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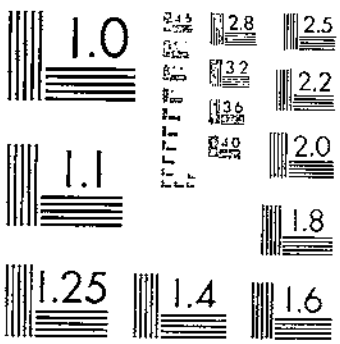

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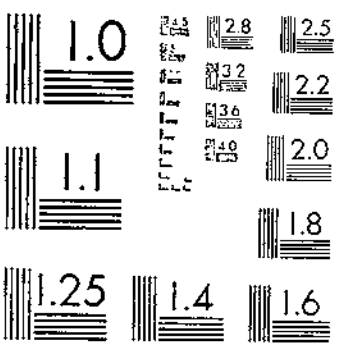

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INVESTIGATIONS ON RUNNER AND FRUIT PRODUCTION OF EVERBEARING STRAWBERRIES

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CONTENTS

INTRODUCTION

Everbearing strawberries have been grown for market in the United States for less than 25 years. Though at present they constitute only a small part of the strawberry industry, they are important in home gardens in the Northern States. Since the introduction of the Progressive, Mastodon, and Rockhill varieties they have attracted considerable commercial interest.

Everbearing strawberries are of only limited commercial value, for which there are several reasons. As a general rule they fail to produce a sufficient number of new runner plants either to provide a uniform production of fruit during the late summer or to insure adequate propagation. Great difficulty has been experienced in keeping plants both vigorous and productive at the same time, especially during seasons of unfavorable weather conditions. Droughts of sufficient duration to check growth and production of everbearing strawberries occur during most seasons in most sections. The investigations reported here were undertaken to gain information on the growth characteristics of everbearing strawberries that might help in overcoming the difficulties encountered in their production.

HISTORY

Dammer (*1*)[1] reported on an experiment made by Duerkoptf which showed that frequent removal of runners increased fruit production.

[1] Italic numbers in parentheses refer to Literature Cited, p. 14.

Similar results were obtained by Darrow (*2*), who also found that frequent removal of runners caused more to be formed. Mann and Ball (*5*) found that deblossomed plants were more vigorous during midsummer and fall than plants allowed to fruit, but that all plants appeared identical by the following April. Mann (*4*) has shown that deblossomed plants continue to grow vigorously, retain their lateral roots, and develop new leaves and runners at an earlier date than plants bearing fruit. He also states that removing flowers at an early stage has the same effect as nitrogen in stimulating vegetative growth in spring in order to maintain greater vigor in the plants during the period of flowering and fruit setting.

Vilmorin (*7*) and Darrow (*2*) have reported on the formation of fruit buds and flowering stems in the axils of the leaves of everbearing strawberries instead of runners. The writer (*8*) found that under Maryland conditions fruit buds of everbearing strawberries were differentiated throughout the growing season except possibly in April and early May. He also reported that following the ripening of the spring crop practically no more fruit ripened until early July, and that during this fruitless period runners were produced from the axils of the leaves.

The removal of the spring flowers of everbearing varieties is a generally recommended practice. Millet (*6*) has recommended the removal of blossoms for the "fraisiers des quatre-saisons" (*Fragaria vesca* var. *semperflorens*), the everbearing variation of the European wood strawberry, from April 25 to May 15, in order to get continuous fruiting from the last of June until the autumn frosts. Vilmorin (*7*) recommended that the perpetual (everbearing) varieties be prevented from flowering and bearing fruit in May and from forming any runner plants at all, and that they be manured, mulched, and watered freely from July to the end of September. Fletcher (*3*) has recommended removal of blossoms until July 1, in the North.

METHODS AND MATERIALS

These investigations were carried on each summer from 1926 to 1931. The major portion of the work was done at the United States Plant Introduction Garden near Glenn Dale, Md., where irrigation was not available. Some work was done at the Arlington Experiment Farm, near Rosslyn, Va., where water for irrigation was available for two seasons. The Progressive variety was used in all the experiments, and the Mastodon in most of them. Several other named varieties as well as everbearing selections originated by the United States Department of Agriculture were also used.

The experiments were planned chiefly to show the effect of partial and continuous flower removal and partial and continuous fruit production upon runner and runner-plant production. The effect of partial and continuous runner removal was also studied. Records were made each season of the number of flowers and runners removed, berries produced, runners and runner plants produced, and the weight and number of berries per plot. Because the 1930 plots were planted to varying numbers of plants, the yield record for that year was calculated as yield per mother plant.

