RELATION OF FERTILIZER TREATMENTS AND CROPPING SEQUENCE TO POPULATIONS OF *PRATYLENCHUS SCRIBNERI* [RELACION ENTRE TRATAMIENTOS DE FERTILIZANTES, LA SECUENCIA DE CULTIVOS Y LAS POBLACIONES DE *PRATYLENCHUS SCRIBNERI*].

R. Rodríguez-Kábana and R. J. Collins, Department of Botany, Plant Pathology and Microbiology, Auburn University, Alabama 36849, U.S.A.

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ABSTRACT

Soil and root populations of *Pratylenchus scribneri* Steiner in a continuing three-year rotation scheme responded to crop development. The rotation scheme consisted of summer crops of corn, soybean, and cotton, followed, respectively, by wheat, fallow, and mixed common vetch and crimson clover. The rotation was superimposed on plots that received combinations of N, P, K, minor elements, and lime. Populations of the nematode were unrelated to rainfall or changes in soil temperature. Among the summer crops, highest numbers of the parasite were detected in plots with corn, followed by soybeans and cotton in descending order. The inclusion of wheat or winter legume in the rotation sequence resulted in low numbers of *P. scribneri*. Results indicated that highest populations of the nematode were not necessarily found in plots receiving complete nutrient regimes. Seasonal changes in numbers of *P. scribneri* in plots with different fertilization regimes were significantly correlated.
Key Words: Lesion nematodes, population dynamics, pest management, Glycine max, Gossypium hirsutum, Vicia sativa, Trifolium incarnatum, Zea mays.

INTRODUCTION

The effects of fertilization and plant nutrition on populations of plant parasitic nematodes have been reported repeatedly (3, 10, 12, 13, 14). The majority of these reports have been on results obtained in the laboratories or in short-term field experiments. Generally, there is agreement in the literature that addition of high levels of nitrogenous amendments containing or releasing NH_3 result in reductions of the number of plant parasitic nematodes in the soil (4, 16, 17). There is however, no agreement as to the effect of other major plant nutrients on populations of nematodes. The long-term effects of fertilization regimes on nematode populations have received little attention. Since these effects could be significant for the management of nematode populations in the field we studied changes in populations of plant parasitic nematodes in a long-term fertility experiment. Results obtained from these studies for *Helicotylenchus dihystera* (Cobb) Sher and *Trichodorus christiei* Allen have been published recently (15). The present paper constitutes a part of the study and presents results and a discussion of the effect of fertility on *Praylenchus scribneri* Steiner.

MATERIALS AND METHODS

Plots were located on the Agronomy farm at Auburn University, Alabama, U.S.A. The plots are part of the Cullar's rotation established in 1914 which includes a variety of fertilization schemes with corn, cotton, and soybeans as the major crops. Crop sequences, fertilization treatments, experimental designs, and soil sampling were as described before (15).

Numbers of *P. scribneri* in the roots were determined only after August 1970 in conjunction with the determinations of soil populations of the nematode. For each soil sample a 100 g aliquot was taken for extraction of roots. Each aliquot was placed in a 2-liter stainless steel beaker and a strong jet of tap water was applied to make a 1600 ml suspension. The suspension was immediately passed through a 1 mm mesh wire basket. The procedure was repeated 3 times and resulted in the separation of the soil and roots. The roots retained in the wire basket were placed in a covered petri dish with enough water to keep the roots moist for 8 days when the nematodes in the dish were counted.

Meteorological data were collected in a weather station established in the field. Statistical analysis of the data were as for the previous study (15).

