APPLICATION OF THE CERES-MAIZE MODEL TO MAXIMUM YIELD RESEARCH

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Maximum yields are obtained when as much assimilate as possible is partitioned into the grains of corn. The amount partitioned into the grains depends on several major factors. Grains per unit area is probably the most important of these factors. Other important considerations for grain filling include the duration of the grain filling period, the amount that can be repartitioned from stem storage to the grains, the photosynthesis rate, and the temperature.

Several factors influence the number of grains in each ear capable of being filled or the number of ears that will fill. Those are related to weather, management, soil and genetics. Because of the complexity of the system affecting corn yields a computer simulation model has been developed to provide a means to integrate the major factors influencing various components of yield.

The model for corn called CERES-Maize, is a part of a series of cereal models that have been developed by a multidisciplinary team of soil scientists, agronomists, and crop physiologists. The models are designed to simulate crop phenological development, growth, and economic yield wherever the crops can be grown. They operate on a daily time step basis, are user-oriented, are computationally efficient, and require minimal weather, soil, and genotype-specific inputs. Weather inputs are daily maximum and minimum air temperatures, solar radiation, and precipitation. The soil water component of the models requires estimates of volumetric water contents at the drained upper limit and at the lower limit of plant-extractable water. Differences among crop cultivars result from differences in genotype-specific coefficients related to photoperiod, temperature response, thermal time required for certain phenological events, and dry matter partitioning.

Two versions of CERES-Maize are available. The first version simulates the effects of weather, soil water management, and genotype on crop growth and yield. The second version simulates these processes as well as nitrogen dynamics in the soil and crop. The models are user oriented and can be run on IBM compatible microcomputers.

The major processes considered in CERES-Maize include: 1) Phasic development, 2) mass accumulation and organ development, 3) soil water balance, and 4) soil and plant nitrogen balance.

Runs of the CERES-Maize model were compared with the field research conducted by in 1985 at East Lansing, Michigan on two maximum yield experiments. A detailed description of the work is presented in the 1985 "Soil Fertility Research Report", Department of Crop and Soil Science, Michigan State University Agricultural Experiment Station.

Two corn hybrids (Pioneer 3475 and 3707) were grown on two different soils (Metea Loamy Sand and Capac Loam). The genotype characteristics had to be estimated as there was no previous data

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available. Two different fertility strategies were followed. One was 250#/A of N preplant with 50#/A N at planting. The second strategy was 50#/A N preplant, 50#/A N at planting and 200#/A N applied in 10 weekly applications. All treatments were irrigated with the objective of maintaining a moisture regime that would not limit crop growth.

Only the sidedressed treatments were measured for biomass accumulation over the season. Figures 1-4 show that the model tracked this growth early in the season but under-predicted the biomass during the second half of the growing season on all treatments. A major reason that the difference is so great is that the predicted values which are plotted do not include the cob and husk weight which are in the measured values. The final stover weights compare more favorably because the measured stover, in this case, does not include the cobs or the husks. The under-prediction of biomass was particularly great for the crop grown on the capac loam. Here the model was fairly low both on yield and stover prediction. The reason for this is not clear.

Tables 1-2 show the measured and predicted values for a number of different parameters. Grain yields on all treatments were predicted with reasonable accuracy, generally within 6 or 7 percent. The model showed some moisture stress which would account for the consistently depressed estimated yields. This would indicate that the characterization of the soil profile should be reviewed to see if we have the soil water parameters correct. The stover yields were off by quite a bit, particulaly on the capac soils, as was previously mentioned. The deviation of the nitrogen uptake can be attributed to the discrepancy in the biomass production and the consistent over-prediction of the nitrogen content of the grain and stover. The nitrogen balance routines in the model have received the least amount of testing, particularly in this climatic region. The deviation in the predictions of kernel weight and production points to errors in our estimates of the genetic inputs.

The nitrogen uptake of the grain was predicted to be substantially higher than was measured. This obviously was due to the higher predicted percent nitrogen in the grain. The stover uptake was also predicted to be higher than measured. In this case, the difference is due to the higher prediction of stover production, for the estimate of percent nitrogen in the stover is close to that which was measured.