EXPERIMENTS AFFECTING RUNNER PRODUCTION

Since production of too few runner plants is the chief difficulty in the commercial growing of everbearing strawberries, studies were begun in 1926 to determine the effect of picking off flowers for different periods on runner production. The plants used were runner plants of 1925. The runners produced in 1926 were not removed, and none were produced after July 3. The result of removing the flowers was to increase the number of runners by 500 percent, as shown in table 1, and demonstrates clearly that runner production is very greatly stimulated by flower removal.

TABLE 1.—*Runner production of the Progressive variety of strawberry during the summer of 1926 under two treatments*

[25 plants in each treatment]

Treatment	Runners produced to—			Increase
	May 26	June 15	July 3	
	Number	*Number*	*Number*	*Percent*
No flowers removed		9	12	
All flowers removed to Aug. 21	27	62	72	500

Table 2 presents the results of a more extended study of runner production from the same plants for 2 years during the summers of 1927 and 1928 at Glenn Dale, also without irrigation. Plants of the Progressive variety were set in a special planting early in April 1927. Each treatment consisting of 10 plants was replicated five times, so that the data represent the runners produced by 50 plants. Under treatments A to E the runners were left attached to the mother plant and allowed to root. All runner plants produced in 1927 were taken out of the plots in the spring of 1928.

TABLE 2.—*Runner production of the Progressive variety of strawberry during the summers of 1927 and 1928, under treatments indicated*

[50 plants per plot]

Treatment	Runners produced			Increase over check
	1927	1928	Total	
	Number	*Number*	*Number*	*Percent*
A, continual flower removal	60	122	182	108
B, flower removal to July 1	64	47	111	63
C, flower removal to Aug. 1	68	89	157	131
D, flower removal to Sept. 1	79	157	236	247
E, check, no flower or runner removal	60	8	68	
F, flowers and runners removed to Aug. 1	83	82	165	143
G, runners removed to Aug. 1, flowers removed to Sept. 1	95	152	247	263

All treatments resulted in increased runner formation. However, treatments where flowers were either removed throughout the summer, or where they were removed up to September 1, resulted in the production of the most runners. The graphs in figure 1 show that runner production was highest during the month of June, just as in 1926, but covered a somewhat longer period the first year (1927) than

in the second year (1928). The check plants with no flower removal formed as few runners as any plot the first year, whereas during the second year the plants were so weak that the 50 plants produced only 8 runners. During both years a large part of the mother plants (47 percent) in all plots produced no runners. Where both runners and flowers were picked off in treatments F and G there was a slight increase in total number of runners produced in 1927, but as shown by treatment D in 1928, flower removal alone to September 1 was as effective as flower removal plus runner removal in treatment G.

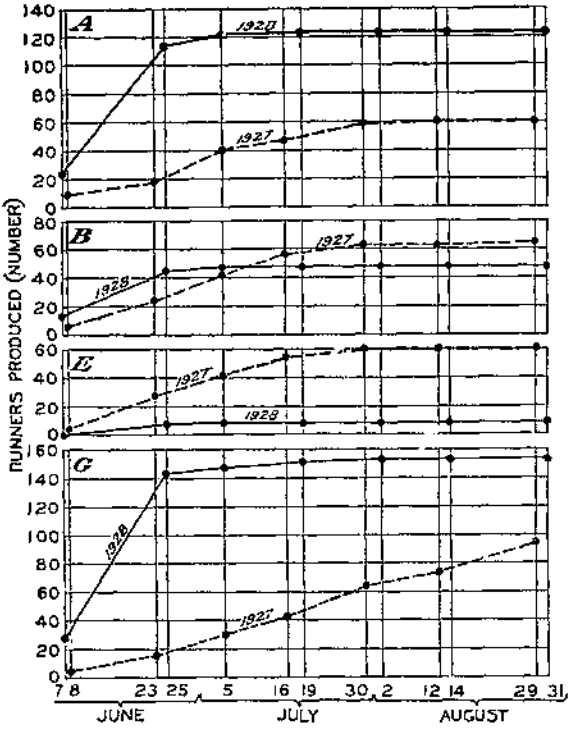

FIGURE 1.—Cumulative runner production per plot of 50 plants of the Progressive variety in 1927 and 1928 under the following treatments: *A*, Continual flower removal; *B*, flower removal to July 1; *E*, check, no flower or runner removal; *G*, runners removed to August 1, flowers removed to September 1.

Runner production per plant was greater in 1928 than in 1927. However, fewer mother plants produced runners in 1928 than in 1927, as shown in table 3, except in treatment A, with continual flower removal, and treatment D, with flower removal up to September 1. As indicated by the records for plots A, C, D, F, and G, both flower and runner removal in 1927 increased runner production in 1928 in mother plants already producing runners.

