RESPONSE TO FERTILIZER NITROGEN

Nitrogen fertilizer trials are being conducted throughout the state to: 1) survey the current response of sugar beets to N fertilization and the effectiveness of the crop in utilizing accumulated nitrates; 2) evaluate soil analyses, water analysis, crop history and fertilizer history as predictors of the need for N fertilization; 3) use plant analysis to evaluate the nutritional status of plants and to develop procedures for determining the need for supplemental N application; and 4) to determine nitrogen pollution potential as effected by level of fertilization.

To date, the six trials indicated in Table 1 have been completed. A brief summary of these trials follows.

Optimum Levels Of N Fertilization

Fertilization rates producing maximum net income were 0 pounds of N per acre in one trial, 60 pounds in two trials, 120 pounds in two trials, and 300 pounds in one trial. Figure 1 illustrates the importance of correct fertilization to profit or loss from sugar beet production in four of these trials.

Efficiency of Nitrogen Uptake and the Nitrogen Requirement Per Ton of Roots

The efficiencies of nitrogen uptake, in terms of the percentage of the initial soil nitrogen to a depth of 3 feet taken up by the nonfertilized crop and the percentage of the fertilizer nitrogen taken up by the crop producing maximum sugar per acre are estimated in Table 2 for three trials where our laboratory analyses are complete. Calculations for estimating these figures are given in footnotes to the table. Note that less than 50% of the initial NO_3-N and NH_4-N present to a depth of three feet at the start of the experiment showed up in the nonfertilized crop. Actual efficiencies would be somewhat less than this as no account is taken of the amount of nitrogen that may have been mineralized from the organic fraction throughout the season. Most tensiometer readings in sugar beet experiments indicate that the greatest root activity occurs in the top 3 feet of soil. Thus, we think 3 feet is a reasonable depth to sample. Sampling to a depth of 6 feet usually indicates that more nitrogen is available than the maximum crop can use, yet responses to nitrogen fertilization are usually obtained.

The "nitrogen requirement" as calculated in the last column of Table 2 is not based on actual pounds of N found in the crop, but is the amount of fertilizer nitrogen used to produce maximum sugar per acre plus the amount of N as nitrate and ammonium in the soil to a depth of 3 feet plus any significant amount of nitrate N in the irrigation water divided by the tons of root per acre of the crop producing maximum sugar. For a particular trial to give a useful estimate, there should be no factors, other than nitrogen, limiting production and there must be a response to nitrogen. There was no response to nitrogen in trial number 6, thus the nitrogen requirement is excessively high. In trial number 4 production may have been limited by sugar beet nematode and there were too few replications of some treatments due to a mistake by the commercial applicator resulting in the fertilization of several plots.

Based upon trials 1, 2, 3, and 5 a N requirement of 14 pounds per ton of roots would effectively estimate the correct amount of fertilizer to use if the root yield of each trial could have been correctly estimated. In trial number 1 for example: soil + water N = 375 lb. N/acre; nitrogen demand = 32 tons per acre x 14 lb. N/ton = 448 lb. N. Subtracting soil + water N from nitrogen demand gives, 448 - 373 = 75 lb. N/acre to be applied as fertilizer. The efficacy of such a procedure can only be tested by many more trials.

Pulp Nitrate and Percent Sucrose

Dr. Albert Ulrich and Staff Research Associate Carlos Llanos have developed a quantitative method for nitrate using diphenylamine (the same reagent used to obtain "blue numbers" on beet pulp) which is more accurate for low concentrations of nitrate than the phenyldisulfonic method we have been using for petiole analysis. Fresh root samples from these experiments have been analyzed by this method. Blue numbers were run on the same samples in the usual way at the sugar company laboratories. The correlations presented in Table 3 indicate significant correlations of percent sucrose on nitrate N in pulp determined by the new method in five of the six trials, while in only two trials was there a significant correlation between percent sucrose and diphenylamine rating. More tests of this type need to be run to more extensively evaluate the new diphenylamine quantitative tests with other methods of nitrate analysis.