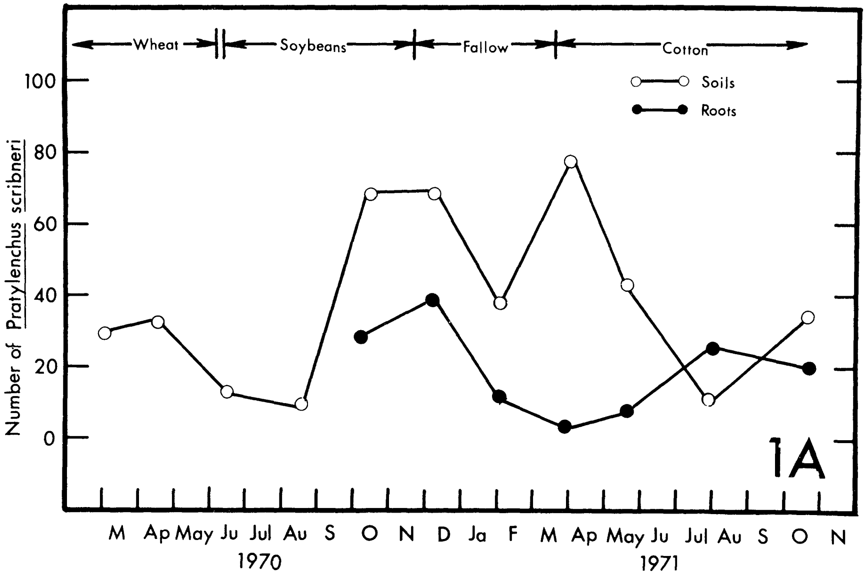
RESULTS

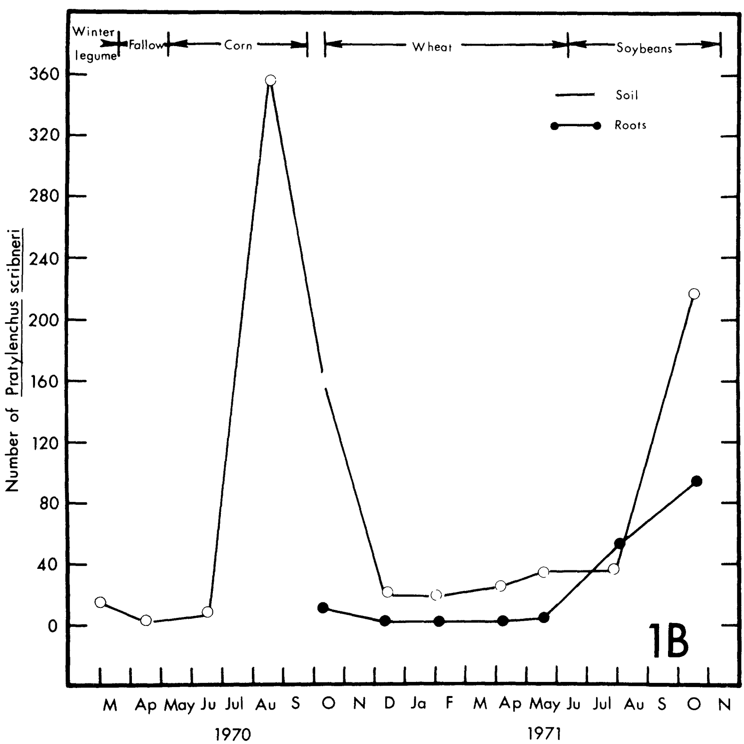
Seasonal variations and crop effects. Soil Populations. Numbers of *P. scribneri* in soil were lowest during December through June (Fig. 1) except after the fallow period (Fig. 1A) and immediately after planting cotton (March 1971) when population peaks were observed. Among the main crops, highest numbers of the parasite in soil were detected in plots with corn (Fig. 1B), followed by soybeans and cotton (Fig. 1C) in descending order. For corn and soybeans population maxima occurred either towards the end of the season or post-harvest. Thus, highest numbers for soybeans occurred in December and for corn in July-August (1970) or October (1971). Numbers in plots with cotton did not show definite maxima in either 1970 or 1971. The inclusion of wheat or winter legume in the rotation sequence resulted in low populations of *P. scribneri*. Fallowing caused an initial decline in numbers of the parasite followed by an increase immediately after preparation of the land for planting cotton (Fig. 1A).

Data for soil temperature and rainfall were presented in the previous paper (15). Changes in number of *P. scribneri* in soil were not related to changes in soil temperature or the amount of rainfall.

Root populations. Changes in root populations of *P. scribneri* were significantly (P = 0.01) correlated with corresponding changes in soil populations (r = +0.49). Highest numbers of the parasite in the roots were detected at harvest (corn) or post harvest (soybeans) (Fig. 1). A slight increase in numbers of *P. scribneri* in cotton roots was observed (Fig. 1A) with development of this crop. Among the summer crops highest numbers of the nematode were observed in corn roots followed in decreasing order by soybeans and cotton. The winter crops sustained lowest numbers of *P. scribneri* in the roots and fallowing resulted in a decline in numbers of the nematodes in the roots still present from the previous soybean crop. Changes in nematode numbers in the roots were unrelated to changes in soil temperature or rainfall.