TABLE 3.—*Number of plants of the Progressive variety of strawberry producing 0, 1, 2 to 3, and 4 or more runners each during the summers of 1927 and 1928 under treatments indicated*

Treatment	Plants that in 1927 produced—				Plants that in 1928 produced—			
	No runners	1 runner	2 to 3 runners	4 or more runners	No runners	1 runner	2 to 3 runners	4 or more runners
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
A, continual flower removal	23	11	12	4	18	7	11	14
B, flower removal to July 1	21	15	10	4	31	7	8	4
C, flower removal to Aug. 1	21	7	17	5	20	7	7	10
D, flower removal to Sept. 1	18	10	16	6	13	7	16	14
E, check, no flower removal	25	8	14	3	45	2	3	0
F, flowers and runners removed to Aug. 1	18	10	13	9	31	4	6	9
G, runners removed to Aug. 1, flowers removed to Sept. 1	18	11	11	10	21	4	9	16

During the summer of 1928 another plot of Progressive strawberry plants was tested under irrigation at the Arlington Experiment Farm. In this test 10 treatments with 10 plants in each were tried as shown in table 4. Since in 1927 runner removal in addition to flower removal slightly increased runner production, it was considered possible that cutting runners from the mother plant after the first plant of the runner series had rooted would also increase runner production and that more new runner plants might be obtained from the mother plants by the end of the season. As shown in table 4, more runners were produced by the mother plants where the runner was cut after the first runner plant had taken root, but only half as many new runner plants were finally obtained. Apparently, new runner plants, even after taking root, still draw upon the mother plant for nourishment, and when the connecting runner was cut the growth of the runner plants was checked. The mother plant, however, when not helping to support growth in the runner plants, is able to produce more runners, especially when not developing fruit, as shown by treatment F.

TABLE 4.—*Runner and runner-plant production of the Progressive variety of strawberry under irrigation in 1928*

[10 plants per plot]

Treatment	Runners produced by mother plants	Runners producing plants	Total plants rooted
	Number	*Number*	*Number*
A–1, continual flower removal	31	29	307
A–2, continual flower removal, runners cut	35	28	105
B–1, flower removal to July 15	20	20	274
B–2, flower removal to July 15, runners cut	21	18	101
C–1, check (no flower removal)	19	18	270
C–2, check (no flower removal), runners cut	33	24	143
D–1, flower removal to Aug. 15	23	24	282
D–2, flower removal to Aug. 15, runners cut	43	38	110
E, flower removal to July 15, runners removed	22		
F, flower removal to Aug. 15, runners removed	74		

Under irrigation, continuous fruit production did not decrease runner production, as shown by treatment C. Although the number of runners produced was slightly lower where the runners were not cut from the mother plant (C–1), there were still approximately as many runner plants produced as in the other treatments.

Figure 2 shows graphically the period of runner production under eight of the treatments given. These graphs indicate that by cutting or removing runners even on plants producing fruit, runner production was extended into September, while the normal period of runner production is late June and early July.

In order to find out whether there were differences among varieties in their runner production habits, studies were made in 1929 on the period when runner-plant formation of six varieties of everbearing strawberries actually took place. Results of this study are given in table 5. U. S. D. A. 836 produced a great number of runner plants from June until October, forming nearly as many as most spring-bearing varieties. Because it produced low yields of berries in late summer, it is not considered a desirable everbearing strawberry under

these conditions. Superb produced most of its runner plants in September and October, starting later than other sorts.

TABLE 5.—*Runner plants taking root each month, produced by 10 mother plants in each of 6 everbearing varieties of strawberries in 1929*

Variety	June	July	August	September	October	Total
	Number	*Number*	*Number*	*Number*	*Number*	*Number*
Superb			10	51	37	98
U. S. D. A. 836	14	58	30	52	89	240
Mastodon		18	6	28	39	91
Progressive	2	11	28	24	6	71
Berri Supreme		3	9	16	6	34
U. S. D. A. 427	1	2	1	7	1	12

Figure 3 shows diagrammatically the runner-plant production of a single plant of the Progressive variety under irrigation. This plant

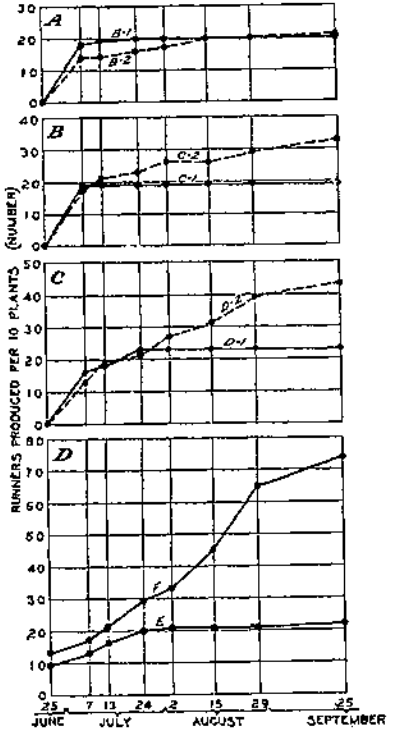

FIGURE 2.—Cumulative runner production per 10 plants of Progressive everbearing strawberries under irrigation showing the effect of cutting runners after the first runner plant had taken root, and of runner removal: *A*, Treatments B-1 and B-2 (table 4); *B*, treatments C-1 and C-2; *C*, treatments D-1 and D-2; *D*, treatments E and F.

