particularly high in the 0- to 2-ft depths under corrals. Although there were no marked differences in NH_4^+–N in concentrations in deeper layers, the average concentrations of NH_4^+–N in profiles under croplands, pastures and corrals were considerably higher than under the controls (graph 1). The NO_3^-–N load of the profile is presented in graph 3. Only two sites from each category were presented.

For the croplands and pastures, the lowest (sites 3 and 14) and highest (sites 4 and 12) NO_3^- concentrations in groundwater were presented. The average (two sites each) NO_3^-–N concentration was highest under the corrals, followed by the pastures, then the croplands and the controls had the lowest. The NO_3^-–N concentration in corrals was about three times higher than that under croplands. However, on an areal basis, the croplands would probably contribute more NO_3^- to the groundwater than corrals since the cropland area is about 13 times larger than the corral area.

The NO_3^- concentrations in waters sampled from the shallow wells and deep wells are shown in graph 4. The NO_3^- in shallow wells under pastures ranged from 151 to 930 parts per million, whereas the NO_3^- under croplands ranged from 62 to 359 parts per million. In contrast, waters sampled from deep wells had considerably lower NO_3^- contents as compared with those sampled in shallow wells, and no NO_3^- concentration in deep well waters exceeded the PHS standard of 45 parts per million NO_3^-. Total salt concentrations were also generally higher in shallow well waters than in deep well waters. Thus, the present practice of dairy manure disposal to croplands and pastures is potentially hazardous to groundwater with acceptable NO_3^- contents. Shallow wells near corrals and other heavily manured areas could be contaminated with NO_3^-. A real problem with NO_3^- can arise if the profile is sandy.

Disposal rates

Data presented in the table show the method used to predict the NO_3^- concentration in the water leaving the root zone of pastures and croplands. Data in the first column show the disposal rate in terms of cows per acre. The total N excreted was based on a daily excretion by a cow of 0.40 lbs N. Assuming 50% of the total N excreted was lost by volatilization of NH_3, only half was available for incorporation into the soil. The amount recycled in crops was estimated from graph 5, based on knowledge of the forage crops and farm management in the area. Likewise, excess N values were estimated from graph 5. The concentration of NO_3^- in the unsaturated zone was calculated from simple dilution assuming a drainage volume of 15 surface inches per year, which corresponds to a leaching fraction of about 0.30 (usual for successful irrigation projects). The 35% loss represents the fraction of the excess N that is either lost by denitrification or by becoming a part of the organic N pool in the surface layers. The estimates with low degree of accuracy are the drainage volume, NH_3 volatilization loss, and denitrification loss.

The average cow population in the area is about 10 cows per disposal acre and at this disposal rate and at 35% loss, about 327 ppm NO_3^- in the water of the unsaturated zone is predicted. This is in close agreement with the average value of about 315 ppm NO_3^- found in the water at a 10- to 19-ft depth underneath croplands and pastures. From these data it is predicted that the disposal rate must be about three to four cows per acre per year to obtain a NO_3^- level of less than 45 ppm in the drainage water.

Research needs

The manure disposal problem in the Chino-Corona area is aggravated by (1) high costs of land; (2) the grouping together of many dairies to increase the efficiency of production, which favors even higher concentrations of cows than presently exists; and (3) manure trucking costs which make disposal of wastes on lands outside of the dairy area economically unattractive. If high rates of manure disposal within the dairy area are to continue, research is needed on (1) recycling of N and other nutrients under the local conditions so that proper limits can be placed on the rate of disposal of manure under present handling and disposal practices; and (2) modification of the product to remove salts and N so that rates of disposal can be increased without adverse effects on water quality. Research is also needed on alternatives to land disposal of manures.

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A progress report . . .

DATES

Asparagus is direct-seeded in California from early spring until late summer, with reasonable success. Normally, the plantings are made as early in the spring as possible, similar to the practice followed in transplanting crowns.

Direct-seeded asparagus plantings are grown for two seasons before the first harvest is made. The year of seeding is counted as one season of growth. Depending on the date of planting, the physiological age of the plants at the time of first harvest could vary as much as six months. This difference in the ages of the plants would result in considerable differences in plant size at first harvest and could adversely affect the performance of the planting in subsequent years.

This report summarizes the data obtained on plant size, plant density, and initial yields, as influenced by date of planting and cultural practices.

Three tests

Three tests were initiated at the Citrus Research Center, Riverside—all on Ramona sandy loam soil. In 1967 the trial was sprinkler irrigated. In 1968 a comparison was made between sprinkler and furrow irrigation. Asparagus Var. 500W was planted in two rows 14 inches apart in the bottom of flat-botton, pre-formed beds 8 inches deep. The beds were spaced 5 ft apart, center to center. Plants were grown the first season in open beds. Prior to the beginning of the second season, the beds were reshaped and the plants were covered with 6 inches of soil. The irrigation furrow was moved to the outside of the planted rows.

