

# Improved Asparagus Harvester

second experimental set-level, nonselective machine used to harvest test plots in commercial fields during 1957 season

Robert A. Kepner

**Relative yields** of green asparagus obtained by mechanical harvesting and by hand cutting, the operational characteristics of the machine in commercial plantings, and plant growth characteristics that influence the results of set-level harvesting, were studied in field test plots on two types of soil during the 1957 canner season.

The original experimental harvester—tested at Davis in 1952 and 1954—covered a bed width of only 15" and hence was not suitable for yield studies in conventional bed plantings. To permit recovery of spears from a band 30"–36" wide, as required for the older bed plantings, a new machine was built and—after preliminary trials late in the 1956 season—was field tested in 1957.

The new harvester utilizes the same basic principles as the original model, but the number of gripper units in the pickup assembly was increased to give a 35" effective width. Facilities for depositing the spears in boxes were also added. Sheet-metal dividers—about 2" above the flat-top bed—guide the standing spears into the rotating gripper units. A bandsaw type of blade, passing around four large pulleys, cuts the spears at or just below the ground surface immediately after they have been gripped. The cut spears are lifted by the grippers and dropped onto a cross-conveyor belt at the rear, which transfers them to an elevating conveyor discharged into a field box.



Cutting blade, conveyor, and roller of the second model asparagus harvester.

To carry the harvester and provide power, a small tractor was modified by moving the engine to the right, adding an extension in the rear-axle housing, and making various other changes. The total weight of the machine is 3,400 pounds and the wheel tread is 60". As on the first machine, most of the weight of the lifted portion at the rear is balanced by heavy springs. There is just enough weight on the depth-gage roller to keep the roller firmly on the bed.

Two test plots were selected—one on a peat soil on Jones Tract about 11 miles west of Stockton and the other on a clay loam on Union Island about seven miles south of the peat soil plot. Both plots were in commercial plantings of Mary Washington variety asparagus. The beds in the peat soil plot were 13 years old with an 8' row spacing. In the clay loam

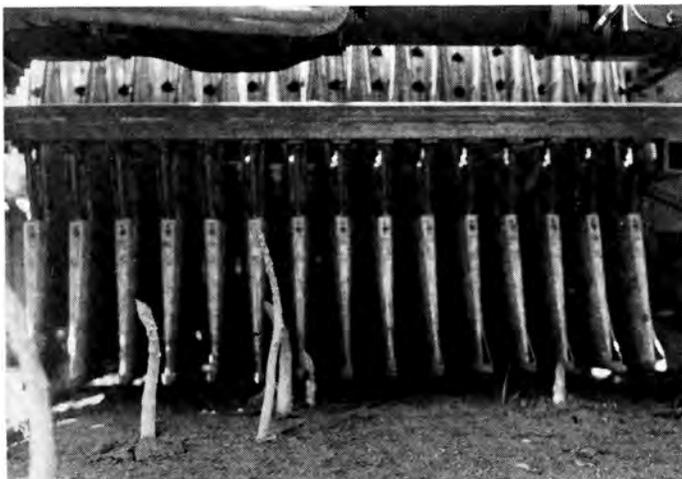
plot the 11-year-old beds had a 7½' row spacing.

Each test plot was 18 rows wide and 400' long. Four rows distributed across the plot were hand-cut by University personnel at the normal cannery-cutting stage of 4½" green. Two other rows were hand-cut at 6" green to determine the effect of spear height upon yield. The remaining 12 rows were machine harvested at three different stages of growth to determine the optimum schedule for maximum yields. The machine rows were cut at a soil depth of ¼"–½" when 2%–6% of all spears over 3½" in length were taller than 12" for Schedule A, 10" for Schedule C, and 8" for Schedule B.

The period of the tests corresponded approximately to the canning and freezing season, which started somewhat later than usual. The tests were initiated on April 22, when all beds in both test plots were disked. After disking, a special crowder-type of bed shaper was used on all machine rows to form the required flat-top beds, about 6" high and 32" wide on top.

From 8–10 machine cuttings were made between April 29 and June 9 on each of the various spear-length schedules. The special shaper was run over the machine beds once during this period. On several occasions a home-made wood-float harrow with spikes projecting downward about ¾" was pulled along

Left—Front view of harvester showing how spears are guided into pickup units by sheet-metal dividers. Right—Tractor adapted to carry harvester. Note the flat-top bed.



on top of the beds, immediately after cutting, to break crusts formed after rains. The hand-cut beds were disked a second time on May 25, in conformance with the normal practice of disking at intervals of 25-30 days to control weeds and reshape the beds.