Nitrate Pollution Potential

Trials 3 and 4 were instrumented to collect soil solution samples following each irrigation below sugar beet fertilized with 0, 120, 240, and a split application of 60 + 60 lb. N/acre. The information from trial number 3 (Kern County) is nearly complete and indicates an average seasonal nitrate N concentration in the soil solution below the root zone for 0, 120, and 240 lb. N/acre respectively of 2.5, 4, and 12 ppm. The Federal and State allowable concentration of nitrate N in drinking water is 10 ppm. Thus, in this trial, fertilization for a maximum economic yield (120 lb. N/acre) did not excessively pollute groundwater.

Assuming a 30% leaching fraction, that is, applying enough irrigation water for 30% of it to leach below the root zone, a 15 inch depth of irrigation water would move to the underground water supply, carrying with it 8.5 13.5, and 40.8 lb. nitrate N/acre from beets fertilized with 0, 120, and 240 lb. N/acre, respectively.

1973 Trials

Six to eight similar trials are planned for 1973. An additional objective this year will be to estimate a critical level for nitrate N in root pulp and to evaluate the usefulness of such a critical level compared to critical levels for petioles and for soluble N in blades of mature leaves.

Table 1. Nitrogen Trials, 1971-72.

Trial No.	Location	Cooperators: Grower	Cooperators: Farm Advisor	Soil type	% Organic matter, 0-1 ft.
1	Mountain House Alameda Co.	Manuel Costa	Harwood Hall	Rincon clay	0.8
2	Brawley, Imperial Co.	Roger Davis	Bob Hagemann	Holtville clay	1.7
3	Copus Road & 99 Kern Co.	Charles Fanucchi	Dave Woodruff	San Emigdio sandy loam	0.34
4	Santa Maria Santa Barbara Co.	Owen Rice	Warren Bendixen	Elder loam	2.12
5	Butte City Glenn Co.	Angel Farms	Bob Sailsbery	Marvin silty clay loam	2.18
6	Gerber, Tehama Co.	Ray Dutro	Bob Sailsbery	Columbia silt loam	1.9

Table 3. Correlation coefficients1/ and coefficients of determination for mean % sucrose at harvest on mean diphenylamine rating and mean NO_3-N concentration of pulp at harvest.

Trial No.	Correlation coefficient, r: Diphenylamine rating	Correlation coefficient, r: ppm NO_3-N, fresh pulp	Coefficient of determination, (r^2): Diphenylamine rating	Coefficient of determination, (r^2): ppm NO_3-N, fresh pulp
1	NA2/	-.90	NA	.82
2	.08	-.17	.006	.03
3	-.83	-.71	.69	.50
4	0	-.96	0	.91
5	0	-.89	0	.79
6	-.87	-.91	.76	.86

1/ Required r values for statistical significance at 5 and 1% levels, respectively: 0.707, 0.834.

2/ Blue numbers not available.

Table 2. Efficiency of nitrogen uptake and nitrogen requirement per ton of roots produced by the crop producing maximum sugar per acre.

Trial No.	Soil N, lb/acre 3 ft. 1/	No N crop, tons roots per acre	Maximum crop		N uptake, lb/acre		Efficiency of uptake, %		Nitrogen requirement, lb N/ton roots 4/
			roots, tons/acre	lb fert. N/acre	No N crop	Max. crop	Soil N 2/	Fert. N 3/	
1	373	27.5	32.0	60	109	139	29	50	13.5
2	258	20.5	36.0	240	97	215	38	49	13.8
3	313	28.0	33.0	120	135	191	43	47	13.1
4	543	28.5	33.0	60					18.3
5	432	33.0	40.0	120					13.8
6	818	45.0	45.0	0					18.2

1/ NO_3-N plus NH_4-N plus NO_3-N in irrigation water if more than 15 lb/acre.

2/ Efficiency of uptake of soil N = [(lb N/acre in non-fert. crop)/(lb soil N/acre)]100.

3/ Efficiency of uptake of fertilizer N = {[(lb N/acre in maximum crop) - (lb N/acre in non-fert. crop)]/[(lb fert. N/acre to produce maximum crop)]}100.

4/ N requirement = (soil N + fert. N for maximum crop)/(tons roots/acre of maximum crop).

