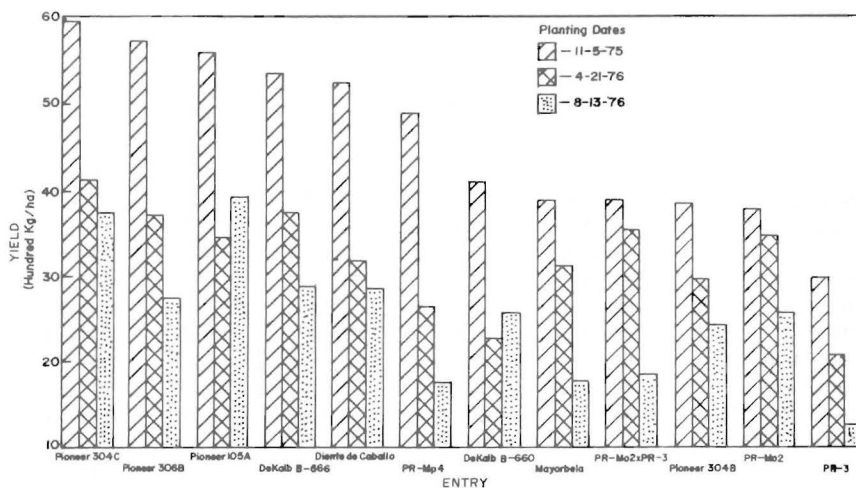


FIG. 1.—Comparison of yield in 12 corn hybrids and selections in three plantings on the same site in the same year at Isabela, P. R.

Test weight ranged from 78.2 to 84.8 kg/ha. The highest test weight, which was that in the local variety Mayorbela, was significantly different from those of the other entries. Most of the other entries had test weights of 80 to 82 kg/hl, but Diente de Caballo and PR-3 had test weights of 79.0 and 78.2 kg/hl, respectively.

Leaf blight ratings ranged from 1.4 to 2.9. The best six entries for leaf blight resistance were Pioneer 304C, PR-Mp4, Pioneer 306B, Pioneer 105A, Diente de Caballo, and Pioneer 304B, with ratings from 1.4 to 1.9, respectively.

Yields ranged from 2992 to 5975 kg/ha (table 1 and fig. 1). The most productive entries, in descending order, were the Pioneer hybrids 304C,

306B, and 105A; DeKalb B-666; and Diente de Caballo. The yields of these five entries ranged from 5975 to 5223 kg/ha and were significantly higher than those of the other entries, except PR-Mp4. The lowest producer was PR-3. Data on yields of the top five entries agree with those reported by Baynes (1), who conducted variety trials on four Caribbean Islands during 3 years, and by Chesney (2) in Guyana. In Puerto Rico, Fox et al. (7) reported yields of more than 6,000 kg/ha from Pioneer 306B with the application of nitrogen fertilizer at 134 kg/ha.

SECOND CROP

Table 2 shows means for the various characters in the 12 entries grown under the long days of the second planting.

TABLE 2.—Yield and other characters of 12 corn entries planted on April 21, 1975, at Isabela, P. R.¹

Entry	Time to midsilk	Height to lowest ear	Test weight	Leaf blight rating ²	Yield
	Days	Cm	Kg/ht		Kg/ha
Pioneer 304C	57.4 de	97.5 d	72.6 d	1.4 b	4103 a
Pioneer 306B	60.4 bcd	103.9 cd	70.4 e	2.1 ab	3703 ab
Pioneer 105A	58.0 cde	102.3 cd	74.4 cd	2.1 ab	3428 abc
DeKalb B-666	62.2 b	120.8 ab	73.2 cd	1.8 ab	3736 ab
Diente de Caballo	60.0 bcd	114.3 abc	70.2 e	1.7 ab	3180 abcd
PR-Mp4	60.0 bcd	93.9 d	70.0 e	1.9 ab	2616 cde
DeKalb B-660	65.6 a	122.8 a	63.4 f	1.8 ab	2284 de
Mayorbela	53.4 e	106.9 bcd	79.4 a	2.4 a	3109 bcd
PR-Mo2 × PR-3	54.8 e	105.8 bcd	75.2 bc	2.2 ab	3518 abc
Pioneer 304B	61.3 bc	99.3 cd	72.3 de	2.1 ab	2961 bcde
PR-Mo2	55.4 e	100.7 cd	76.6 b	1.8 ab	3455 abc
PR-3	60.6 bcd	106.9 bcd	70.6 de	2.4 a	2068 e
\bar{X}	59.1	106.3	72.4	2.0	3180
C.V., %	4.1	10.4	2.1	25.2	20.6