Effect of fertilization regimes. Changes in numbers of *P. scribneri* in the soil in plots with different fertlization regimes were significanly correlated (Table 1) and conformed to the pattern described under seasonal variations. However, although variation in numbers of the nematode for all treatments agreed in time, the magnitude of the changes in numbers at any one sampling time was not the same. Thus when data from plots with a complete fertilization regime (LNPK+, M. E.) were correlated to those from plots with less complete fertilization schemes, the slope values (Table 2) were significantly lower than 1.00 for plots lacking P, for plots that received LNPK but no winter legume, and even for plots with no minor elements in an otherwise complete fertilization formula. This indicates that numbers of *P. scribneri* in these fertilizer deficient plots were higher throughout the season than in plots receiving complete fertilization. Other correlations with data from plots receiving complete fertilization


Wheat
Soybeans
Fallow
Cotton
Soils
Roots
Number of Pratylenchus scribneri
100
80
60
40
20
0
1A
M Ap May Ju Jul Au S O N D Ja F M Ap May Ju Jul Au S O N
1970
1971


Winter legume
Fallow
Corn
Wheat
Soybeans
Soil
Roots
Number of Pratylenchus scribneri
360
320
280
240
200
160
120
80
40
0
1B
M Ap May Ju Jul Au S O N D Ja F M Ap May Ju Jul Au S O N
1970
1971

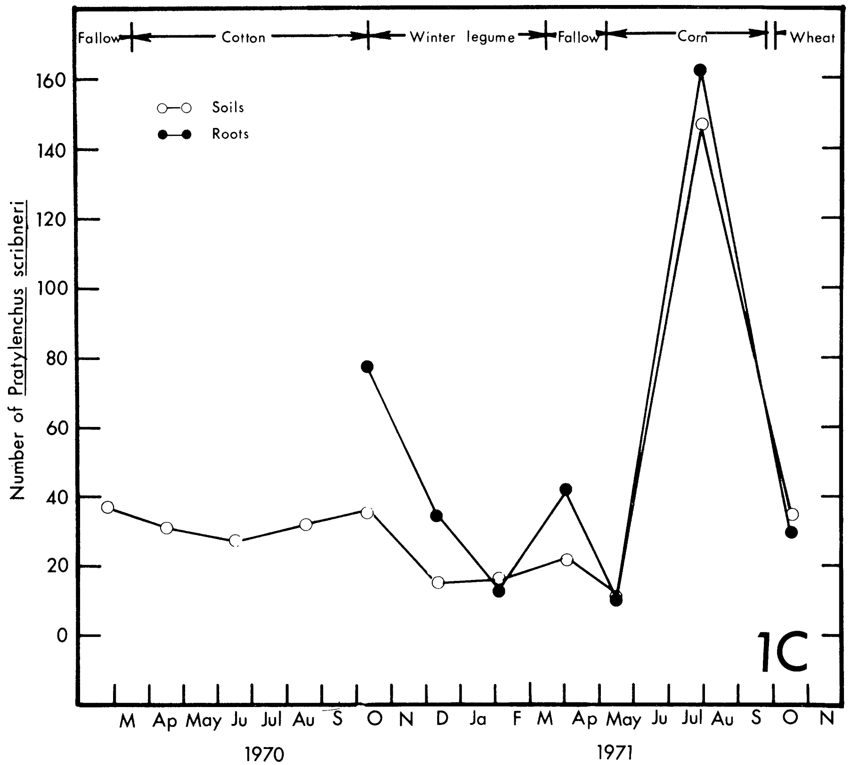


Fig. 1. Seasonal changes in number of *Pratylenchus scribneri* during a two-year period in plots with soybeans and cotton (A), corn and soybeans (B), and cotton and corn (C) as the major crops.

schemes gave slope values that differed little from 1.00 or that were significantly above 1.00, indicating that numbers of *P. scribneri* throughout the season were either similar or lower than those observed for the plots with complete fertilization. Similar comparisons of data from plots receiving no minor elements but with an otherwise complete fertilization formula (LNPK+) gave slope values significantly below 1.00 for plots receiving no lime, no K, no P, or no winter legume but with an inorganic source N (LNPK-). The absence of a winter legume in an otherwise complete fertilization scheme resulted in slope values of all correlations being significantly above 1.00 except for that corresponding to P-deficient plots. Plots receiving no lime, K, or P, or N had significantly higher populations of *P. scribneri* (slope values < 1) than plots that received LPK with winter legume as a source of N. P-deficient plots evidenced higher numbers of *P. scribneri* (slope values > 1) than those that received LPK and no winter legume, NPK+ and no lime, or those with no K.