The harvester recovered an average of 94% of all spears longer than 3½". Approximately one third of the missed spears were in the 3½"-4" length range. Tops of spears shorter than 3¼"-3½" are below the normal gripping level and are not recovered. The percentage of all culls other than seedy or open heads was a little greater for machine harvesting

**Cull Percentages for UC Hand Cutting, 4½"-Green Asparagus and for Machine Cutting, Schedule A**

Test plot	Peat		Clay loam	
	A	B	A	B
Machine cutting Nos. . . . .	2-5	2-5	8, 9	9
Total days . . . . .	24	23	9	9
Average mean temp., °F.	62.4	62.7	71.7	71.7
<b>Machine culls, % of total trimmed weight</b>				
Seedy or open heads . . . . .	9.9	14.8	41.9	41.9
All other culls . . . . .	13.7	10.8	12.5	12.5
Total culls . . . . .	23.6	25.6	54.4	54.4
<b>Hand-cut culls, % of total trimmed weight</b>				
Seedy or open heads . . . . .	3.3	6.2	32.3	32.3
All other culls . . . . .	9.1	6.6	9.2	9.2
Total culls . . . . .	12.4	12.8	41.5	41.5

No culls were discarded in the field during cutting.

than for UC—University personnel—hand cutting. Spear side damage caused by the machine amounted to 2%-3% of the total trimmed weight. Broken tips in machine harvesting represented another 2%-3%, as compared with only 1% for the UC hand cutting.

Mechanical performance of the harvester was satisfactory during the relatively short total operating time involved in the tests. There were no breakdowns and no serious problems in either type of soil. Most of the tests were at a forward

speed of 2½ miles per hour, but comparative runs at 3½ miles per hour demonstrated that there is no increase in percentage of missed or damaged spears at the higher speed. There were no apparent disadvantages or problems in operating at 3½ miles per hour.

The bandsaw blades—specially filed with four teeth per inch—were operated at a linear speed of 1,500' per minute. To determine wear rates for each soil type, one blade was used only in the peat soil and a second blade was used only in the clay loam. The results indicate that a blade will need replacement after 6-7 hours of operation in abrasive soils or 30-40 hours in peat soils.

During the first part of the season, cutting was at a depth of ¼"-½". Later, as the beds became more firm, the blade tended to bow up over the top of the bed with very little penetration. This lack of penetration did not appear to create any problems, and perhaps tended to reduce the rate of blade wear. At no time during the season was there evidence of regrowth from the cut stumps in the beds.

The harvester proved to be an effective means of controlling weeds on top of the beds. Thus, the need for reworking beds several times during the season—a current practice with hand cutting—would be eliminated.

### Growth Characteristics

The distribution of spears, by lengths, for the three machine schedules is indicated in the table at the right. The preponderance of spears in the shorter lengths—undesirable for set-level harvesting—is a result of the increased rate of growth of a spear as it becomes taller. For example, during a 5-day period of warm weather—85°-101°F maximum temperatures and 74°F average mean

temperature—average amounts of growth of 12 spears during successive 24-hour periods were 1.0", 1.6", 2.8", 4.7", and 6.1", giving a total 5-day height of 16.2". During a relatively cool period when the average mean temperature was only 60°F, growth rates increased much more slowly, ranging from 0.8" during the first 24 hours to 1.9" during the fifth 24 hours. In general, the rate of growth per hour during the daytime was 2-3 times as great as during the night. Thus, 55%-65% of the total 24-hour growth occurred between 8 a.m. and 5 p.m.

