CORN FERTILITY STUDIES AND RECOMMENDATIONS IN MASSACHUSETTS

Stephen J. Herbert and John H. Baker
Department of Plant and Soil Sciences
University of Massachusetts

Over the last three years we have been conducting field experiments at the Research Farm and at other farms in Massachusetts to provide some basis for the recommendations programmed into the computer that generates your soil test report for silage corn. In general, we feel the results from our fertility studies show that the recommendations for corn incorporated in the computer program for Massachusetts are conservative for both phosphorus and potassium. Further, they will not lead to undue depletion of residual soil fertility or cause major fluctuations in recommended fertilizer levels from year to year.

In 1982 we extended our investigation of potash fertilizer recommendations to five sites away from the Agricultural Experiment Station Research Farm in South Deerfield. These experiments were conducted with the cooperation of Regional Dairy Specialists and Massachusetts dairy farmers growing corn for silage. Two of these experiments were carried to completion, however Massachusetts weather (a very wet spring) and a mixup on plot plans and harvest schedules (farmer harvest enthusiasm) resulted in incomplete data collection at the other three sites. These experiments were in addition to the ongoing fertility experiments established in 1980 at the Research Farm in South Deerfield.

The results of the three years of experimentation at the Research Farm are shown in Table 1 for the factorial design. This experiment was established in 1980 as a 2^4 factorial with two fertilizer levels each of broadcast nitrogen, phosphorus, potassium and sidedressed nitrogen. Phosphorus and potash rates for 1980 were as listed in Table 1. In 1981 no fertilizer phosphorus or potassium was applied. In 1982 residual treatments of phosphorus and potassium were retained as established in 1980 and factorially combined with additional levels of phosphorus and potassium which replaced the nitrogen broadcast and sidedressed treatments.

In 1982 as in the previous two years, there were no responses or interactions to any of the fertilizer treatments. Yields for the Agway 584S corn hybrid were slightly lower than the previous year but this was probably a nitrogen effect, as will be discussed later. Tissue levels of phosphorus and potassium were not well correlated with fertilizer treatments and reflect the extremely high residual fertility of this site. Soil test phosphorus levels were 'very high', in excess of 26 to 30 ppm and thus fertilizer P would not be recommended in the computer generated output (Table 3). Soil test potassium levels were in the medium-high range according to the way the computer is programmed and the recommended fertilizer K_2O rates would have ranged 160 to 210 lb/acre.

The second experiment at the Research Farm was the response surface, central composite design in incomplete blocks adjacent to the above factorial experiment. In this experiment we examined three factors at five levels as follows:

Broadcast nitrogen	20	68	140	212	260	lbs/acre
Broadcast P_2O_5	0	30	75	120	175	lbs/acre
Broadcast K_2O	0	50	125	200	250	lbs/acre

Table 1. Corn fertilizer studies at the Massachusetts Agricultural Experiment Station Research Farm (South Deerfield). No significant differences were determined at the 5% level of confidence for main effects or interactions in each year.