¹ Data are means for five replicate plots. In each column, means followed by one or more letters in common do not differ significantly ($P = 0.05$) according to Duncan's multiple range test.

² Rating scale: 0 (no lesions) to 4 (75 to 100% of leaf area covered with lesions).

Time to midsilk ranged from 53.4 to 65.6 days. DeKalb B-660 and DeKalb B-666 were the last to reach midsilk, in 65.6 and 62.2 days, respectively. The time to midsilk for DeKalb B-660 was significantly different from those of other entries.

Height to the base of the lowest ear ranged from 93.9 to 122.8 cm. The greatest ear height, in DeKalb B-660, was significantly different from those of the other entries, DeKalb B-666, Diente de Caballo, Mayorbela.

PR-3 had the next highest ear heights. The lowest ear heights were on Pioneer 304B, Pioneer 304C, and PR-Mp4.

Test weight ranged from 63.4 to 79.4 kg/hl. The highest test weight, in Mayorbela, was significantly different from those of the remaining entries. Entries PR-Mo2 and PR-Mo2 × PR-3 ranked second and third in test weight, with 76.6 and 75.2 kg/hl, respectively.

Leaf blight ratings ranged from 1.4 to 2.4. The entries with leaf blight ratings of less than 2.0 were PR-Mp4, DeKalb B-666, DeKalb B-660, PR-Mo2 and Diente de Caballo. Pioneer 304C had the lowest rating (1.4) and, therefore, the best resistance to leaf blight.

Yields ranged from 2068 to 4103 kg/ha (table 2, and fig. 1). The best producers were Pioneer 304C, DeKalb B-666, Pioneer 306B, and PR-Mo2

TABLE 3.—Yield and other characters of 12 corn entries planted on August 13, 1976, at Isabela, P. R.¹

Entry	Time to midsilk	Height to lowest ear	Test weight	Yield
	Days	Cm	Kg/hl	Kg/ha
Pioneer 304C	59.2 c	85.4 de	49.7 a	3729 a
Pioneer 306B	61.4 abc	104.1 abcd	58.3 a	2735 ab
Pioneer 105A	60.8 bc	90.5 cde	55.5 a	3911 a
DeKalb B-666	64.3 ab	118.4 a	56.7 a	2879 ab
Diente de Caballo	61.0 bc	104.8 abc	64.8 a	2848 ab
PR-Mp4	62.0 bc	98.5 bcde	53.2 a	1752 b
DeKalb B-660	66.2 a	115.0 ab	53.3 a	2584 ab
Mayorbela	60.5 bc	83.0 e	57.7 a	1753 b
PR-Mo2 × PR-3	60.1 bc	104.3 abcd	52.1 a	1826 b
Pioneer 304B	62.3 abc	97.7 bcde	56.7 a	2402 ab
PR-Mo2	60.0 bc	93.6 cde	53.3 a	2576 ab
PR-3	61.5 bc	93.3 cde	48.4 b	1285 b
\bar{X}	61.6	99.0	55.0	2523
C.V., %	4.5	11.1	14.2	36.7

¹ Data are means for five replicate plots. In each column, means followed by one or more letters in common do not differ significantly ($P = 0.05$) according to Duncan's multiple range test.

× PR-3, with yields of more than 3500 kg/ha. The four lowest producers were Pioneer 304B, PR-Mp4, DeKalb B-660, and PR-3, with yields of less than 3000 kg/ha.

THIRD CROP

Table 3 shows means for the various characters in the 12 entries in third planting.

Time to midsilk ranged from 59.2 to 66.2 days. DeKalb B-660 was the

last to reach mid silk, a time that was significantly different from that for most of the other entries.