**Length Distribution for Spears Over ¾" Diameter Produced on Machine-Harvested Beds**

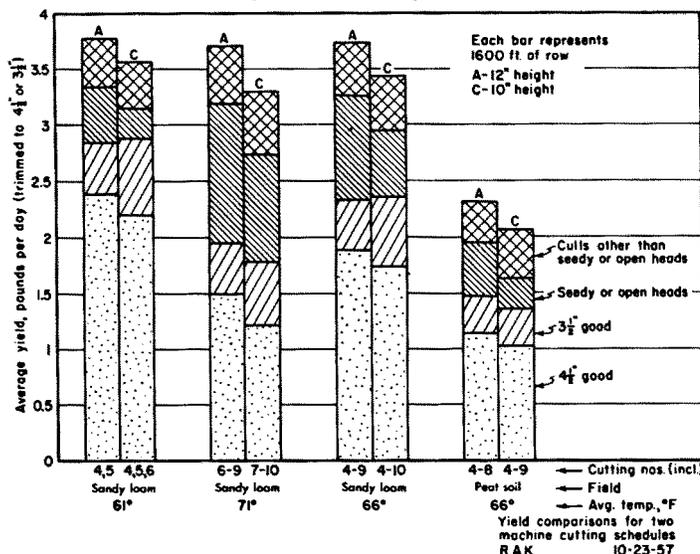
Test plot	Peat		Clay loam	
	A	B	A	B
Cutting schedule . . . . .	5-8	5-9	7-10	6,8,10
Cutting Nos. . . . .	5-8	5-9	7-10	6,8,10
Total No. spears* . . . . .	3,900	8,500	6,900	3,500
<b>Per cent of total number of spears</b>				
0"-3½" length** . . . . .	47.7	42.9	52.5	59.9
3½"-6" length . . . . .	25.7	25.8	28.1	31.1
6"-8" length . . . . .	13.4	15.0	12.5	7.6
8"-10" length . . . . .	7.5	9.4	5.0	1.4
10"-12" length . . . . .	3.5	4.7	1.6	0.0
Over 12" length . . . . .	2.2	2.2	0.3	0.0

\* Obtained by counting all emerged spears over ¾" diameter just prior to each cutting.  
 \*\* Determined by subtraction. Other length groups counted after harvesting. Missed spears as well as those recovered are included.  
 Results include only cuttings made on-time. Total emergence counts were not made for any of the first four cuttings.

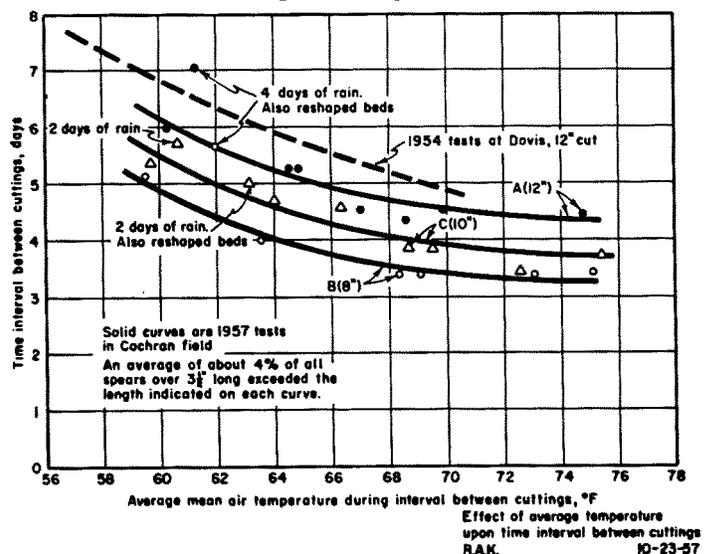
Time intervals between machine cuttings were considerably greater in cool weather than in warm weather. For a given mean air temperature, rain tends to retard the growth rate and increase the time interval, perhaps because of reduced soil temperatures. In general, there was about one half day difference between schedules A and C and between C and B. Time intervals for Schedule A ranged from about 4½-6 days.

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**Comparative yields for machine-cutting Schedules A and C in sandy loam and in peat soils.**



**Time intervals between machine cuttings, in relation to average air temperature.**



# ASPARAGUS

Continued from preceding page

Another growth characteristic that adversely affects yields from set-level harvesting is the decrease in trimmed-spear weight as the spears become taller. There was a marked decrease in trimmed-spear weight between heights of 4½" and 6"-7", although not much further decrease at greater heights. The 4½" trimmed weights of 6"-green hand-cut spears were about the same as for 5"-6" machine-cut spears. Spear weights were about the same in both fields. An additional undesirable factor is the tendency for the taller spears to become seedy or open, especially in warm weather.