The data for *P. scribneri* in the roots was not sufficiently extensive to enable comparisons among fertilization regimes. However, since soil and root populations were closely correlated the relations described for soil populations can be expected to be true also for root populations.

Table 1. Linear correlation coefficients (r) established between populations of *Pratylenchus scribneri* in plots with different fertilization regimes in a study of a long term rotation with corn, soybeans, and cotton as the major crops

Fertilization Regime	Fertilization Regime								
	LPK-	NPK+	LNP+	LNK+	LPK+	LNPK-	LNPK+ (Super)	LNPK+ (Triple)	LNPK+ & Minor Elements
LPK- [x]	1.00	0.62	0.67	0.85	0.61	0.83	0.75	0.41	0.66
NPK+		1.00	0.53	0.60	0.36	0.59	0.75	0.48	0.68
LNP+			1.00	0.63	0.39	0.62	0.60	0.56	0.63
LNK+				1.00	0.73	0.94	0.79	0.51	0.71
LPK+					1.00	0.85	0.44	0.52	0.58
LNPK-						1.00	0.68	0.58	0.74
LNPK+(Super)							1.00	0.61	0.87
LNPK+(Triple)								1.00	0.89
LNPK+ & Minor elements									1.00

[x] L = Lime; + or - denote the presence or absence of winter legume in the fertilization regime, respectively,

[y] The number of pairs used to calculate each coefficient was 33; r values greater than 0.35 are significant at P = 0.05.

Table 2. Slope values of linear equations relating changes in populations of *Pratylenchus scribneri* from plots with varying fertilization regimes in a study of a long term rotation with corn, soybeans, and cotton as the major crops

Fertilization Regime (X) [y]	Fertilization Regime (Y) [y]							
	LPK-	NPK+	LNP+	LNK+	LPK+	LNPK-	LNPK+ (Super)	LNPK+ & Minor Elements
LPK- [x]	1.00	1.42	1.46	3.22	0.72	2.38	1.37	1.20
NPK+		1.00	0.60	1.89	0.48	1.34	0.89	1.32
LNP+			1.00	1.75	0.47	1.26	0.63	1.27
LNK+				1.00	0.31	0.68	0.48	0.40
LPK+					1.00	1.99	2.01	1.17
LNPK-						1.00	0.76	0.54
LNPK+							1.00	0.88
LNPK+ & Minor elements								1.00

[x] L = Lime; + or - denote the presence or absence of winter legume in the fertilization scheme, respectively.
[y] Y refers to independent variables and X to dependent variable.
[z] Number of pair used to calculate each slope value was 33.