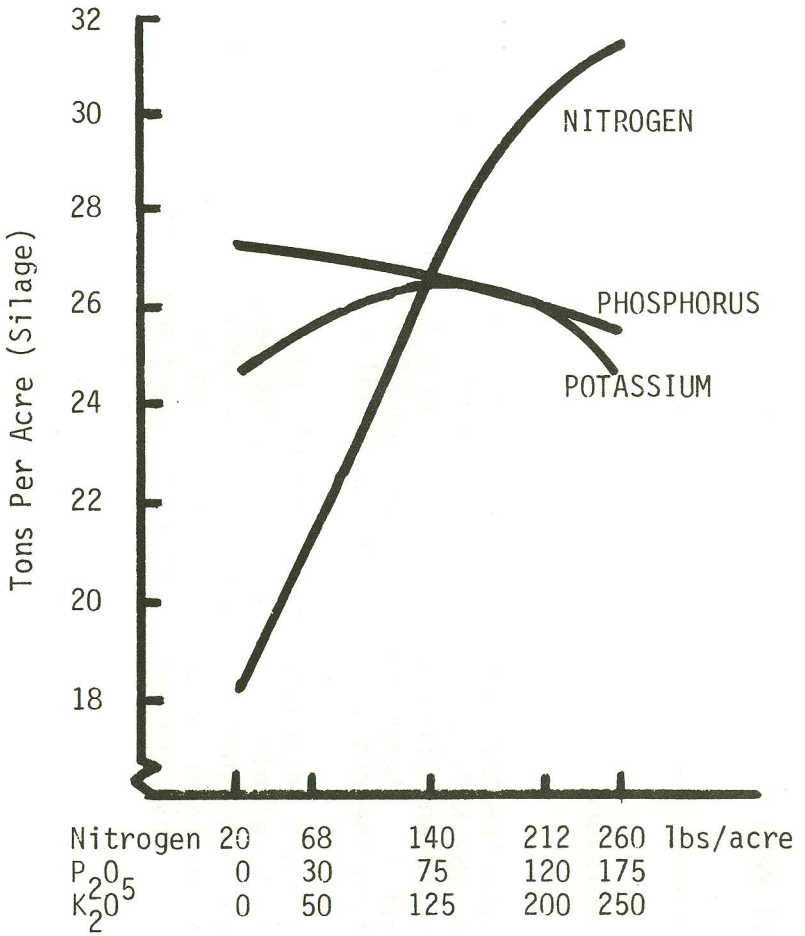
Fertilizer Rate		Silage Yield†			Tissue P	Tissue K
1980	1982	1980	1981	1982	1982	1982
lb/ac		ton/ac			%	%
Phosphorus (P_2O_5)						
50	0	26.1	29.1	28.8	.389	2.14
50	100			26.5	.378	2.06
150	0	25.1	29.6	26.4	.394	2.08
150	100			27.6	.419	2.17
Potassium (K_2O)						
100	50	25.3	29.1	27.0	.384	2.07
100	250			27.6	.388	2.09
200	50	25.9	29.6	27.1	.424	2.18
200	250			27.7	.384	2.10
Overall Mean		25.6	29.4	27.3	.395	2.11

† 70% moisture

The potash treatments were imposed on residual treatment levels of 50, 90, 150, 210, 250 lbs K_2O/acre, first established in 1980. There were no interactions among nitrogen, phosphorus or potassium and the main effects of each are shown in Figure 1. Phosphorus and potassium effects were not significant at P = 0.05, supporting the results from the factorial experiment.

Nitrogen increased yield linearly up to a rate of 212 lbs per acre, then began to level off. In the previous two years at this site no response to nitrogen had been found when fertilizer N rates varied from 60 to 260 lbs per acre. Rainfall exceeded 10 inches in June, and this probably contributed to the nitrogen response. Nevertheless, high yields were measured at the high nitrogen fertilizer rate.

Figure 1. Response surfaces for nitrogen, phosphorus, potassium in South Deerfield, 1982.