The variation in predicted and observed kernels per ear and kernel weight is highly dependant on genotype data so these indicate that our estimates of these inputs need to be improved for these hybrids.

TABLE 1

A TOTAL OF 300 LBS/A OF N APPLIED AT OR BEFORE PLANTING

	METEA LOAMY SAND					
	PIONEER 3707			PIONEER 3475		
YIELD	MEAS	PRED	%DEV	MEAS	PRED	%DEV
GRAIN (BU/A)	190	182	-4.2	197	186	-5.6
STOVER (T/A)	3.88	3.73	-3.9	3.7	3.48	-5.9
N UPTAKE (LBS/A)						
GRAIN	132.6	147.4	11.2	125.1	150.8	20.5
STOVER	46.6	68.4	46.8	40.7	62.9	54.5
TOTAL	179.1	215.7	20.4	165.8	213.7	28.9
KERN/EAR	479	446	-6.9	540	491	-9.1
KERN WT (GRAMS)	0.281	0.261	-7.1	0.249	0.261	4.8
GRAIN N (%)	1.44	1.72	19.4	1.31	1.71	30.5
STOVER N (%)	0.60	0.64	6.7	0.55	0.63	14.5

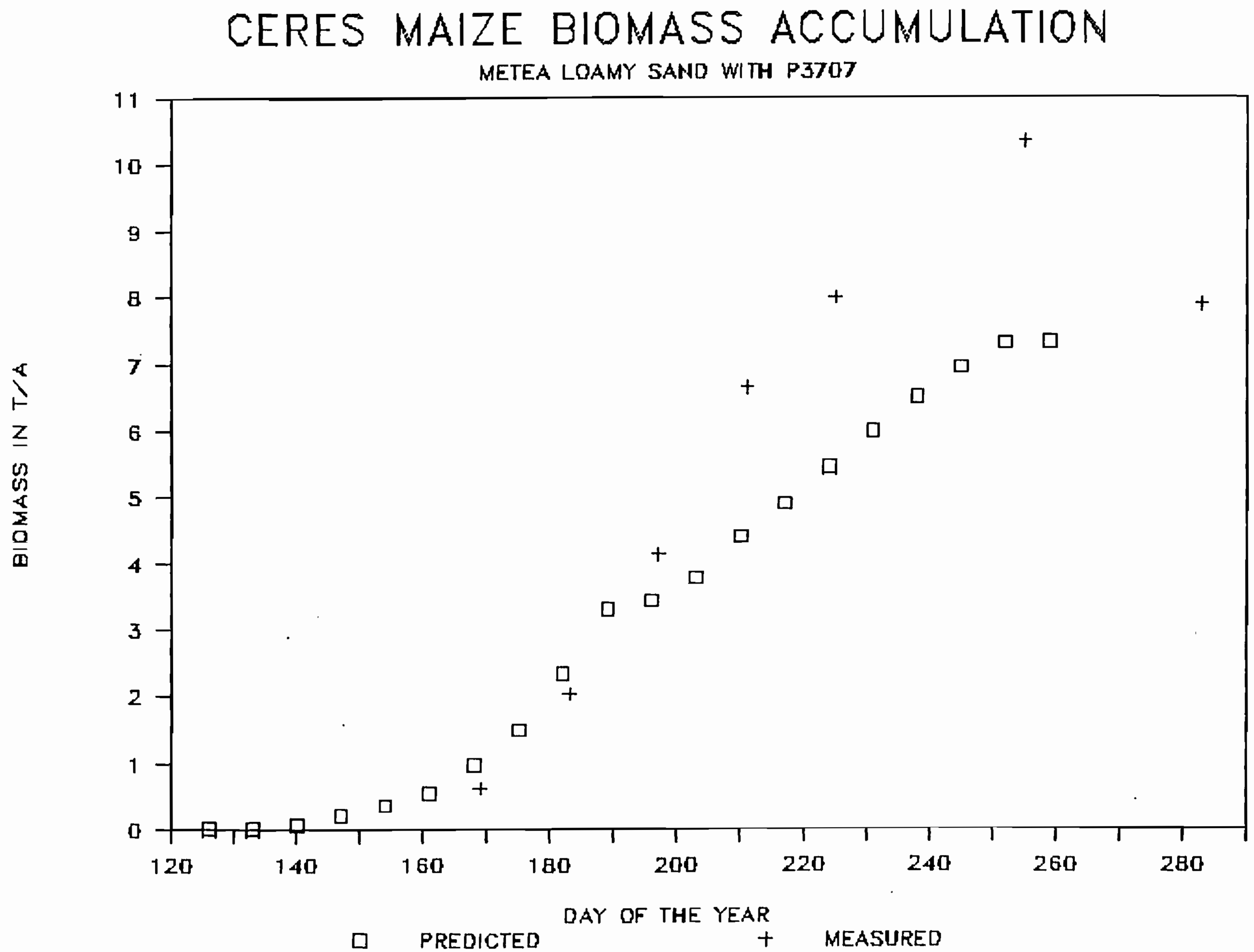
	CAPAC LOAM					
	PIONEER 3707			PIONEER 3475		
YIELD	MEAS	PRED	%DEV	MEAS	PRED	%DEV
GRAIN (BU/A)	199	185	-7.0	193	175	-9.3
STOVER (T/A)	3.51	2.44	-30.5	3.9	2.18	-44.1
N UPTAKE (LBS/A)						
GRAIN	134.9	170.7	26.5	121.7	127.7	5.5
STOVER	38.7	35.8	-7.5	49.9	33.1	-33.7
TOTAL	181.4	142.8	-21.3	171.5	160.8	-6.2
KERN/EAR	532	437	-17.9	552	491	-11.1
KERN WT (GRAMS)	0.265	0.261	-1.5	0.247	0.261	5.7
GRAIN N (%)	1.48	1.54	4.1	1.30	1.54	18.5
STOVER N (%)	0.55	0.44	-20.0	0.64	0.45	-29.7