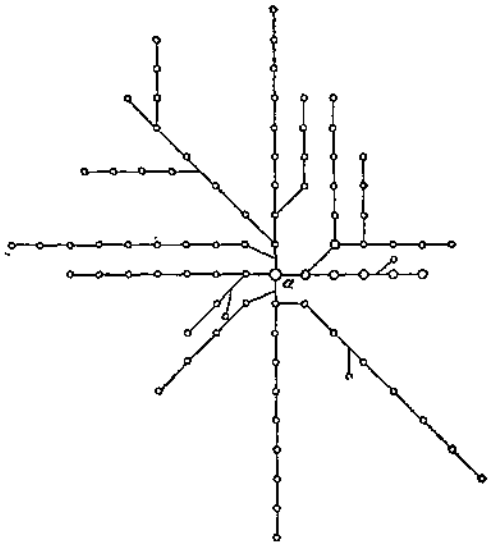

FIGURE 3.—Diagram showing origin of runners and of 84 runner plants from an unusually prolific single mother plant (*a*) of the Progressive variety in 1929 under irrigation.

produced only four runners, but the entire clon formed 84 new plants. The diagram shows several runners originating from the runner nodes. The general trend was toward the production of runner plants in a runner series.

Since previous studies had shown that runner production could be increased by flower removal, further tests were conducted in 1931 without irrigation near Glenn Dale, on plants set in the spring of 1931. All flowers were removed on plants of a number of varieties and U. S. D. A. selections (table 6). Plants were grown under both the matted-row and hill systems with flower removal until July 15, and in the matted row with flower removal until September 1. Each plot was 25 feet long; the number of plants set for each treatment is given in table 6.

There was some evidence of a greater effect of flower removal to September 1 than to July 15 on the production of runner plants. Four varieties produced more runner plants per mother plant where flowers were removed up to July 15, and seven varieties produced more runner plants where flowers were removed to September 1. The varieties gave quite variable responses to the different treatments, but total yields of fruit per plot were generally highest under the hill system and lowest in the matted row when flower removal was continued until September 1.

TABLE 6.—*Total and average runner-plant production and fruit yield for 11 everbearing varieties of strawberries under three treatments in 1931*

PRODUCTION OF RUNNER PLANTS

Variety	Total per 25-foot plot			Average per mother plant		
	Flower removal to Sept. 1, matted row, 15 mother plants	Flower removal to July 15, matted row, 20 mother plants	Flower removal to July 15, hill system, 25 mother plants	Flower removal to Sept. 1, matted row, 15 mother plants	Flower removal to July 15, matted row, 20 mother plants	Flower removal to July 15, hill system, 25 mother plants
	Number	*Number*	*Number*	*Number*	*Number*	*Number*
Mastodon	135	213		9.0	10.6	
Progressive	191	605		12.7	30.2	
Berri Supreme	462	322		30.8	16.1	
U. S. D. A. 1200	145	203		9.7	10.1	
U. S. D. A. 1207	41	137		2.7	6.8	
U. S. D. A. 1213	235	228		15.7	11.4	
U. S. D. A. 426	28	18		1.9	.9	
U. S. D. A. 1210	388	435		25.9	21.7	
U. S. D. A. 1223	199	154		13.3	7.7	
U. S. D. A. 1227	247	140		16.5	7.3	
U. S. D. A. 1232	214	101		14.3	5.0	

FRUIT YIELD

	Grams	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*
Mastodon	1,630	2,601	2,460	108.7	130.0	98.6
Progressive	869	2,517	3,903	58.0	125.8	156.1
Berri Supreme	913	1,324	2,520	60.9	66.2	100.8
U. S. D. A. 1200	1,570	3,255	3,919	104.7	162.7	156.8
U. S. D. A. 1207	981	3,318	2,185	65.4	165.9	87.4
U. S. D. A. 1213	848	914	1,916	56.5	45.7	76.6
U. S. D. A. 426	783	1,403	2,328	52.2	70.1	93.1
U. S. D. A. 1210	2,753	2,547	3,108	183.5	127.3	124.3
U. S. D. A. 1223	1,408	1,400	2,246	97.9	70.3	89.8
U. S. D. A. 1227	1,450	2,895	4,064	96.6	144.7	162.6
U. S. D. A. 1232	464	1,057	1,290	30.9	52.8	51.8

EXPERIMENTS AFFECTING FLOWER AND FRUIT PRODUCTION

Experiments on the effect of runner production, made in 1926, showed that when flowers are removed continuously throughout the summer many more flowers are produced than when they are allowed to mature fruit. For that year the plants from which all flowers were removed up to August 24 produced 49 flowers each; those from which all runners were removed up to August 24, and all the flowers after the early summer crop, produced 44 flowers each; and those fruiting during the same period produced but 19 flowers.