Daily counts of the total number of emerged spears on several of the machine rows indicated that in these plantings there was no apparent tendency for the plants to cycle. After an initial delay of perhaps one half to three fourths day, approximately the same number of new spears appeared each day until the next cutting, provided there was no great variation in the daily mean temperatures and no rain. For set-level harvesting it would be highly desirable to have each plant produce most of its new shoots within a day or two after each cutting.

## Yields

Actual spear lengths in the three most common can sizes for top-grade canned asparagus spears range from 3¾"-4¼". A California Marketing Order proposed for 1951-52 specified 4½" as the minimum delivered length for the top grade, identified as Number 1-4½" green asparagus for canning. A tolerance grade of Number 1-3½" green asparagus for canning was also proposed, with the weight of this grade not to exceed 15% of the total weight of the mixed lot. In the 1957 tests, all hand-cut spears and all machine-cut spears longer than 4½" —and over 3/8" in diameter—were trimmed to a final length of 4½". Machine-cut spears in the as-harvested length range of 3½"-4½" were trimmed to 3½". As an intermediate step, all

spears longer than 7" were trimmed to 7" and weighed. This weight, plus the weight of untrimmed shorter spears in the case of machine harvesting, represents the present basis for payment to the grower.

The percentage of culls from the UC hand cutting was lower than for machine Schedule A by an average of about 12%-13% of the yield. However, there is little doubt that with commercial cutters and the added handling involved in hauling from the field, tip damage would be considerably greater than the 1% figure for UC hand cutting, thus reducing the total cull difference between machine and hand harvesting.

With machine-harvested asparagus the portions removed in the final trimming have some value—as green center cuts or soup cuts—which tends to compensate

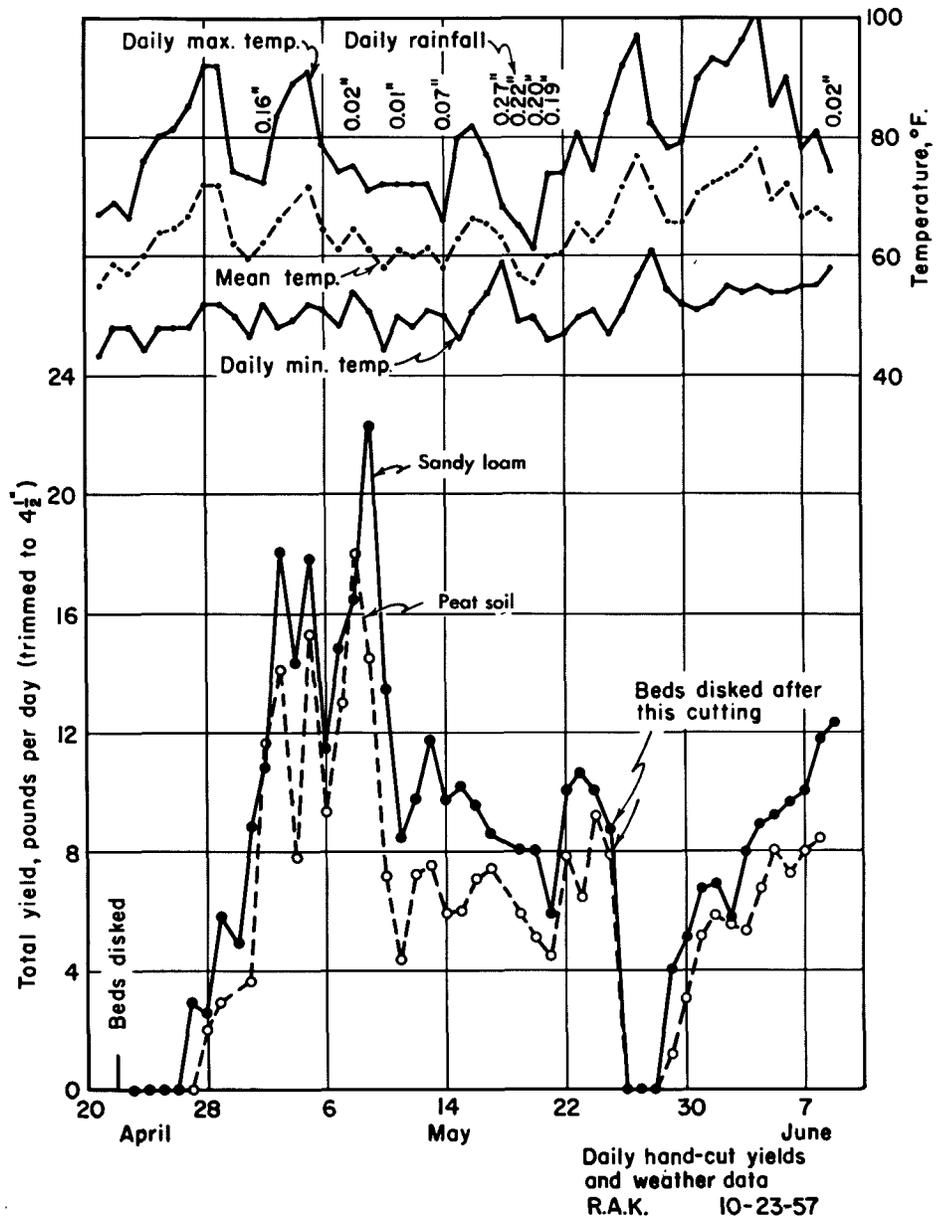
for any slightly greater percentage of culls. Furthermore, grading is rather arbitrary, particularly in regard to seedy or open heads. For these reasons, comparative yields are based upon the total of the 3½" and the 4½" trimmed weights, including culls.