TABLE 2

APPLIED 100 LBS/A AT OR BEFORE PLANTING
SIDEDRESSED 200 LBS/A IN TEN WEEKLY APPLICATIONS

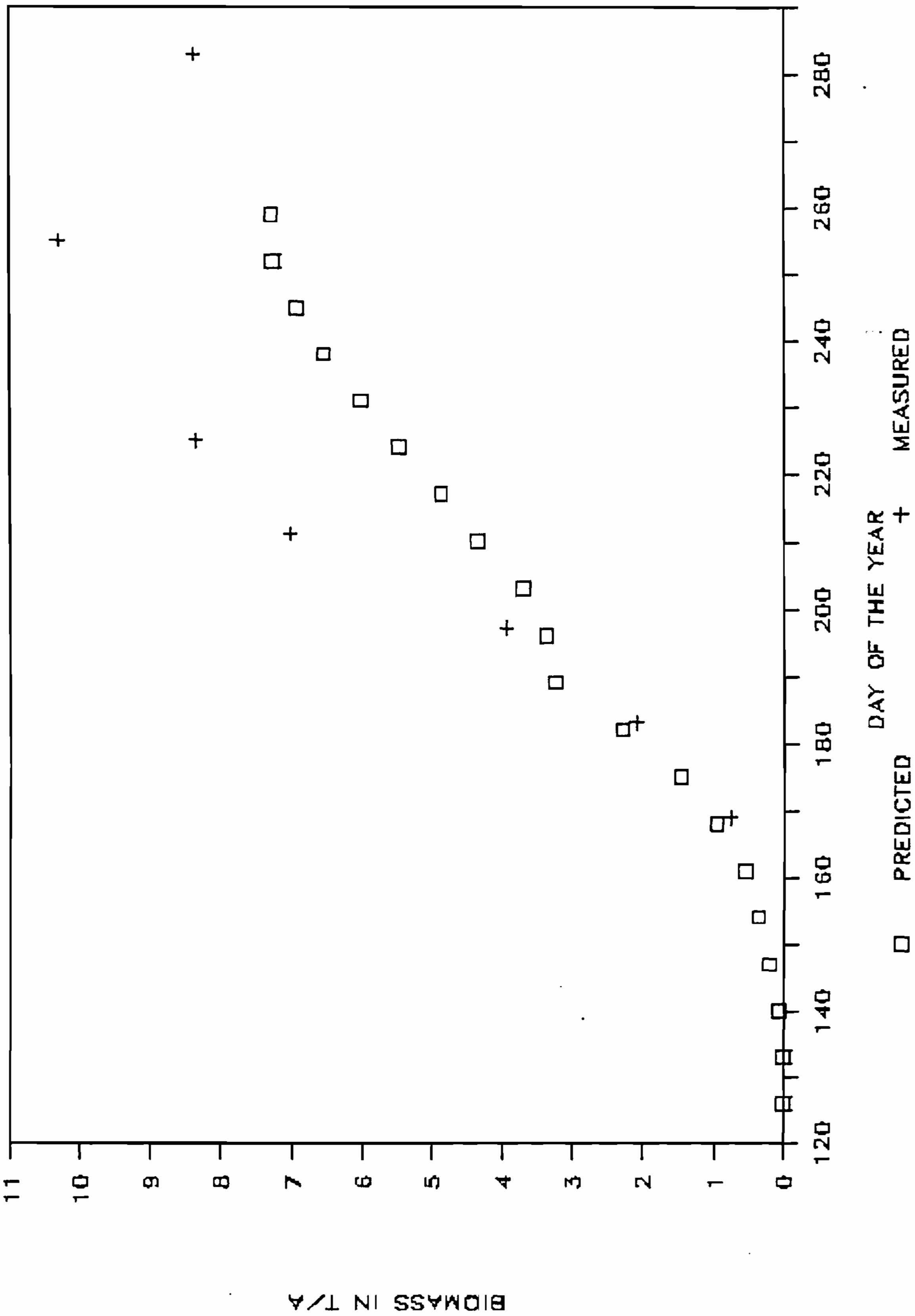
	METEA LOAMY SAND					
	PIONEER 3707			PIONEER 3475		
YIELD	MEAS	PRED	%DEV	MEAS	PRED	%DEV
GRAIN (BU/A)	188	188	0.0	201	198	-1.5
STOVER (T/A)	3.43	3.82	11.2	3.61	3.53	-2.2
N UPTAKE (LBS/A)						
GRAIN	130.3	153.3	17.7	124.7	160.6	28.8
STOVER	44.6	72.9	63.5	47.7	67.4	41.3
TOTAL	174.9	226.2	29.3	172.4	228	32.2
KERN/EAR	479	442	-7.7	540	494	-8.5
KERN WT (GRAMS)	0.278	0.261	-6.1	0.246	0.261	6.1
GRAIN N (%)	1.43	1.72	20.3	1.28	1.72	34.4
STOVER N (%)	0.65	0.67	3.1	0.66	0.65	-1.5