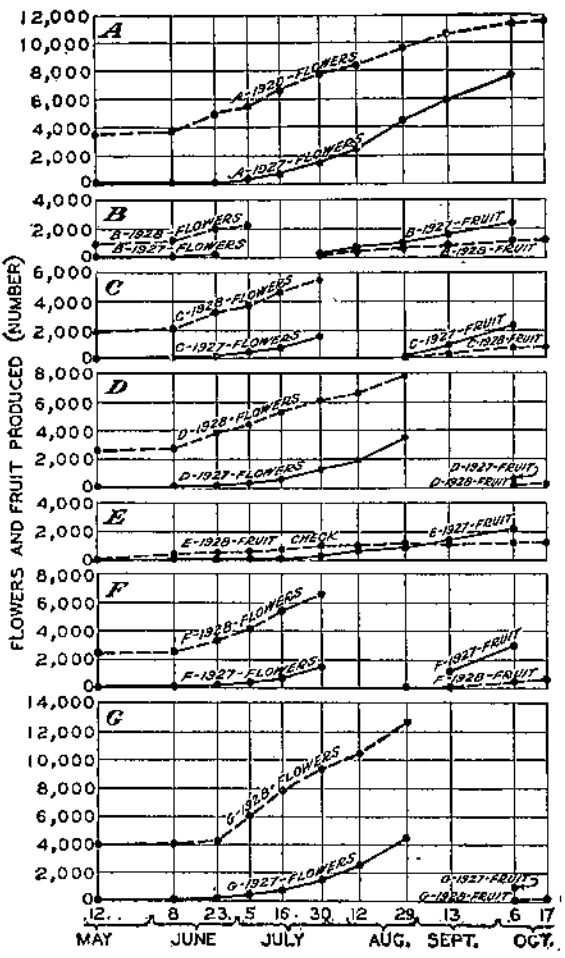

FIGURE 4.—Effect of flower removal and of fruit production on flower and fruit production in the Progressive everbearing strawberry in 1927 and 1928 under the following treatments: *A*, Continual flower removal; *B*, flower removal to July 1; *C*, flower removal to August 1; *D*, flower removal to September 1; *E*, check, no flower or runner removal; *F*, flower and runner removal to August 1; *G*, runner removal to August 1 and flower removal to September 1. (Cumulative data.)

The same response was noted in the studies during 1927 and 1928 (table 7). During these 2 years over five times as many flowers were produced by plot A (continual flower removal) as fruits by plot E (check). Figure 4 shows that in 1927 where flowers were continually removed (A) and where they were removed up to September 1 (D and G), there was in general an increase in the number of flowers removed as the season advanced. In 1928, however, under continual flower removal (A) there was a dropping off in flower formation in late September and in October. Runner removal plus flower removal (G) resulted in increased flower production toward the end of the season in both years and also in a very great amount of spring bloom in 1928. All treatments, as shown in figure 4, indicate a period of almost no flower production following the removal of the first spring blossoms. Figure 4 also shows that almost no fruit was produced from June 15 until after July 1 in the check plot E.

TABLE 7.—*Flower and fruit production of the Progressive strawberry under different treatments during the summers of 1927 and 1928*

[50 plants per plot]

Treatment	Flowers removed			Flowers produced		
	1927	1928	Total	1927	1928	Total
	Number	*Number*	*Number*	*Number*	*Number*	*Number*
Plot A, continual flower removal	7,753	11,528	19,281	0	0	0
Plot B, flower removal to July 1	146	2,232	2,378	2,360	1,168	3,528
Plot C, flower removal to Aug. 1	1,573	5,493	7,066	2,273	752	3,025
Plot D, flower removal to Sept. 1	3,416	7,851	11,267	536	151	687
Plot E, check; continual fruit production	0	0	0	2,310	1,278	3,588
Plot F, flowers and runners removed to Aug. 1	1,536	6,644	8,180	3,010	726	3,736
Plot G, runners removed to Aug. 1, flowers removed to Sept. 1	4,584	12,646	17,230	1,053	211	1,264

Table 7 gives the total number of flowers removed and fruit produced for all treatments for 1927 and 1928. The plots where flowers were removed to July 1 (B) and to August 1 (C) produced almost as many fruits as plot E, where the plants were allowed to fruit continually. The flower-removal plots also produced much larger berries. Where flower removal was continued to September 1, the number of berries matured was greatly reduced. Removal of both runners and flowers to August 1 resulted in the largest number of berries the first year, but not as many the second year as plot E with continual-fruiting treatment.