Heights to the base of the lowest ear ranged from 83.0 to 118.4 cm. Ear heights for DeKalb B-666, DeKalb B-660, Diente de Caballo, PR-Mo2 × PR-3, and Pioneer 306B were greater than 104 cm. The lowest ear heights were 85.4 and 83.0 in Pioneer 304C and Mayorbela, respectively.

Test weight ranged from 48.4 to 64.8 kg/hl. No significant differences in test weight were observed among entries, except that the lowest test weight, in PR-3, was significantly different from all others.

TABLE 4.—Nematodes in soil after harvest of the third crop of 12 corn entries at Isabela, P. R.

Entry	Nematode	
	<i>Pratylenchus zae</i>	Others ¹
	Mean no./plot ²	
Pioneer 304C	480	96
Pioneer 306B	592	16
Pioneer 105A	832	112
DeKalb B-666	740	128
Diente de Caballo	816	32
PR-Mp4	528	80
DeKalb B-660	480	128
Mayorbela	800	80
PR-Mo2 × PR-3	1232	48
Pioneer 304B	384	80
PR-Mo2	736	96
PR-3	1040	80

¹ *Helicotylenchus* spp., *Tylenchus* spp., *Aphelenchus* spp., and *Xiphinema* spp.

² Based on a 250-cm³ soil sample from five replicate plots for each entry.

Yields ranged from 1285 to 3911 kg/ha. Pioneer hybrids 105A and 304C were the top producers, with yields of 3911 and 3729 kg/ha, respectively. The four lowest producers were (in descending order), PR-Mo2 × PR-3, Mayorbela, PR-Mp4, and PR-3, with yields of less than 2000 kg/ha.

Table 4 shows the mean number of nematodes per plot after harvest of the third crop. The most abundant nematodes found in the soil rhizosphere were *Pratylenchus zae* and species of *Helicotylenchus*, *Tylenchus*, *Aphelenchus*, and *Xiphinema*. Analyses of covariance and correlation of yield and numbers of nematodes identified no significant relationships. However, nematode counts after harvest of the third crop may not have been sufficient to reveal such a relationship; data on the prevalence of nematodes before each of the three plantings might have been more informative.

No reports are available in Puerto Rico on the effect of soil nematodes on corn, but there are many reports of studies conducted elsewhere. Edmunds et al. (6) cited various studies indicating that *Pratylenchus* spp. seem to be the most prevalent nematodes associated with corn. Young (12) reported that the most abundant nematodes that severely damaged roots of field corn in Texas were *Trichodurus christiei*, *P. brachyurus*, *P. zaeae*, *Xiphinema americanum*, and species of *Criconemoides* and *Belonolaimus*. Johnson (9) concluded that plant parasitic nematodes, especially *Criconemoides ornatus*, species of *Helicotylenchus*, and *T. christiei*, were mainly responsible for reduced yields of sweet corn in Georgia.

Hernández-Catalán (8) evaluated 10 grain sorghum (*Sorghum bicolor* (L.) Moench) lines on the same site where the three corn crops were established in the present study. He found that the average grain yield for the 10 lines was about 3095 kg/ha when the soil was treated with fensulfothion (*O*, *O*-dimethyl *O*-[*p*-(methylsulfinyl)phenyl]phosphorothioate) at 33.7 kg of active ingredient per hectare, but was only 2650 kg/ha when the soil was not treated. The soil contained an average of 481 *Pratylenchus* spp. per 250 cm³ before treatment but only 18 per 250 cm³ at harvest after treatment (8).

COMPARISON OF THE THREE CROPS

Mean periods to mid silk were similar in crops 1 and 3, 62.1 and 61.6 days, respectively, but only 59.1 days in crop 2 (tables 1-3). The coefficients of variation (C.V.'s) for the time to mid silk were low, from 2.8 to 4.5%, in all three crops.

As judged from mean height to the base of the lowest ear, plants in crop 1 (April planting) were taller than those in crops 1 (November planting) and 3 (August planting). Mean ear heights were 106.3, 87.1, and 99.0 cm, respectively (tables 1-3). The C.V.'s for ear height in the three crops were very similar, about 11%.