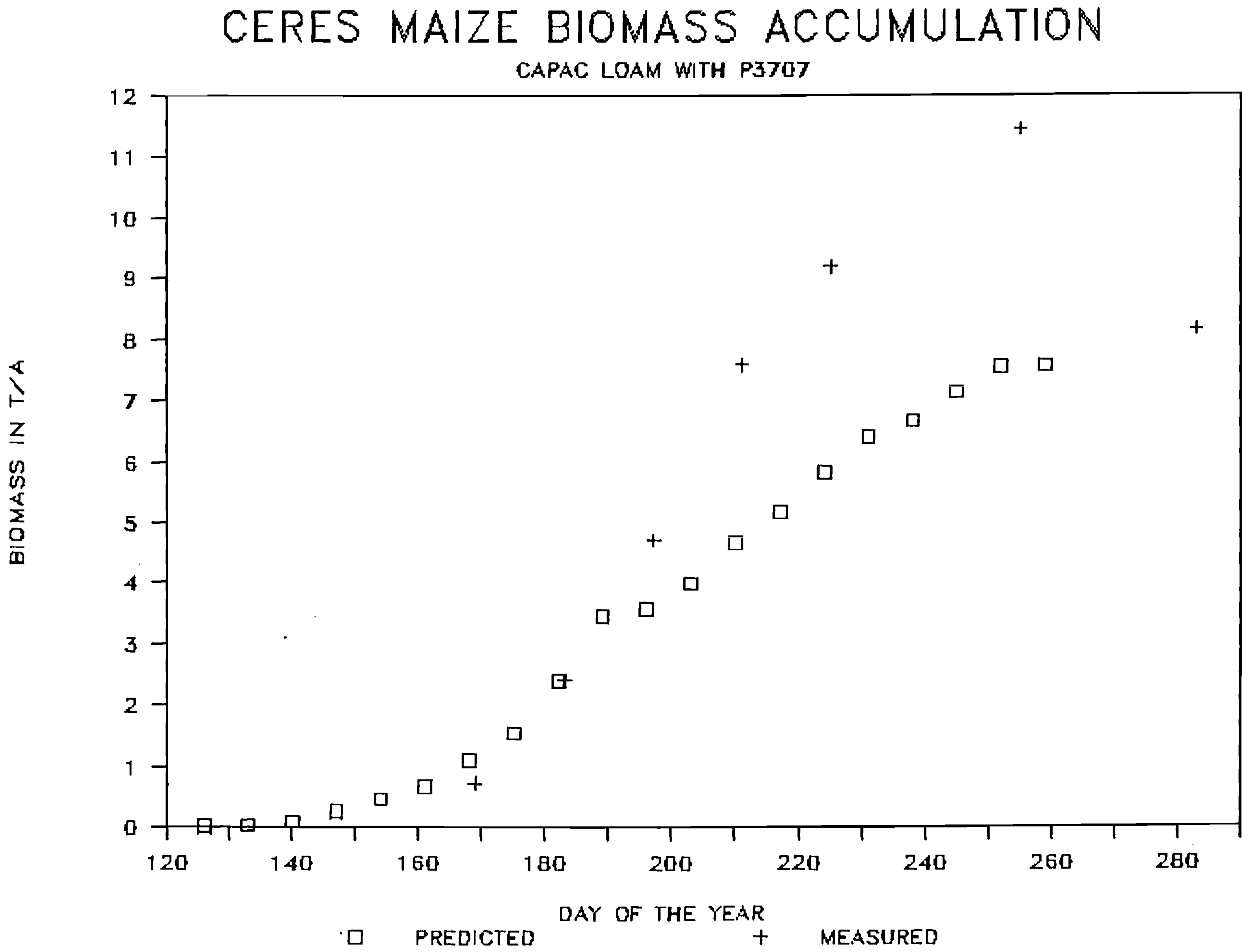
	CAPAC LOAM					
	PIONEER 3707			PIONEER 3475		
YIELD	MEAS	PRED	%DEV	MEAS	PRED	%DEV
GRAIN (BU/A)	200	186	-7.0	205	183	-10.7
STOVER (T/A)	3.42	2.62	-23.4	3.91	2.36	-39.6
N UPTAKE (LBS/A)						
GRAIN	128.0	144.9	13.2	140.5	158.3	17.5
STOVER	37.6	48.8	29.8	38.3	50.5	31.9
TOTAL	165.6	193.7	17.0	178.8	208.8	16.8
KERN/EAR	532	436	-18.0	552	486	-12.0
KERN WT (GRAMS)	0.266	0.261	-1.9	0.263	0.261	-0.8
GRAIN N (%)	1.32	1.64	24.2	1.29	1.63	26.4
STOVER N (%)	0.55	0.57	3.6	0.49	0.58	18.4


CERES MAIZE BIOMASS ACCUMULATION
METEA LOAMY SAND WITH P3707
BIOMASS IN T/A
0
1
2
3
4
5
6
7
8
9
10
11
120
140
160
180
200
220
240
260
280
DAY OF THE YEAR
PREDICTED
MEASURED