In the test under irrigation at the Arlington Experiment Farm in 1928, as shown in table 8, where the runners were cut there was little difference in the number of berries produced between the continual-fruiting plot (C–2) and the plot where flowers were removed to July 15 (B–2). However, where the runners were left uncut the check plot (C–1) produced more berries than the plot where flowers were removed to July 15 (B–1), but not so many as the plot where both flowers and runners were removed to July 15 (E). The cutting of runners apparently increased flower production under continual flower removal (A–1 and A–2) and also the production of fruit where flowers were removed to July 15 (B–1 and B–2).

TABLE 8.—*Flower and fruit production of 10 plants of Progressive strawberries under irrigation in 1928*

[Plants set in spring of 1928]

Treatment	Flowers removed	Berries produced
	Number	*Number*
A–1, continual flower removal	830	
A–2, continual flower removal, runners cut	1,159	
B–1, flower removal to July 15	214	229
B–2, flower removal to July 15, runners cut	181	357
C–1, check (no flower removal)		346
C–2, check (no flower removal), runners cut		337
D–1, flower removal to Aug. 15	620	187
D–2, flower removal to Aug. 15, runners cut	925	239
E, flower removal to July 15, runners removed	259	538
F, flower removal to Aug. 15, runners removed	996	188

Since runner removal increased flower and fruit production, a comparison of yields of 11 varieties was made in 1931 between the hill system with all runners removed and the matted-row system where the runner plants were allowed to take root and fruit. The results of a portion of the test are given in table 9 and figure 5. Two treatments were given those in the matted row, namely, flower removal to July 15, the same as in the hill system, and flower removal to September 1. In general, the average size of berry for the season was smallest and yield the greatest under the hill system. The lowest yields were obtained generally from the matted rows with flower removal to September 1, but this treatment produced the largest berries. The yield and size of berry were generally intermediate under the matted-row system with flower removal to July 15.

TABLE 9.—*Total yield per 25-foot row and average weight per berry of everbearing strawberries under 3 different treatments in 1931*

[Plants set in spring of 1931]

Variety and treatment	Total weight	Total berries	Average weight per berry
Progressive:	*Grams*	*Number*	*Grams*
Matted row, flowers removed to Sept. 1	865	363	2.39
Hill system, flowers removed to July 15	3,895	1,791	2.18
Matted row, flowers removed to July 15	2,515	1,037	2.43
Mastodon:			
Matted row, flowers removed to Sept. 1	1,030	335	4.86
Hill system, flowers removed to July 15	2,455	688	3.58
Matted row, flowers removed to July 15	2,590	661	3.93
Berri Supreme:			
Matted row, flowers removed to Sept. 1	913	148	6.17
Hill system, flowers removed to July 15	2,520	572	4.40
Matted row, flowers removed to July 15	1,324	271	4.88
U. S. D. A. 426:			
Matted row, flowers removed to Sept. 1	783	213	3.67
Hill system, flowers removed to July 15	2,328	707	3.29
Matted row, flowers removed to July 15	1,403	424	3.31
U. S. D. A. 1219:			
Matted row, flowers removed to Sept. 1	2,655	563	4.72
Hill system, flowers removed to July 15	3,110	882	3.52
Matted row, flowers removed to July 15	2,535	691	3.68

The cumulative yield graphs for the four varieties shown in figure 5 indicate that the treatment affects the yield in different parts of the season. Plants of Progressive and U. S. D. A. 1219 gave high yields under the hill system in August, dropped to a period of lower yield in early September, then rose to another peak at the end of September and early October, and dropped off in late October and November. Mastodon, in the hill system, dropped off after the first peak production in August and had no period of high production during September and October. Such varieties do not appear to be adapted to the hill system, since after the first peak production the plants became very weak. However, U. S. D. A. 1227 seems to be particularly adapted to hill culture. Its production was low in August but reached a very high peak in September and continued high into October.

Where the flowers were removed to September 1 in the matted-row plantings all varieties showed a peak production in late September and October. U. S. D. A. 1219 showed the highest production. Mastodon also had high peak production at that time. In general,

the usual matted-row system of culture with flower removal to July 15 in contrast shows two periods of peak production, the first in August and the second in late September and October. Most varieties produced about equal amounts during each peak period, although the second peak generally extended over a longer period.

Figure 6 gives the yield and berry size for four varieties of everbearing strawberries in 1930 during a season of severe drought. The strawberries were grown without irrigation but on soil of good moisture-holding capacity. During this season Progressive and U. S. D. A. 1227 grown under the usual matted-row system with flower removal to July 15 gave peak periods of production in late September. Mastodon and U. S. D. A. 1217, also grown in the same system, gave peak periods in late August. U. S. D. A. 1217 during the relatively wet season of 1931 gave a greater production in its second period of high production in October than in the first period (fig. 7). Figure 7 shows U. S. D. A. 1202 also with two periods of high production in 1931.

