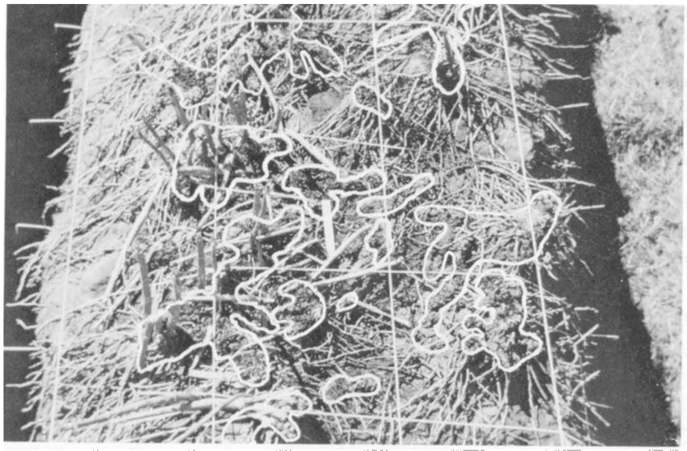

Fig. 2. Exposed asparagus bed showing crown placement and storage roots after 15 years of growth.

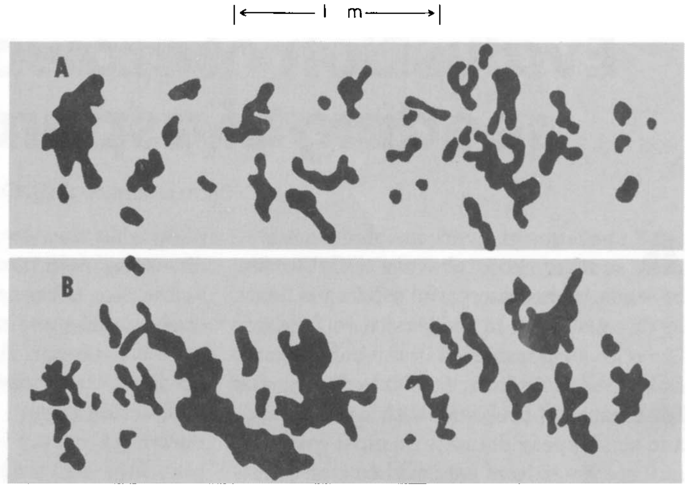

Fig. 3. Configurations of viable crown material from (A) crown planted and (B) direct seeded asparagus after 15 years of growth. Notice the size and segmentation of the crowns.

the entire experiment.

The exposed direct seeded plot contained 59 crowns which had a total crown area of 16,963 cm^2 (18.26 $feet^2$) and a mean crown area of 287 cm^2 (44.5 $inches^2$). The crown planted plot contained 76 crowns with a mean crown area of 148 cm^2 (22.9 $inches^2$) and a total crown area of 11,278 cm^2 (12.14 $feet^2$). The amount of bed covered by viable crowns was 23.5 percent and 15.6 percent for the direct seeded and crown planted plots, respectively.

A representative portion of the print made from the polyethylene sheeting is presented to demonstrate the differences observed (figure 3). The original location of plants in each plot is obscured due to the growth and segmentation that occurred over the 15 years. The number of crowns changed dramatically from the initial population. The direct seeded plots' initial population of 216 plants was reduced to 49, a loss of 157 plants. In contrast, the crown planted plot increased by 49 plants to a plant population of 76. The change in crown numbers is thought to be due to two main factors. The reduction of plants in the direct seeded plot was probably due to high plant competition; the increase of plants in the crown planted plot was due to segmentation, a possible result of *Fusarium* sp. infestation.

The larger crown area found in the direct-seeded plot is believed to be related to better adapted plants remaining intact over the 15 year period. The crown planted plot probably had some of the better adapted plants but since the direct seeded plot contained 8 times the initial population of the crowns planted, chances of having more plants that were better adapted to the conditions present during the experiment were greater.