CERES MAIZE BIOMASS ACCUMULATION

METEA LOAMY SAND WITH P3475




CERES MAIZE BIOMASS ACCUMULATION
CAPAC LOAM WITH P3707
BIOMASS IN T/A
0
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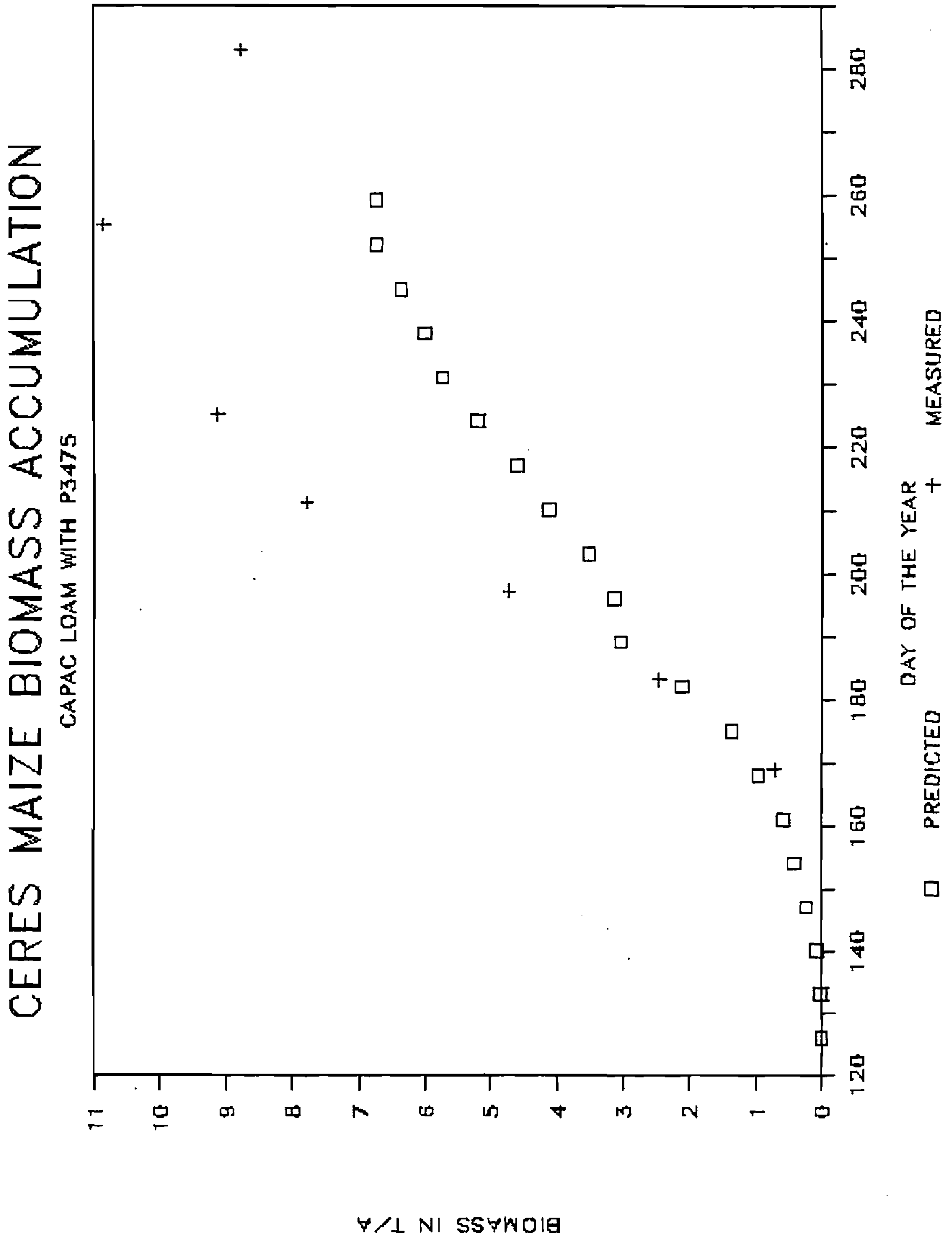
DAY OF THE YEAR
PREDICTED
MEASURED


CERES MAIZE BIOMASS ACCUMULATION
CAPAC LOAM WITH P3475
BIOMASS IN T/A
0 1 2 3 4 5 6 7 8 9 10 11
DAY OF THE YEAR
120 140 160 180 200 220 240 260 280
PREDICTED
MEASURED

PROCEEDINGS

OF THE SIXTEENTH NORTH CENTRAL EXTENSION-INDUSTRY SOIL FERTILITY WORKSHOP

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