The mean test weight decreased from 81.2 to 72.4 to 55.0 kg/hl in crops, 1, 2, and 3, respectively (tables 1-3). The CV for test weight was only 1.4% in crop 1 and 2.1% in crop 2, but increased to 14.2% in crop 3.

The mean leaf blight rating was 2.0 in both crop 1 and crop 2 (tables 1 and 2). The CV was 16.2% in crop 1 and 25.2% in crop 2.

The mean grain yield for the 12 entries decreased to 4598, to 3180, to 2523 kg/ha in crops 1, 2, and 3, respectively (tables 1-3). The respective C.V.'s for the crops were 17.1, 20.6, and 36.7%. The highest yield had been expected in crop 2, when the entries were grown under long days (April planting), rather than in crop 1.

The analysis of variance for the three harvests combined showed that three Pioneer hybrids (304C, 105A, and 306B) and DeKalb B-666 were

the top grain producers, with yields ranging from 12,000 to 14,000 kg/ha/year. Differences in yield among these four entries were not statistically significant.

Diente de Caballo was the fifth best producer, and it was followed by PR-Mo2, PR-Mo2 × PR-3, and Mayorbela; the grain yields in these four entries ranged from 9,418 to 11,307 kg/ha/year. Entries PR-Mp4, Pioneer 304B, and DeKalb B-660 were next, with yields ranging from 9,024 to 9,294 kg/ha/year. The yield of 6,468 kg/ha/year in PR-3 was significantly lower than those in the other entries.

Besides showing the potentials of hybrids, population samples, and local corn varieties, this study demonstrated that three corn crops on the same site in the same year can produce grain yields of more than 13,000 kg/ha/year. Diente de Caballo produced more than 11,000 kg/ha/year, a yield that compares favorably with that of a well-adapted hybrid such as Pioneer 304C.

RESUMEN

Doce selecciones de maíz (híbridos y selecciones) se sembraron en el mismo lugar durante las siguientes fechas: 5 de noviembre de 1975 (cosecha 1); 21 de abril de 1976 (cosecha 2) y 13 de agosto de 1976 (cosecha 3). Los experimentos se llevaron a cabo en la finca experimental de Isabela del Instituto Mayagüezano de Agricultura Tropical del Departamento de Agricultura de los Estados Unidos. Las 12 selecciones de maíz fueron las siguientes: híbridos Pioneer 304C, 306B, 105A; DeKalb B-660 y B-666; selecciones de PR-Mp4, PR-Mo2, PR-3, PR-Mo2 × PR-3, y las variedades nativas Diente de Caballo y Mayorbela. Se utilizó un diseño de bloques al azar con cinco repeticiones.

Los resultados indican que: 1) los días transcurridos desde la siembra a la mitad de la floración fueron similares para las cosechas 1 y 3, pero las plantas fueron más precoces en la cosecha 2; 2) el peso prueba (kg/hl) medio descendió de la cosecha 1 a la 3; 3) la infección causada por *Bipolaris maydis* fue, en promedio, similar en las cosechas 1 y 2; 4) el mejor productor en las tres cosechas fue Pioneer 305C con 5975, 4103 y 3729 kg/ha, respectivamente. La producción media de las 12 selecciones fue de 4598, 3180 y 2523 kg/ha para las cosechas 1, 2 y 3, respectivamente; 5) el nematodo principal, al finalizar la tercera cosecha, fue *Pratylenchus zaei*; 6) el híbrido Pioneer 304C, el mejor productor en las tres cosechas, arrojó el segundo número menor de nematodos por 250 cm³ de suelo; 7) la selección PR-3 y el híbrido PR-Mo2 × PR-3 arrojaron la infestación más alta de nematodos con 1040 y 1232 por cm³ de suelo; 8) existe una buena posibilidad de que la pobre producción que se observó en las cosechas 2 y 3 pueda atribuirse a la infección de nematodos antes mencionada.

Este estudio demostró, además, que es posible lograr tres cosechas de maíz en el mismo lugar con producciones sobre 13,000 kg/ha. La variedad nativa Diente de Caballo fue una de las cinco mejores productoras al totalizar las tres cosechas, con 11,307 kg/ha.

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