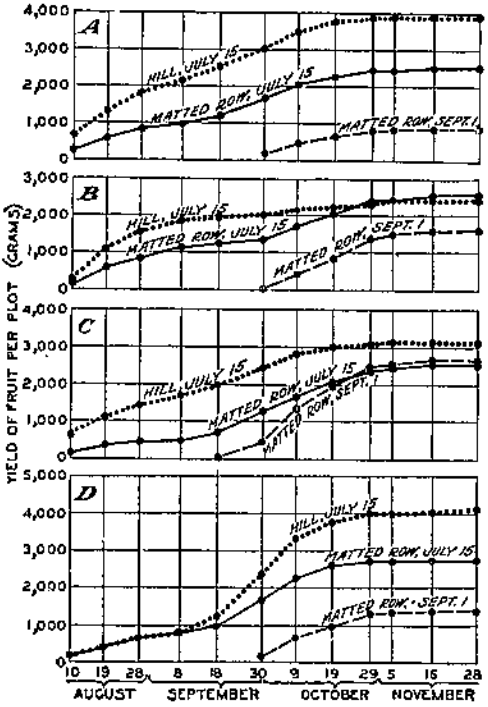

FIGURE 5.—Cumulative yield of fruit per plot from four varieties of everbearing strawberries under three different treatments in 1931 (flowers removed to Sept. 1, matted row; flowers removed to July 15, matted row; flowers removed to July 15, hills): *A*, Progressive; *B*, Mastodon; *C*, U. S. D. A. 1210; *D*, U. S. D. A. 1227.

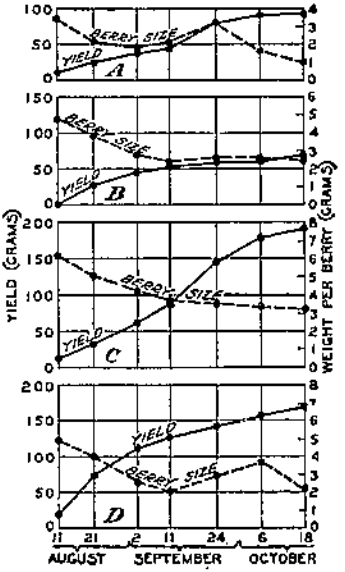

FIGURE 6.—Cumulative yield per mother plant and average size of berry of four varieties of overbearing strawberries in 1930, a season of extraordinary drought, in matted row; flower removal to July 15: *A*, Progressive; *B*, Mastodon; *C*, U. S. D. A. 1227; *D*, U. S. D. A. 1217.

SIZE AND YIELD OF BERRIES

Although in general the berries were large during the periods of high production in all these experiments, as shown by figures 6 and 7, they were usually largest at the beginning of the season. This is

because the primary berries which ripen first are the largest berries on the clusters. Ordinarily the size of berry began to decrease just prior to the drop in total production. Since the primary berries seldom constitute the greatest number of berries produced, the smaller secondary and tertiary berries make up the major portion of the yield which is therefore of smaller average size.

DISCUSSION

Everbearing strawberries are simply varieties that are able to form fruit buds during long summer days at high temperatures in contrast with the other sorts that form fruit buds during the shorter days of fall at cooler temperatures. Ordinary sorts show great variations in their response to even slight differences in day length and temperature, and everbearing varieties may also be expected to show wide variations in their responses to day length and temperature, just as the records given here have shown.

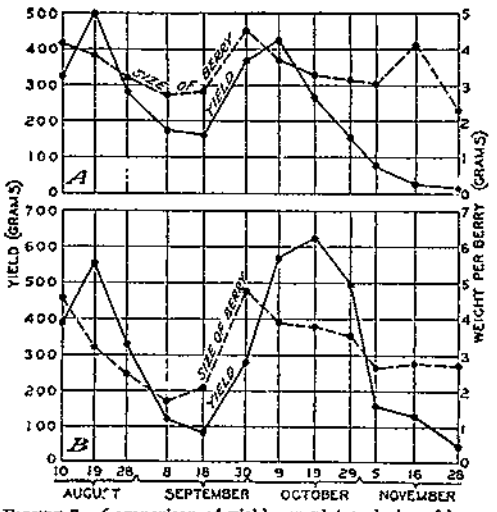

FIGURE 7.—Comparison of yield per plot and size of berry of two varieties of everbearing strawberries in 1931, showing that fruit production comes in cycles of high and low yields. Grown in matted row, with flower removal to July 15: *A*, U. S. D. A. 1202; *B*, U. S. D. A. 1217.

Ordinary sorts form runners during the long days of summer. Most runners are produced by everbearing sorts during the longest days of June and the early part of July. Apparently the period of long days is not long enough to induce the formation of as many runners as is desirable in the latitude of Washington, D. C., except as growing conditions are very favorable.