Brian L. Benson is Staff Research Associate, Department of Vegetable Crops, UC Davis; G.C. Hanna was Olericulturist, Department of Vegetable Crops, UC Davis—now with Peto Seeds, Woodland; and Frank H. Takatori is Specialist, Department of Plant Sciences, UC Riverside.

Response of corn to fertilizer, plant population, and planting date

Renuka D. Arjal ■ John D. Prato ■ Maurice L. Peterson

Corn for grain in California has increased steadily in acreage and yield over the past 20 years. In 1960, corn was grown on 130,000 acres with an average yield of 4032 pounds per acre. By 1975 the crop was grown on 290,000 acres averaging 6160 pounds per acre. This 52 percent yield increase in 15 years (about 3.5 percent annually) can be attributed to improved hybrids and cultural practices.

Fertilizer rates, planting dates, and number of plants per acre all are known to influence corn yields. Previous studies considered these factors singly. An experiment at the Davis Campus of the University of California considered all three factors simultaneously.

Two planting dates were used, May 9 and 30. Nitrogen fertilization was at three rates: 0 (unfertilized check), 200, and 400 pounds per acre of actual nitrogen applied as ammonium sulfate with 21 percent nitrogen. The plant populations were 18,000, 26,000, and 34,000 per acre, respectively, giving plant spacing within the 30-inch rows of 6, 8, and 12 inches. Plots were hand thinned 20 days after planting to provide required plant population. The nitrogen levels as well as the plant populations represent values used in commercial corn production, with the middle values near those used by many growers. The two planting dates are somewhat later than the average for commercial plantings in the Davis area. Other cultural practices were designed to achieve a high level of production. The experiment was planted with DeKalb XL361, a three-way cross hybrid. Most of the currently grown hybrids are single-crosses. All yields reported here are in pounds per acre at 15.5 percent moisture. Grain protein percentages are reported on a 100 percent drymatter basis.

The mean yields of all populations and nitrogen fertilizer rate are summarized in table 1. Corn planted on May 9 averaged 12,180 pounds per acre, and the May 30 planting averaged 10,990 pounds, a reduction of 1,190 pounds per acre (significant at the 10 percent probability level). The higher yield from the earlier planting confirms the experience of corn growers in California.

Nitrogen fertilization at 200 pounds

per acre significantly increased the yield by 3,200 pounds over the check treatment of 0 nitrogen averaged across planting dates and plant populations. While this difference was highly significant, the 400-pound treatment of applied nitrogen actually decreased yields by about 200 pounds per acre.

The mean yield for 18,000 plants per acre averaged across planting dates and fertilizer rates was 10,440 pounds per acre, significantly less than for the two higher plant populations, respectively 12,150 and 12,160 pounds for 26,000 and 34,000 plants per acre. However, the interaction between planting dates and plant population was highly significant (see figure 1). Yields improved with increasing plant population for the May 9 planting but decreased from 26,000 to 34,000 plants for the May 30 planting. Reasons for this decline may be related to the rapidly declining hours of sunlight during grain ripening of the late planting. Plants were taller with May 30 planting date than with May 9 planting. Competition for light at the later date would be expected to be greater in high plant populations. Since the decrease in yield with the later date occurred only with the highest population, the results indicate that competition was involved. In practice it may be advantageous to reduce the plant population for some varieties if planting is delayed.

Nitrogen fertilizer rates showed no interaction with either plant population or planting date. From these results, it appears that growers need not alter nitrogen fertilization if only moderate changes are made in either planting date or plant populations.

The percent protein in the grain was measured for all treatments to estimate any influences on corn quality. The results are given in table 2. Nitrogen fertilization resulted in a highly significant difference in protein content. Protein averaged 8.8 percent without added nitrogen and 11.2 percent with 200 pounds added nitrogen. An additional 200 pounds of nitrogen did not increase protein content. Higher protein content provides better grain quality when fed to some classes of livestock.

Plant populations had a highly significant effect on percent protein. Percent protein decreased as plant population increased. Planting date alone had no influence on protein, but the interaction of planting date with population for protein was significant. Protein was highest at 18,000 plants per acre for the May 9 planting, whereas with the May 30 planting the protein content was essentially the same for the first two populations and lower for the highest population (see figure 1).