During the 7-week period of these tests the 4½"-green UC hand-cut rows on the peat soil plot produced 800 pounds of 4½" spears per acre and the clay loam plot had a yield of 1,150 pounds per acre. On the 7" basis these yield figures would be just twice as great.

Analysis of the daily hand-cut yields indicates that for the eight days following the second disking, the total production was equal to about three days' production at the average rate obtained during the preceding two weeks and the

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Daily production from 4½"-green hand-cut rows in test plots. Temperatures and rainfall data are shown at the top.



Trimmed length, inches	Ave. weight, gm per spear*	
	Peat soil plot	Clay loam plot
Hand-cut, 4½"-green... 4½"	11.8	11.8
Hand-cut, 6"-green... 4½"	10.2	10.2
Machine-cut, Sched. A		
3½"-4½"..... 3½"	8.4	7.8
4½"-5"..... 4½"	10.9	10.9
5"-6"..... 4½"	10.1	10.4
6"-8"..... 4½"	9.0	9.4
8"-12"..... 4½"	9.1	9.0
All over 3½"..... 3½", 4½"	9.3	9.3

\* Weights are averages for entire season and include culls as well as good spears.

fact that vigorous plants usually silk early—when ample pollen is available—while weak plants silk late. Full stands of vigorous, uniform plants, silking over a relatively short period, are necessary to minimize blanking.

Varieties can show genetic differences in susceptibility to blanking. In three replicated variety trials in Coachella Valley and near Riverside, T Strain and T-51 showed an average of only 3% blanking, while Creamcross—poorly adapted to these areas—had 32% severe blanking. The difference was highly significant. None of these plots was subjected to serious wind. The blanking in Creamcross was principally near the tips, and reflects the frequent inability of this variety to develop ear tips on which kernels can develop.

Two replicated trials were planted in January and February, 1957, in Coachella Valley to test the effect of seed size on plant vigor and blanking. Random samples of seed from bulk lots of Golden Cross Bantam T Strain were separated into three size groups, averaging 219 mg—milligrams—177 mg, and 144 mg per seed. No significant differences were obtained in per cent germination, tillers per plant, or per cent of ears with blanking. However, weather conditions in these trials were favorable for rapid germination and growth. Under unfavorable conditions, it is possible that small seed might produce weaker plants, with more tendency toward blanking.

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*When these studies were made, R. Kasmire was Farm Advisor, Riverside County, University of California; and C. D. McCarty was Principal Laboratory Technician in Horticulture, University of California, Riverside, and both men assisted in certain parts of the work.*

*The above progress report is based on Research Project No. 1380*

## SHRIVEL

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Under more optimum growing conditions shrivel could be expected to be much less severe than in this particular trial. Under adverse or suboptimal conditions, on the other hand, spacing could be a much more critical factor.