The four plantings (treatments) were made about the fifteenth day of the months of March, May, July, and September. Harvest data were collected on the furrow irrigated test. The two sprinkler tests were terminated the second season.

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OF PLANTING FOR ASPARAGUS PRODUCTION

These tests show that a good initial stand of asparagus can be obtained through direct seeding from early spring to late summer; however, the final established stand was dependent upon the cultural practice following the first season of growth. Plantings made in July or later, in warm production areas such as southern California, do not gain sufficient size during the first season to permit covering with soil before the second season. The production of marketable spears from one-year-old plants was limited, and it appeared that this reduction in quality may be carried over into subsequent harvest seasons.

Initial stand

The germination and emergence of the seedlings varied from approximately 25 days in the March plantings to 14 days in the July and September plantings. Little or no difference was observed in the per cent germination for the different planting dates or between the two systems of irrigation. The average number of seedlings per linear foot of bed for the three trials was 6.5 plants or approximately 56,000 plants per acre.

Physical measurements taken at the end of the first growing season showed a considerable difference in plant size (table 1). The March planting produced the largest plants in all categories in which comparisons were made, and those seeded in September were the smallest, as expected. Plants in the July planting were also considerably smaller than expected. Little or no growth was made by the seedlings during the summer months. During the months of July, August, and September, the air and soil temperatures in Riverside are high, which may account for the inhibition of growth during this period. Studies in the greenhouse indicate a sharp reduction in storage root formation when soil temperatures exceed 85° F.

Established stand

It was difficult to determine plant density in direct-seeded asparagus the second season except in treatments where a severe reduction in plant population had occurred. Table 2 shows the relative plant density as estimated by three methods.

The estimated density in the March planting was 4.9 plants per linear ft of bed, or 42,988 plants per acre, with a progressive loss in plant population with delayed planting date. This suggests that a loss of plants occurred in all treatments, with the greatest mortality rate in the smallest plants. In subsequent fall plantings, where no soil was moved over the plants after the first season of growth, little or no loss of stand occurred.

Yield

The difference in yield for the different planting dates was large and was primarily a reflection of the difference in plant density. The overall production in all categories of spear size favors the earlier plantings (table 3).

The planting made in July yielded approximately 50% fewer spears, but a high percentage of those produced were of larger marketable size. This suggests the survival of the larger, more vigorous plants as well as the reduced competition among plants at the lower population densities.

Since no plants in the September planting survived the second season, these rows were re-seeded the following spring (March 1969) and harvested the second season. The first harvest of these one-year-old plants yielded little or no marketable spears of medium size or larger. The production in number of spears the second season was good; however, the spear size was still small. The data indicate that the production of marketable spears would be too limited to consider harvesting the second season after planting.

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TABLE 1. PHYSICAL MEASUREMENTS OF ASPARAGUS SEEDLINGS FROM FOUR PLANTING DATES, AFTER ONE SEASON'S GROWTH

Plant measurement averages	Planting dates—1968 March	May	July	Sept.
Canes (no.)	9.5	6.0	3.0	2.0
Fern length (in.)	16.9	13.0	3.5	1.5
Fern wt. (gm)	16.5	8.1	.32	.20
Storage roots (no.)	39.5	21.5	4.2	3.0
Storage roots wt. (gm)	39.5	13.2	.48	.25

TABLE 2. ESTIMATIONS OF ESTABLISHED ASPARAGUS STANDS THE SECOND SEASON FOR FOUR PLANTING DATES

Plant measurement averages	Planting dates—1968 March	May	July	Sept.
Spears/1 ft. beds (no.)	21.9	15.3	1.4	0.0
Plants/1 ft. beds (no.)	4.9	4.2	2.2	0.0
Total length of spaces more than 6" long in 20 ft of row (in.)	17.0	71.0	121.0	240.0

TABLE 3. PRODUCTION OF ASPARAGUS (PER ACRE) IN 1970 AND 1971 RESULTING FROM FIVE DIFFERENT PLANTING DATES

		Planting dates—1968 March	May	July	Sept.	March*
		No.	No.	No.	No.	No.
Marketable spears	1970	66,144	58,936	27,613	0	10,123
	1971	92,469	78,837	59,063	0	90,587
Large spears	1970	1,484	1,113	265	0	0
	1971	4,012	5,114	4,913	0	3,137
Medium spears	1970	16,695	16,112	6,042	0	636
	1971	37,206	33,019	27,332	0	36,411
Small spears	1970	47,965	41,711	21,306	0	9,487
	1971	51,251	40,704	26,818	0	51,039

*March 1969