In summary, yields were optimum at nitrogen fertilizer rates and plant populations near those used in commercial production. We found no evidence that nitrogen fertilizer rates should be altered with only moderate changes in planting date or plant population. A significant interaction for yield between plant population and planting date indicates that with the hybrid used in this study the planting rates may need to be reduced as planting date is delayed. Nitrogen fertilization at 200 pounds per acre gave a large increase in grain protein with the early planting date and somewhat less with the later planting date. Increases in plant population had an average negative effect on protein content.

Mrs. Renuka D. Arjal is a former graduate student in Agronomy, until recently with the Agricultural Development Bank, Kathmandu, Nepal. John D. Prato, now deceased, was Extension Agronomist and Maurice L. Peterson is Professor of Agronomy and Range Science, University of California, Davis.

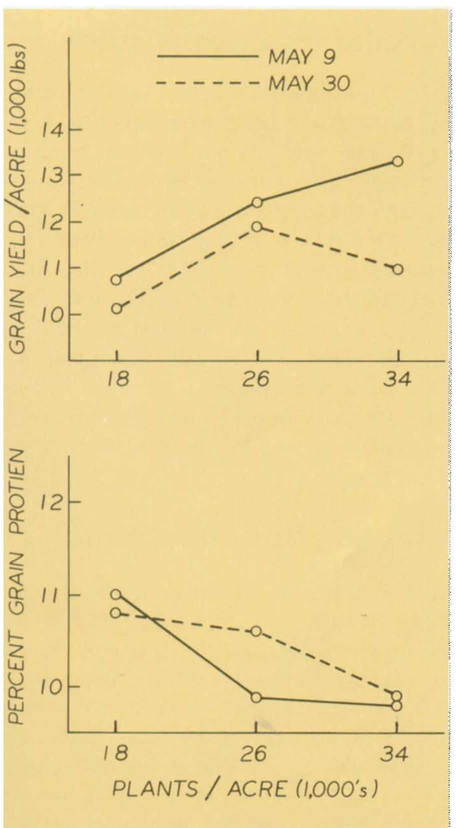

Fig. 1. Grain yield and protein percent of field corn for two planting dates and three plant populations.

TABLE 1. Effect of planting date, nitrogen rate, and plant population on grain yield.

Planting date	Population, plants/acre	Nitrogen applied, pounds/acre 0	200	400	Population means (over nitrogen rates)
		Grain yields, pounds/acre			
May 9	18,000	9,370	11,520	11,430	10,770
	26,000	9,340	14,040	13,940	12,440
	34,000	10,170	15,190	14,610	13,320
Mean (over populations)		9,620	13,590	13,330	12,180
May 30	18,000	8,520	10,960	19,870	10,120
	26,000	10,710	12,320	12,570	11,870
	34,000	9,190	11,850	11,960	11,000
Mean (over populations)		9,480	11,710	11,800	10,990
Nitrogen means (over dates and populations)		9,550	12,750	12,560	

LSD .05 for means of nitrogen rates = 1141 pounds/acre; population means = 549 pounds/acre; populations within planting dates = 1098; planting dates within populations = 1111.

TABLE 2. Effect of planting date, nitrogen rate, and plant population on grain yield.

Planting date	Population, plants/acre	Nitrogen, pounds/acre 0	200	400	Population means (over nitrogen rates)
		Grain protein, percent			
May 9	18,000	9.0	12.0	13.0	11.0
	26,000	8.0	11.0	10.8	9.9
	34,000	8.2	10.5	10.8	9.8
Mean (over populations)		8.4	11.2	11.2	10.2
May 30	18,000	9.5	11.5	11.5	10.8
	26,000	9.8	11.0	11.0	10.6
	34,000	8.5	10.8	10.4	9.9
Mean (over populations)		9.3	11.1	11.0	10.4
Nitrogen means (over dates and populations)		8.8	11.2	11.1	

LSD .05 for means of nitrogen rates = 0.50; population means = 0.3; populations within planting dates = 0.5; planting dates within populations = 0.4.