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Photo 1. The loss in asparagus stand shown above resulted from extending cutting season to 120 days.

THE LENGTH OF HARVEST SEASON for asparagus is frequently determined by economic factors or by factors other than a consideration of how the length will affect the plants and future performance. One of the most widely used practices is to terminate the harvest when the plants show a decrease in spear size. This termination is usually done arbitrarily and may occur after permanent damage to the field has taken place.

Past studies have shown that each asparagus producing area has an optimum or normal harvest period determined by the length of the growing season and by the plants' capability to synthesize and store reserve sugars for the subsequent season. Extending the "normal" cutting season for two weeks has been shown to result in a significant decrease in spear size, and an extension of four weeks reduced the stand of asparagus as well as plant vigor.

In the desert areas of southern California the growing season is long; the summers are hot, and the winters are mild. The extreme climatic conditions of the summer months and the mildness of the winter period could adversely affect the synthesis and storage of reserve sugars either directly or indirectly. What the optimum length of the cutting season is, and whether there is a possibility of harvesting every month of the year were the main questions to be answered in this study.

The test reported here was conducted at the Citrus Research Center, Riverside, California, from 1963 through 1969. The experimental design was a randomized block with four replications. Each plot consisted of two rows, 35 ft in length, with crowns spaced 24 inches apart in-row. The beds were 60 inches wide. The test area was fertilized each year at the rate of 100 lbs of nitrogen per acre and furrow irrigated.

The treatments consisted of: (1) a 30-day harvest, in February and March, (2) a 60-day harvest in February, March, and April; (3) 90-day harvest in February, March, April, and May; (4) a 120-day harvest in February, March, April, May and June; (5) a 60-day harvest in June and July; (6) 60-day harvest in July and August; (7) a 60-day harvest in August and September; (8) a 60-day harvest in September and October; (9) a 60-day total harvest, 30 days in February and March, plus 30 days in August and September; and (10) a 60-day total harvest, 30 days in February and March, plus 30 days in September and October. The initial harvest treatments each season occurred between February 20 and 27.

Yield

The yield by weight and number of marketable spears for the five harvest seasons are given in tables 1 and 2 respectively. Treatment 2, a 60-day cutting period made during the spring produced the largest total weight for the five cuttings. The largest number of marketable spears were produced for treatment 9, a 30-day harvest in the spring plus a 30-day harvest in the fall. This was followed closely by treatment 2. The difference in number of spears between the two treatments was small and not statistically significant. The data suggest that if the test plots had been harvested for another season the yield of marketable spears for treatment 2 would have been larger than for treatment 9, since the production of spears for treatment 2 increased with each successive harvest season. This trend (an increase in yield with the age of the planting) was not characteristic of the yield for treatment 9.

Extending the cutting season from 60 days to 90 or 120 days increased the production of marketable spears in the first season (1965) but decreased production the following year. The decrease in production during the second harvest season was caused by a loss in spear size. During the third and fourth harvest seasons, both weight and number of marketable spears

ARAGUS YIELDS AND PLANT VIGOR as influenced by time duration of cutting

decreased. The reduction in number of spears produced during the third and fourth harvest season, was caused by a loss in stand, as shown in table 3 and photo 1.

The production of marketable spears during the summer months (June through October) was low. Treatment 5, a 60-day harvest during the months of June and July showed the greatest reduction in yield. The low yield of marketable spears during the summer months was caused primarily by the large percentage of off-grade spears characterized by loose heads, branching, excessive spear taper and whips (photo 2) rather than by low overall production.

In treatments 9 and 10, where the plants were harvested for one month in the spring and one month in the fall for a combined total of 60 days per season, trends were similar to those for treatment 3 where the cutting period was 90 days.

General growth

An estimate of the general vigor and growth of the plants subjected to the various treatments for four seasons was made by harvesting all the treatments for a period of 60 days during the spring of 1969 and using the yields as a measure of plant vigor. This comparison appeared logical since the stand for all the treatments except treatment 3 and 4 was similar (table 3).

The largest yield in both weight and number of marketable spears was obtained from treatment 1, followed by

TABLE 1. INFLUENCE OF TIME AND DURATION OF CUTTING SEASON ON THE WEIGHT OF ASPARAGUS SPEARS

Treatment number	Harvest period	No. days harvest	Weight of marketable spears (pounds per acre)*					
			1965	1966	1967	1968	1969†	1965–1969
1	Feb–March	30	1,261	587	2,940	3,121	4,225	12,136
2	Feb–April	60	2,745	3,975	5,333	5,745	3,644	21,444
3	Feb–May	90	4,119	3,291	3,501	3,479	1,384	15,776
4	Feb–June	120	4,857	2,675	2,206	2,278	669	12,687
5	June–July	60	808	934	692	761	1,031	4,227
6	July–Aug	60	1,810	1,500	873	722	1,342	6,248
7	Aug–Sept	60	1,745	2,458	1,344	1,069	1,805	8,423
8	Sept–Oct	60	2,526	2,874	2,063	1,143	2,479	11,087
9	Feb–April, Aug–Sept	60	3,471	2,074	2,626	3,475	3,248	14,895
10	Feb–April, Sept–Oct	60	2,553	2,449	2,738	2,561	2,468	12,770

* All treatments on 60-inch beds, crowns spaced 24 inches apart.
† All treatments harvested for 2 months during spring 1969.

