Crop rotation and efficient fertilization practices minimize the amount of nitrate nitrogen reaching groundwaters from fertilizers. Cereal crops reduce soil nitrogen levels by using nitrogen remaining after previous crops.

Crop rotation improves nitrogen utilization

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Concern that excessive amounts of nitrate from nitrogen fertilizers might be reaching groundwaters prompted the initiation of a field trial in 1973 to determine optimum nitrogen levels for crops, with miminum deep percolation losses. The trial, starting with sugar beets, continued with rotation to fresh market tomatoes in 1974 and barley in 1975. Nitrogen fertilizer was applied in 60-pound increments (0 to 300 pounds per acre) to the sugar beets; for the tomato crop, additional nitrogen treatments (0, 150, 300 pounds per acre) were superimposed on all sugar beet treatments; no additional nitrogen was applied to the barley crop. Soil samples were taken to monitor the fertility levels between each crop.

The nitrate status in the soil solution was monitored by soil suction probes during each irrigation. The nitrate concentration increased with increases in nitrogen fertilizer rates. Deep percolation losses were greatest with early irrigations under high nitrogen rates, but little nitrate movement was detected toward the end of each growing season.

Maximum sugar production in 1973 resulted from an application of 120 pounds of nitrogen per acre (table 1). Sugar yield data show that split applications were not as efficient as a single application. Petiole samples were taken periodically during the season. The 60- and 120-pound fertilizer treatments resulted in NO_3-N petiole levels that decreased to 1,000 ppm four to six weeks before harvest, giving higher sugar percentages than beets whose petioles remained above 1,000 ppm after that time.

The high nitrogen rates (180, 240, and 300 pounds per acre) produced high tonnages of large beets, but resulted in low sugar percentages and thus less total sugar production per acre. These results correspond with findings of numerous other sugar beet fertilization studies—i.e., excessive nitrogen applications reduce total sugar production and can cause large deep-percolation losses of nitrogen.

Fresh market tomato data from the second year of the experiment indicate that, for an indeterminate (continually growing and setting) variety, 150 pounds of nitrogen fertilizer applied to the crop produced 8.62 tons per acre of marketable fruit. Plots that received twice as much fertilizer—300 pounds per acre—yielded only 9.47 tons per acre, and those that received no nitrogen yielded 6.58 tons. None of the 1974 fertilizer rates had a significant effect on tomato fruit quality or size, but there was an indication that both the 150- and 300-pound nitrogen rates gave a higher proportion of larger fruit.

Use of statistical analysis to isolate effects of the residual nitrogen from 1973 applications showed significant tomato yield response, with the highest marketable yield (9.98 tons per acre) obtained from the 300-pound 1973 nitrogen fertilizer rate. Further analyses show that the nitrogen carryover from previous crop fertilization had a greater impact on tomato yield than fertilizer applied specifically to that crop. Soil samples from nitrate nitrogen before and after the tomato crop revealed sizable residual nitrogen levels following the tomato season. This may indicate that tomatoes, with their tap-root system, are not efficient nitrogen foragers.

TABLE 1. YIELDS OF USH 9 SUGAR BEETS AT VARIOUS NITROGEN FERTILIZER RATES (1973)

Pounds nitrogen per acre		Roots		
May 17	July 19	Sucrose (100 lb/acre)	Tons per acre (fresh)	Percent sucrose (fresh)
0	0	88.7	27.6	16.1
60	0	99.7	31.2	16.0
120	0	106.1	34.0	15.6
180	0	98.0	33.3	14.7
240	0	108.0	36.8	14.7
300	0	94.0	33.8	13.9
60	60	102.3	33.0	15.5
120	60	96.4	32.5	14.9

TABLE 2. NITRATE NITROGEN LEVELS AT VARIOUS DEPTHS IN THE SOIL PROFILE BEFORE AND AFTER THE BARLEY CROP, 1975

Nitrogen rate* (lb/acre)	Nitrate nitrogen (ppm NO_3-N)† Before barley, at: 0′–1′	1′–2′	2′–3′	After barley, at: 0′–1′	1′–2′	2′–3′
0	28.6	12.4	3.9	7.5	5.7	2.9
150	56.6	23.3	5.6	4.3	3.0	2.0
300	92.4	41.2	13.8	8.4	5.5	3.5

* Nitrogen fertilizer applied in 1974.

† Values of nitrate nitrogen are means of six samples.

Yields of barley planted in 1975 over the previous trials gave further evidence of the residual effects of nitrogen fertilizer from the previous crops. Plots that had received 150 pounds of nitrogen in 1974 yielded about 1,200 pounds more barley (5,330 pounds per acre) than those that had received no nitrogen (4,160 pounds per acre). Only 200 pounds more barley (5,530 pounds per acre) were obtained from the previous 300-pound fertilization rate. Soil samples taken before and after the barley crop indicate that barley is an efficient nitrogen forager; little or no nitrogen remained after barley (table 2).

The results obtained in this experiment indicate that, in general, crop rotation and efficient fertilization practices minimize percolation losses of nitrogen. Excessive nitrogen fertilization tends to increase percolation loss, particularly during irrigations early in the growing season. A fibrous-rooted crop, such as barley, included in the rotation can efficiently utilize leftover nitrogen, significantly reducing soil nitrogen levels and the potential for pollution.

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