The timing of nitrogen sidedressing applications to the crop apparently affects the tendency toward shrivel. In the spring of 1957, six treatments were set

Fertilizer Test Plots in Coachella Valley  
(Nitrogen applied by sidedressing)

N* lbs.		Total lbs. N**	No. mkt. ears	Ears showing shrivel %	Shrivel index	
at 12"	at 3'					
103	103	278	104	4.2	0.136	
68	68	208	105	4.0	0.122	
34	34	140	102	5.2	0.164	
68	0	140	100	14.5	0.459	
0	68	140	91	4.0	0.094	
0	0	72	46	32.4	1.096	
Least significant difference (0.05) . . . . .					19	0.168
Least significant difference (0.01) . . . . .					26	0.232

\*Nitrogen applied as ammonium sulfate.

\*\*Includes 72 lbs. nitrogen applied prior to sidedressing application.

out—with in-the-row plant spacing at 12"—in the Coachella Valley. Three of the plots received various total amounts of nitrogen, in two equal sidedressing applications: 1, when the corn was 12" high, and 2, when the tassels began to appear and the corn was about 3' high. One plot was treated only at the 12" stage, and another only at the 3' stage, using the same rate of nitrogen. One plot was held as a control without application of nitrogen. A high incidence of shrivel in the upper ears occurred in the control plot and the plot which did not receive the late application of nitrogen at the early tassel stage. In comparing the three plots that received the same total amount of nitrogen, it is evident that it is the time of the application which is important rather than the total amount applied. The control plot—which received no nitrogen at either growth stage—exhibited severe chlorotic symptoms in the latter part of the growing season. The severe stress placed on these plants is also indicated by yields about 50% lower than the other treatments.

Results of these tests indicate that shrivelling in sweet corn can be greatly reduced by cultural practices such as choosing a satisfactory variety, an adequate fertilizer program, adjustment of plant spacing, and possibly irrigation practices.

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*The above progress report is based on Research Project No. 1175-E.*

## ASPARAGUS

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following week. Thus, the second disking caused a loss equivalent to five days of normal production. The loss following the first—and more severe—disking appeared to be a little greater in terms of days lost. If hand-cut beds are disked on an average of once every 25 days, the over-all yield would be about 80% of the yield during the periods not affected by the diskings.

Hand cutting at the 6"-green stage, rather than at the usual 4½"-green stage for canning, did not affect the total number of spears but reduced both the weight per spear and the total yield by about 15%. In addition, a larger percentage of the spears were culls because of seedy or open heads, especially during warm weather.

Machine cutting Schedule A—with the longest time intervals between cuttings—was a little better than Schedule C and

much better than Schedule B in regard to yields. Cutting less frequently decreases the percentage of spears shorter than 3½" but the percentage of spears with seedy or open heads increases. Although Schedule A produced a considerably greater weight of seedy or open heads than did Schedule C, it also had about 10% more weight of 4½" good spears and about the same total weight of 3½" plus 4½" good spears.

Harrowing the tops of the machine-cut beds to break the crust had no apparent effect upon yields. Reshaping the beds with the special shaper may result in the loss of a day's yield, or perhaps less, depending upon the depth to which the beds are disturbed.

Yields for UC hand cutting and for machine Schedule A were compared for periods during which the hand-cut yields were not affected by disking. Machine-harvested yields did not include spears missed by the machine. For the clay loam plot, the total harvested yield in cuttings

2-5, 8, and 9—periods with no hand-cut disking losses—was 41% of the corresponding hand-cut yield. On the peat soil plot, the machine-harvested yield for cuttings 2-5 was 38% of the hand-cut yield. Considering that the over-all hand-cut yield was about 80% of the average yield for periods not affected by disking, the machine-harvested yield of recovered spears becomes 50% of the over-all average yield for the 4½"-green UC hand-cut rows.

During the early part of the season, hand-cut yields obtained by the University personnel on the plot rows were compared with those obtained by two commercial cutters from the growers' crews on six adjacent rows. After only 10 days of cutting experience, the University cutters were getting about 10% more yield than the commercial cutters, even though the latter were considered to be better than average. Probably the adjustment applied to UC hand-cut yields

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## ASPARAGUS

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should be greater, but on the 10% basis the machine-harvested yield would be 55% of the yield from commercial hand cutting.

During periods not affected by disking, the hand-cut rows and the machine-cut rows on the clay loam plot produced about the same total number of spears. Nearly three fourths of the reduction in yield with machine harvesting was due to the high percentage of spears that were shorter than 3½" when cut. The smaller average weight per spear in comparison with 4½"-green hand cutting accounts for another fifth of the yield reduction. The loss of spears over 3½" missed by the machine is of minor importance.