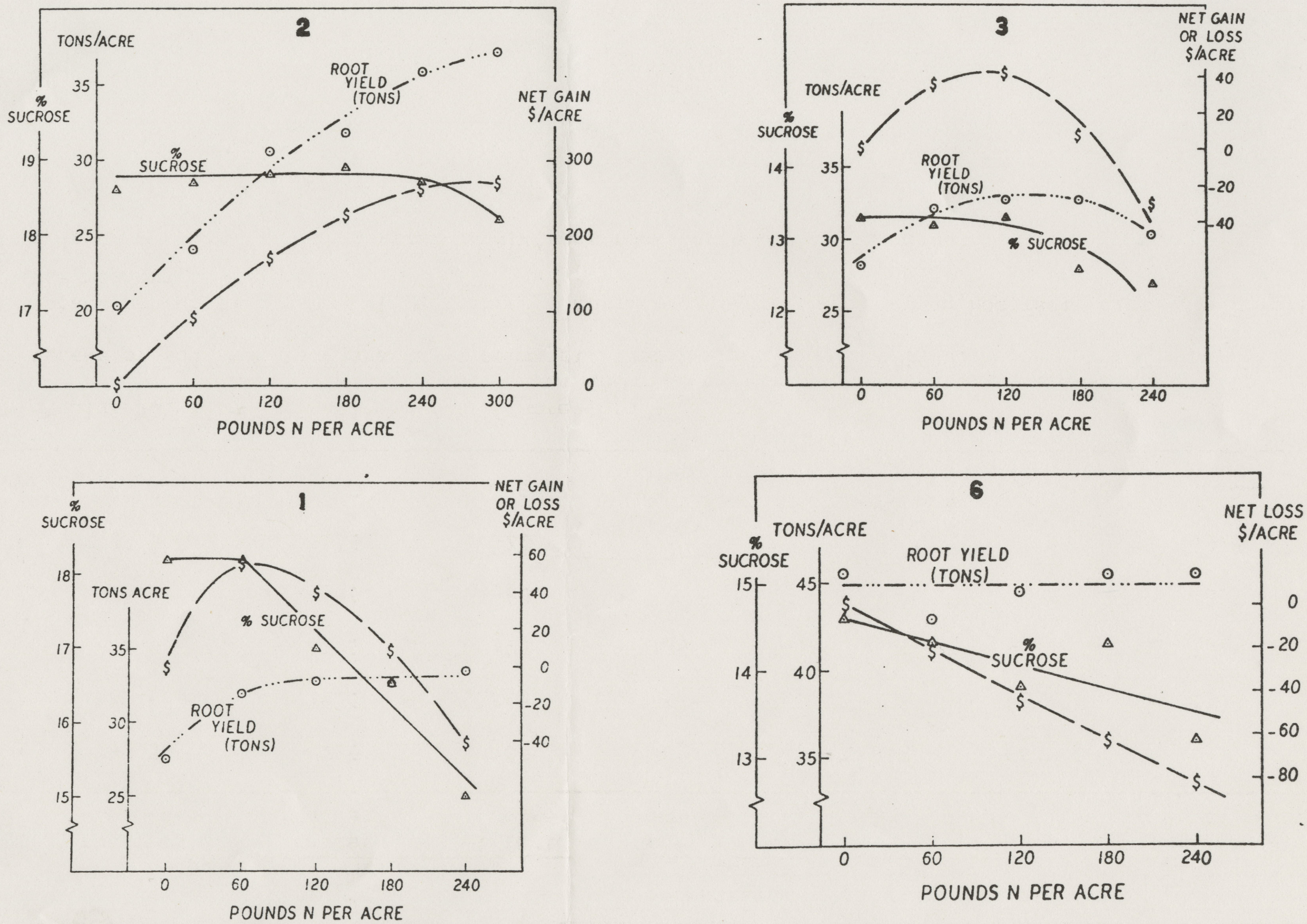

Fig. 1. In trial no. 2 (upper left), 300 lb N/acre increased net gain over unfertilized beets by $272/acre; in trial 3, 120 lb N/acre resulted in maximum net gain of $43/acre; the maximum net gain in trial 1 (lower left) was $57/acre with 60 lb N, but in trial 6, any amount of fertilizer N reduced profit.