TABLE 2. INFLUENCE OF TIME AND DURATION OF CUTTING SEASON ON THE NUMBER OF SPEARS

Treatment number	Harvest period	No. days harvest	Number of marketable spears per acre*					
			1965	1966	1967	1968	1969	1965–1969
1	Feb–March	30	16,801	7,654	40,012	50,902	80,896	196,267
2	Feb–April	60	39,484	51,182	66,739	104,668	76,292	338,366
3	Feb–May	90	62,695	57,996	64,904	83,386	40,697	309,679
4	Feb–June	120	78,687	51,089	41,475	56,005	15,681	242,939
5	June–July	60	17,143	27,660	20,628	30,367	27,878	123,678
6	July–Aug	60	33,292	53,889	28,251	31,114	38,581	185,128
7	Aug–Sept	60	39,919	69,260	51,182	41,070	47,666	249,099
8	Sept–Oct	60	60,766	75,825	80,243	45,426	65,713	327,974
9	Feb–April Aug–Sept	60	71,687	49,658	58,712	82,141	80,772	342,971
10	Feb–April Sept–Oct	60	49,440	66,739	56,130	70,069	61,108	303,487

* All treatments on 60-inch beds, crowns spaced 24 inches apart.
† All treatments harvested for 2 months in spring 1969.

TABLE 3. EFFECT OF TIME AND DURATION OF CUTTING SEASON ON THE STAND OF ASPARAGUS

Treatment number	Harvest period	No. days harvest	Ave. number of crown per plot*				
			1965	1966	1967	1968	1969
1	Feb–March	30	35	35	34	34	34
2	Feb–April	60	35	35	32	33	32
3	Feb–May	90	35	35	27	28	24
4	Feb–June	120	35	35	20	20	15
5	June–July	60	35	35	30	31	31
6	July–Aug	60	35	35	32	32	32
7	Aug–Sept	60	35	35	32	33	33
8	Sept–Oct	60	35	35	33	33	34
9	Feb–April Aug–Sept	60	35	35	33	34	34
10	Feb–April Sept–Oct	60	35	35	32	32	32

* Count taken in December the previous season.

Photo 2. Types of off-grade spears characteristic of asparagus harvest during the summer months.

treatment 2. This was not surprising since the vigor and growth of these plants was suggested by the progressive increase in yield with each harvest season (table 1, 2). The low yields and vigor ratings for plants harvested during the summer months indicate that the ability of these plants to produce spears was greatly reduced.

A harvest period in June and July of 60 days limits the growth period of the fern to three months before harvest and approximately three and a half months after harvest in Riverside. This total growth time appears to be sufficient to prevent the loss of stand but not adequate for good growth and plant vigor.

Harvests made later in the summer (treatments 6 and 7) permitted a longer growth period for the fern before the harvest but stored sugars would be utilized on the production of harvested spears and on growth of fern after the cutting season ends.

Since no harvest was made beginning in October and continuing until soil temperature inhibited the production of spears, it is difficult to project the yield for this period. However, the data suggest that a fall harvest may be feasible providing it begins late in the season and continues until the plant becomes dormant, thereby preventing stored sugars from being lost in fern production after the harvest season.

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A research brief . . .

POTASSIUM ROLE found essential IN STOMATAL FUNCTIONING for plant life

RECENT EXPERIMENTS have shed new light on two age-old and seemingly unrelated questions: why potassium is essential for plant growth; and how the stomata on leaves open and close.

Stomata, the microscopic pores formed by paired guard cells in the leaf epidermis, act as valves that simultaneously regulate water loss by transpiration and the entry of CO_2 from the air into the leaf for photosynthesis. It is known that stomata open when guard cells are inflated by the absorption of water. The inflation results osmotically from the build-up of solutes in guard cells. What had not been resolved in more than a half of a century of research is what the solutes are and how they build up to cause the stomata to open.

Solutes

In a series of papers evidence has been presented that solutes are built up to cause to stomata to open through the uptake of potassium by guard cells in osmotic amounts. Potassium is specifically required for opening brought about by light; no other physiological ion can substitute for potassium in this crucial role.

The first important step in this work in the Department of Water Science and Engineering at Davis began when strips of epidermis were obtained from leaves of broadbeans (*Vicia faba*) with their guard cells still functioning as in intact leaves. Such strips eliminated complications caused by other parts of the leaf in studies of stomata. The effects of ions and other chemicals were tested by floating the strips on solutions. When solutions of various ions at dilute and physiological concentrations were used, only potassium (and rubidium) permitted the stomata to open fully in light. Ions such as sodium, ammonium, magnesium, and calcium permitted little or no opening. Radioactive isotopes were used to determine the amount of potassium taken up during the opening process. From these data it was calculated that a sufficient amount of potassium was absorbed to act osmotically to produce the opening. Evidence was also obtained showing that the energy for potassium uptake came from light, probably via the process called cyclic photophosphorylation.

Reverse process

Closing of stomata in the dark is apparently brought about by the reverse process—a loss of potassium from the guard cells, followed by loss of water and deflation. We have demonstrated that potassium concentrations in epidermal strips and guard cells drop in the dark when stomata close.

The discovery of the role of potassium in stomatal function provides one of the long-missing links in understanding the operation of these important valves in leaves. This work also identifies for the first time a detailed physiological process in which potassium is absolutely necessary and cannot be replaced by other ions normally found in plants. It is now clear why potassium deficiency in plants is known to reduce stomatal opening and, therefore, transpiration and photosynthesis.—*G. D. Humble, R. A. Fischer, T. C. Hsiao, Department of Water Science and Engineering, University of California, Davis.*