### Cost Comparison

At a speed of 3½ miles per hour, a one-row harvester operating in a field with a 7' row spacing should average 2¼ acres per hour and take care of 125 acres. This would require operating 12½ hours per day to cover the acreage in 4½ days as would be required in hot weather. During most of the season, 9-11 hours per day would be adequate. The harvester and operator would replace 15 hand cutters as well as the two men and motorized cart now required to haul out hand-cut asparagus.

To arrive at a cost comparison for machine harvesting and hand cutting, the first cost of the harvester—with tractor—was estimated at \$3,500, total overhead and operating costs for the harvester—including blade replacement in abrasive soils—was estimated at \$10 per acre per season, and it was assumed that 125 acres would be handled by one machine. The hand-cut yield—on a 7" basis—was assumed to be 2,500 pounds per acre, and a typical price paid to grower on the same 7" basis was considered to be 10¢ per pound. Labor cost for cutting and sledding was taken as 3¾¢ per pound plus \$40 per man per season for bringing in Mexican Nationals and for other miscellaneous expenses. The wage rate for the harvester operator was figured at \$1.25 per hour; total overhead and operating costs for present motorized carts at \$2.50 per acre per season. On the basis of the 2,957 field tests, the machine-harvested yield was considered to be 55% of the hand-cut yield.

The total estimated savings per acre, resulting from the elimination of the hand cutters and the motorized carts, would be \$103. Total machine-harvesting charges, including loss of yield, would be \$129 per acre. Thus, neglecting other economic differences, the grower's annual income would be reduced \$26 per acre by the use of the mechanical harvester. For the assumed conditions and estimated costs, mechanical harvesting

and hand cutting would yield the same net return per acre if the machine-harvested yield were 65% of the hand-cut yield.

### Improvement of Yields

Machine-harvested yields would be significantly increased if the percentage of short spears could be reduced. It is possible that existing asparagus varieties may be found or new varieties developed that will have a tendency to cycle when harvested by the set-level method. There is limited evidence from earlier tests that—under some conditions—the percentage of spears longer than 3½" is somewhat greater than observed in the current tests. The effects of cultural practices, height of the bed over the crowns, and various other factors need to be investigated.

Another factor that would affect the ratio between hand-cut yields and machine yields is the age of the beds. Because both fields selected for the 1957 tests were rather old, the spears emerging from each crown were distributed over a relatively large area. In younger beds, where the spears are much closer together, hand cutters could be expected to damage or cut off more short spears adjacent to the one being harvested. Thus, the machine-versus-hand yield ratio should be higher in young beds than

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## ROSE CLOVER

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### Plant Tissue Analysis

To estimate the phosphorus needs of rose clover in the 1957 growing season, plant tissue analyses were made of samples harvested in 1956. By using the basic principle of plant tissue analysis—that the chemical composition of a plant reflects its soil nutrient supply—the critical level of total phosphorus in the entire top at the late-bloom stage of development was determined to be 0.19%. Plants with a phosphorus level below that value were deficient, and a growth response to addi-

tional phosphorus could be expected. Plants at or above the 0.19% level could not be expected to respond to phosphorus applications.

Results obtained in 1957 fulfilled expectations. Plots that received the 300-pound per acre treatment in 1955 produced clover with a phosphorus value of 0.16% in 1956 and clearly responded in 1957 to the repeat treatment. Plant composition and yield were reduced in 1957 where no repeat phosphorus treatment was applied in 1956. Where 600 pounds of superphosphate were applied in 1955 the phosphorus value in the clover in 1956 was 0.19%. Additional phosphorus applied at the same 600-pound rate in

1956 caused an increase in yield which was not quite significant statistically. Re-fertilization of plots originally treated with 1,200 pounds of superphosphate and which produced clover with a phosphorus value of 0.24% in 1956, showed—after retreatment—a slight but not statistically significant increase in yield in 1957.