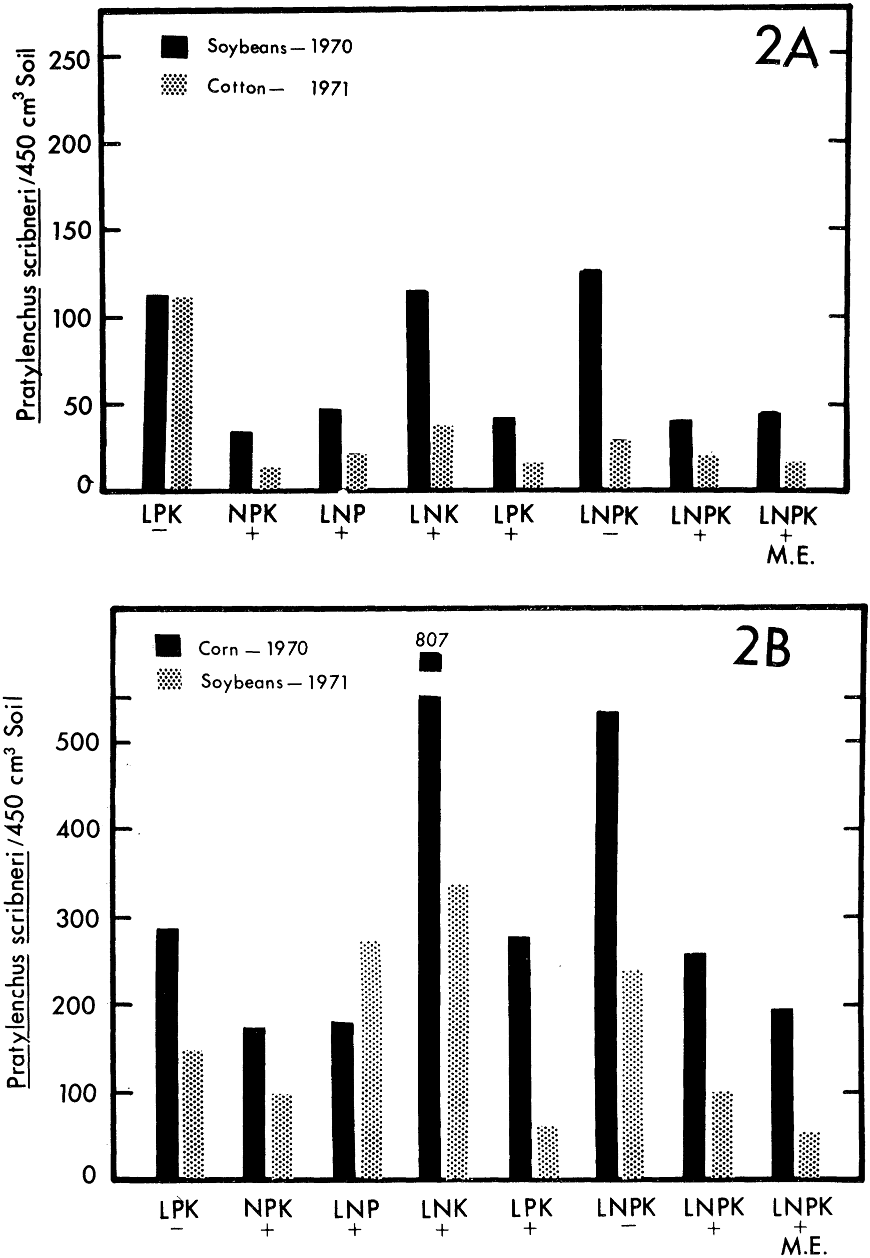
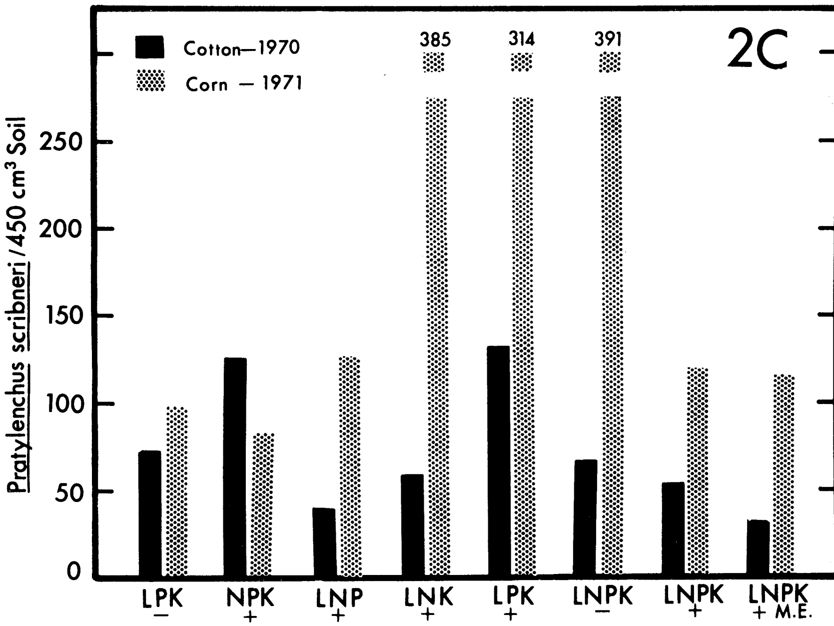


Fig. 2. Population peaks for *Pratylenchus scribneri* in plots with various fertilization regimes (L = lime; + = winter legume; - = no winter legume; M.E. = minor elements).