The experiments to increase runner production show that plant formation may be stimulated greatly by picking off the flowers as they appear, the increase ranging from 63 percent by flower removal to July 1 to 131 percent to August 1, 247 percent to September 1, and up to 500 percent by continuous flower removal under eastern Maryland conditions. They show also that runner production was stimulated through July and August when the runners were removed as they appeared. However, cutting the runners after the first plants had rooted reduced the total runner-plant production by one-half, and is evidence that runner cutting after the plants have rooted is not comparable in effect to continual runner removal and cannot be used under field conditions to stimulate runner-plant production. This response is also evidence of the dependence of the runner plants upon the mother plant for some time after the runner plants take root. Under conditions comparable to those of the experiments, if both flowers and runners are removed during the first season an increased number of runner plants may be expected in the second year.

Under irrigation practically as many runner plants were produced by plants from which no flowers were removed as by those having flowers picked off to July 15, August 15, or even throughout the season. The maintenance of abundant moisture through irrigation is an effective method of increasing runner-plant production in everbearing varieties, and far larger numbers of plants were produced in this way than under any treatment where irrigation was not used.

Striking evidence of the devitalizing effect of fruit production on nonirrigated plants was obtained. Fruit production during the early part of the season weakened the plants so that they produced relatively little later. Plants with flowers removed till July 1 and August 1 produced as many berries as did plants allowed to fruit throughout the season, and plants with both flowers and runners picked off till August 1 actually bore more fruit the first year than those allowed to fruit throughout the season. Even under irrigation, flower and runner removal to July 15 resulted in a decidedly greater yield during the rest of the season than no flower and runner removal. Flower removal must be practiced with the varieties now grown for at least part of the year in order to insure a crop of fair-sized berries for the remainder of the year. The best time to cease flower removal depends upon many factors, such as length and temperature of the growing season, amount of rainfall, whether irrigation is available, soil conditions, and growth habits of the variety.

In order to produce the most marketable fruit a new planting should be set each year, the field irrigated if possible, and the flowers picked off till about July 15. Although most varieties in these tests produced most under the hill system, the growth habit of Mastodon and some other varieties of everbearing strawberries is not adapted to the hill system of culture. The production of a large number of berries on the plants of such varieties at one time seems to weaken the plants, causing the later berries to be small. In such varieties the production of a crop of fruit by runner plants following the production of a crop of fruit by the mother plant seems to be the best production habit. Conditions that favor early production of runners and early rooting of runner plants are best for a late summer and fall crop.

In general, in regions where droughts occur most frequently in the summer, it is difficult to get a good stand of runner plants early enough to get a paying crop of berries from them. In such regions the hill system is most successful. In regions where the average summer moisture conditions are favorable or where irrigation is available, runner plants should be allowed to form on varieties like the Mastodon. The runner- and fruit-production habits of new everbearing sorts will need to be considered in order to determine the best method of growing them.

The data presented here show that everbearing varieties have many characteristic differences and that they respond to different treatments and conditions in characteristic ways. At present there are too few varieties for the various conditions under which everbearing strawberries are now grown. Both runner- and fruit-production studies showed greater differences between varieties than between plots of the same variety given different treatments, and indicate that greater improvement may be made in breeding new varieties than in any treatment given except possibly irrigation. It is still doubtful whether this type of strawberry will be of general importance as far

south as Maryland or of importance in northern districts only. Where temperatures are cooler and the summer days are shorter, in certain sections such as in the central coastal district of California, normal spring-bearing varieties such as the Marshall become everbearing.

SUMMARY

Runner production of everbearing strawberry varieties was stimulated by flower removal.

Runners on such varieties were normally formed under Maryland conditions from late May to early July. The period was longer in 1-year-old than in 2-year-old plants.

Flower and runner removal stimulated more runners and extended the period of runner production into July and August.

Cutting of runners between the mother plant and the first runner plant after the latter had rooted reduced the number of runner plants produced by fully one-half.

Practically no flowers were produced immediately following the removal of the spring flowers, and practically no fruit matured during the latter half of June and early July.

Flower removal stimulated the production of more flowers.

Continual runner removal increased flower and fruit production.

The hill system of culture with flowers removed to July 15 generally gave the largest yield but the smallest berries.

Flower removal to September 1 gave the lowest total yields but the largest berries.

Everbearing strawberries tend to produce their fruit in cycles of high and low yields, different varieties having characteristic cycles.

With flower removal to July 15 there were two periods of peak production; with flower removal continued to September 1 there was only one.

The largest berries were produced at the beginning of the season slightly prior to the period of highest production.

Different varieties showed greater differences in runner and fruit production than did any treatments, except possibly irrigation, of a single variety.

Under irrigation practically as many runners were produced by plants from which no flowers were removed as by those from which they were picked off to July 15 or August 15 or even throughout the season.

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