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*The above progress report is based on Research Project No. 1526*

Effect of Fertilizer Treatment on Uptake of Nitrogen and Phosphorus in Range Forage Expressed as Pounds Total Nitrogen and Total Phosphorus per Acre

Fertilizer treatment			Nitrogen uptake in forage			Phosphorus uptake in forage			Apparent phosphorus recovery		
Super-phos. applied per acre	Lbs. P per acre*		First year 1956	Second year—1957		First year 1956	Second year—1957		As % of original phosph. applied		As % of reapplied phosphorus 1957
	Single applications	Repeat applications		Carry-over	Additional P applied		Carry-over	Additional P applied	1st yr. 1956	Carryover 1957	
			Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	%	%	%
Check	...	...	10.4	15.8	15.8	1.18	1.66	1.66	...	..	...
300	24.9*	49.8	43.0	32.3	86.6	3.68	3.26	9.93	10.0	6.5	26.7
600	49.8*	99.6	69.6	59.8	81.7	6.48	5.80	11.49	10.6	8.4	11.4
1,200	99.6*	199.2	76.2	66.7	85.8	8.36	7.27	11.52	7.2	5.6	4.3

\* These values correspond to 57, 114, and 228 pounds P<sub>2</sub>O<sub>5</sub>—available phosphoric acid—per acre.

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in old ones. Additional tests will be necessary to determine the significance of this factor.

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*Robert Cowden, Senior Laboratory Technician, and Tom Clarke, Engineering Aid, Agricultural Engineering, Davis, assisted in the tests reported in the above article. The K. R. Nutting Co. and Cochran Company, Inc., cooperated in the studies.*

*The above progress report is based on Research Project No. 1693.*

*Results of tests with the first model are described in CALIFORNIA AGRICULTURE for October, 1952, and September, 1954.*

## GROCERY STORES

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alone. Of the smaller stores, from 2% of the stores with one or two employees in Alameda County to 21% in Fresno County, and from none of those with 3-6 employees in Butte and San Diego counties to 4% in Los Angeles County were of the clerk-service only type.

To be continued

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For research on influence of microenvironments on insects	
United Fruit Co. . . . .	\$10,500.00
For research on pathogenic fungus genus Fusarium	

### DAVIS

Beet Sugar Development Foundation . . . . .	\$5,000.00
For research on nematode plant relationships on sugar beets	
California Cooperative Rice Research Foundation, Inc. . . . .	\$771.00
For rice field insect survey and control	
California Grape Certification Association . . . . .	\$2,600.00
For sand culture setup for grape nutrition studies	
Di Giorgio Fruit Corporation . . . . .	20 chests of Cardinal grapes 12 lugs Thompson seedless grapes
For market quality studies of table grapes	
The Dow Chemical Co. . . . .	\$1,500.00
For studies with anthelmintics in sheep and cattle	
Hunt Foods, Inc. . . . .	\$2,400.00
For research on tomatoes	
U. S. Public Health Service . . . . .	
For research on metabolism of phytopathogenic bacteria . . . . . \$4,206.00	
For research on host parasite relationships of <i>Toxocara canis</i> . . . . . \$10,641.00	
For research employing fluorescent antibody . . . . . \$1,561.00	
For study of immunity and pathogenesis of <i>Listeria monocytogenes</i> infections . . . . . \$12,650.00	

### Various donors

E. I. DuPont DeNemours & Co.	Monsanto Chemical Co.
Geigy Agric. Chemicals	Dow Chemical Co.
Chipman Chemical Co., Inc.	Stauffer Chemical Co.
To develop technique for reducing plant competition by chemical application in reseeding of annual rangelands with perennial grasses and annual legumes . . . . . Numerous herbicides	
Wheeler, Reynolds & Stauffer . . . . .	550# carbon bisulfide
For treatment of soils for fanleaf disease in experimental plots at Beaulieu Vineyards, Rutherford, California	

### LOS ANGELES

Merck & Company, Inc. . . . .	\$5,000.00
For isolation and identification of gibberellin-like substances in plants	

### RIVERSIDE

Charles Pfizer & Co., Inc. . . . .	Various compounds
For air pollution research	
Pure Gold . . . . .	\$660.00
For foreign citrus budwood importation project	
Union Carbide Chemicals Co. . . . .	\$1,000.00
For research on chemicals of potential value as nematocides	

### STATEWIDE

Co-Agencies, Inc., W. M. Barnhill . . . . .	1 carton Gopher Tabs
For rodent control studies in Orange County	
L. E. Newell . . . . .	3 Hudson Sprayers
To apply insecticides, weed sprays and fungicides to experimental plots in Los Angeles County	