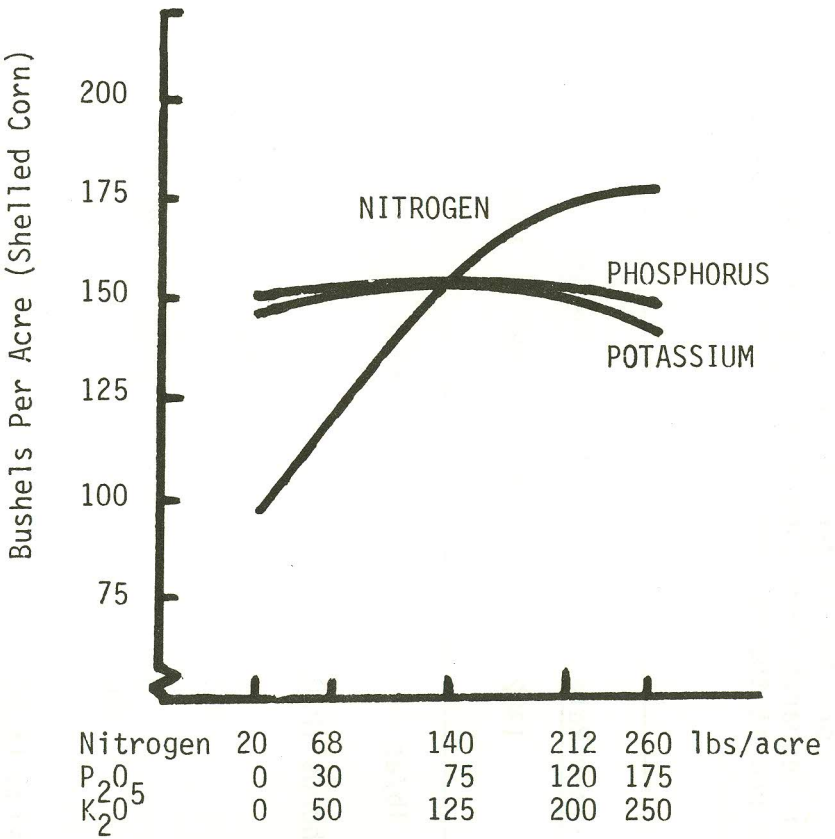


Table 2 shows the experimental design and results from a field study conducted at the Gunn Farm in 1982. At this site, as was found in most sites across Massachusetts, there was a high residual level of reserve potassium and no yield response to potash fertilizer was found. However there was a slight trend of increased tissue K levels of ear leaves sampled at silking, corresponding to the higher potash fertilizer treatments .

Table 2. Potash Fertilizer Study - Gunn Farm, 1982.

Fertilizer K_2O Applied	Available K_2O (Fertilizer & Soil Test)	Change in Soil Test K (Spring-Fall)	Tissue K	Silage Yield
lb/ac	lb/ac	ppm	%	t/ac
0	302	-23	1.69	22
50	346	-18	1.80	21
250	587	+11	1.86	21

It was evident, that even with no potash application there was not a corresponding depletion of K_2O equivalent to crop removal from the plow layer. Crop removal for a 20 ton silage yield has been estimated as 170 lb K_2O per acre, and depletion from the plow layer was in the order of 54 lb K_2O per acre. It is apparent then that the soil below plow depth was supplying the difference. At the high rate of application there was a buildup in soil K (26 lb K_2O per acre) but here the increase was not to an extent that would produce a drastic change in the recommendation the following year (see Table 3). Presumably at the high application rate the crop was removing proportionally more K from the plow layer or there was movement of soil K from the plow layer to lower soil layers. The initial soil K level at this site was 122 ppm K, but this ranged 90-188 ppm K for the 12 contiguous plots sampled where each plot was only 15 x 20 ft. For a 122 ppm soil test K level the computer program recommends 160-170 lb/acre K_2O (CEC=6), resulting in available soil K_2O level of 450 lbs per acre. Thus, while our recommendation may be high for the average fertility of the field they will most often account for the variability existing and not lead to excessive depletion or buildup. We are confident our programmed recommendations for corn are conservative and will maintain the soil fertility if followed both in the short and long term.

Included for your information is Table 3, detailing programmed recommendations for silage corn.

Table 3. Fertilizer recommendations for silage corn.

Nitrogen

Apply 140 to 180 lb/acre using the lower rate for less productive soils.

Phosphorus (P_2O_5) Recommendation			Potassium (K_2O) Recommendation			
				CEC 5	CEC 10	CEC 15
Soil Test P	P_2O_5		Soil Test K		K_2O	
— ppm —	lb/ac		— ppm —		lb/ac	
1	110-120		10	240-250	-250	-250
3	-110	LOW	20	-250	-250	-250
5	-100		30	-250	-250	-250
			40	-240	-250	-250
7	- 90					
9	- 80		50	-230	-250	-250
11	- 70	MEDIUM	60	-220	-250	-250
13	- 60		70	-210	-240	-250
			80	-200	-230	-250
15	- 50		90	-190	-220	-240
17	- 40					
19	- 30	HIGH	100	-180	-210	-230
			110	-170	-200	-220
21	- 10		130	-150	-180	-200
23	- 10					
25	- 10		150	-130	-160	-180
			180	-100	-130	-150
			250	- 60	- 60	- 80

Decrease N-P_2O_5-K_2O by 5-3-6 lb/ac for each ton of dairy manure used if immediately incorporated, 2-3-6 per ton if not incorporated within 2 days.

If corn follows alfalfa reduce nitrogen by 60 lb/acre.

If corn follows birdsfoot trefoil or clover reduce nitrogen by 40 lb/acre.