The effect of fertilization regimes on peak populations of *P. scribneri* was particularly noticeable with corn (Fig. 2). Peak populations (maxima) were observed in plots with corn that received no P or that received a complete fertilization formula with no winter legume. Very high numbers of *P. scribneri* were also detected in 1971 in plots that received N only from winter legume in the fertilization schedule. Peak populations with soybeans were also observed for the 2 years of the study in P-deficient plots and in those with a complete fertilizer formula but with no winter legume in the crop sequence. Lowest final populations of the nematode in soybeans were observed in plots that received all essential nutrients with minor elements and that included winter legumes in the crop sequence. No consistent trend in peak populations was observed for cotton.

Relations between populations of P. scribneri and those of Helicotylenchus dihystera and Trichodorus christiei. Correlation coefficients calculated from data obtained in the study for *H. dihystera* and *P. christiei* (15) and data for *P. scribneri* were not significant.

DISCUSSION

Seasonal variations and responses to crops by *P. scribneri* are similar to those reported for *Pratylenchus* spp. Thus Minton (1) reported that in Alabama numbers of *P. brachyurus* in cotton are highest in late fall or early winter with minimal populations in late spring and that population changes were not related to rainfall or air temperature. Brodie (2) found that corn with or without rye or vetch clover favored an increase in *P. zeae*. Ferris and Bernard (5, 6) and later Johnson et. al (7, 8, 9) reported that *Pratylenchus* sp. increased with corn and soybeans. Barker (1) reported that *P. zeae* peaked in October and later. There is then a consensus that populations of *Pratylenchus* spp. are highest towards the end of the growing season for corn or other host plants.

The influence of fertilization regimes on *P. scribneri* differs markedly from that reported earlier for *H. dihystera* and *T. christiei* (15). Populations of *H. dihystera* were eliminated or drastically reduced in plots deficient in nutritional elements, high numbers occurring only in plots with adequate fertilization. Numbers of *T. christiei* were also reduced in nutrient deficient plots except in those that lacked lime. In contrast, our results indicate that highest populations of *P. scribneri* are not necessarily found in plots receiving complete nutrient regimes, e.g., lack of P resulted in high numbers of *P. scribneri*. Also, an absence of a winter legume in plots that received complete fertilization resulted in high numbers of *P. scribneri* contrasting with results obtained for *H. dihystera* in these plots, where it was virtually absent.

The nutritional regimes studied had little influence on the sequential changes in population numbers of *P. scribneri* with time. Numbers of the nematode varied in all plots in-phase, i.e., maxima and minima occurred at the same time regardless of the nutritional regime. This phenomemon was also found to be true for *H. dihystera* and *T. christiei* in plots where these species occurred in significant numbers (15).

RESUMEN

En un estudio sobre una rotación trienial de cultivos las poblaciones de *Pratylenchus scribneri* fluctuaron de acuerdo con el desarrolo de los cultivos. La rotación consistió de maíz, soya, y algodón, como cultivos estivales y trigo cade tres años como cultivo de invierno. En uno de los otros dos inviernos las parcelas se sembraron con una combinación de trebol caramesí *(Trifolium incarnatum)* y de arveja *(Vicia sativa)* y en el invierno restante se dejó el campo en barbecho. La rotación fue superpuesta sobre parcelas que recibieron varias combinaciones de N, P, K, elementos menores, y cal. Las poblaciones de *P. scribneri* no estuvieron relacionadas con la precipitación o con los cambios de termperatura en el suelo. Las poblaciones más altas del nematodo se encontraron en maíz seguidas en orden descendente por las de soya y algodón. El trigo o las legumbres de invierno dieron poblaciones bajas de *P. scribneri.* Los resultados señalaron que las poblaciones más grandes del nematodo no estuvieron necesariamente en las parcelas que recibieron regímenes de nutrición completa. Los cambios estacionales de población en la magnitud de la poblaciones entre parcelas con diferentes regímenes de fertilización estuvieron altamente correlacionados.

Claves: nematodos lesionadores, dinámica de población, manejo de plagas, Glycine max, Gossypium hirsutum, Vicia sativa, Trifolium incarnatum, Zea mays.

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