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THE EFFECT OF DEFLOWERING ON THE DEVELOPMENT OF RUNNERS,
FRUIT CHARACTERISTICS AND YIELD OF STRAWBERRY

By
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A THESIS

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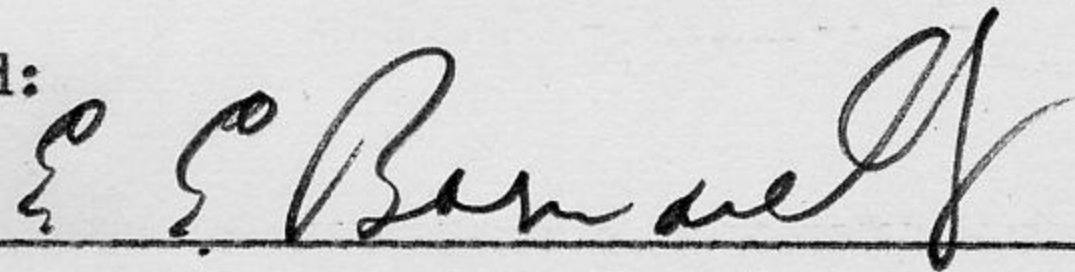
September 1967

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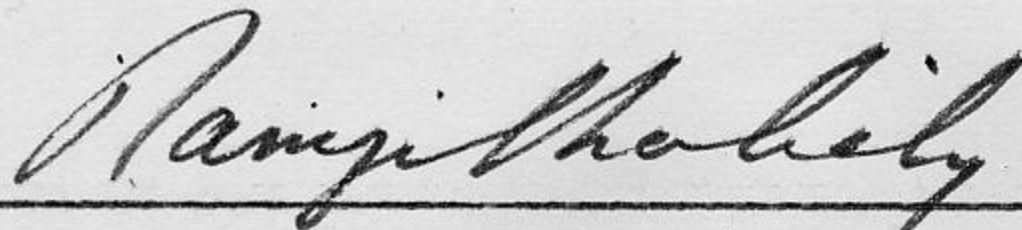
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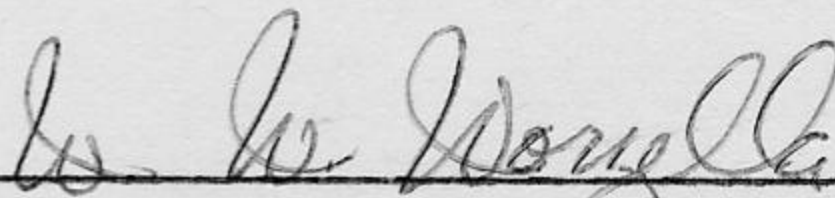
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STRAWBERRY DEFLOWERING

HAMZAKHEYL

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AN ABSTRACT OF THE THESIS OF

Noorgul Hamzakheyl for M.S. in Horticulture

Title: The effect of deflowering on the development of runners, fruit characteristics and yield of strawberry.

A two years study (1966-1967) was undertaken at the Agricultural Research and Education Center of the American University of Beirut located in the central Beqa'a Plain, Lebanon, to evaluate the effect of deflowering on numbers of runners, crowns, trusses, and fruit/plant; size of fruit; and yield of strawberries. This trial, in which the three strawberry varieties Solana, Shasta and Lassen were included, consisted of three treatments, i.e. one month deflowering, two months deflowering and no deflowering. The results obtained indicated that two months deblossomed plants produced more runners, crowns, trusses and yields than control plants. One month deblossomed plants produced more crowns, trusses and yields than control plants but less than two months deblossomed plants. Solana produced more runners than either Shasta or Lassen. Lassen was the highest yield producer and was closely followed by Solana. Shasta produced statistically lower yields than Lassen and Solana.

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I. INTRODUCTION

The strawberry (Fragaria spp.) is a favorite fruit of many people. It is one of the more expensive fruits sold on the market and, in some countries, can be obtained any time of the year. Since the strawberry is adapted to a wide range of climate and soils, it is grown in almost all countries of the world. In the United States of America, from the standpoint of farm value, the strawberry ranks fifth and constitutes over seven percent of all deciduous fruits and berries, while on a tonnage basis, it ranks eleventh among evergreen and deciduous fruits (8). Large quantities of the berries are made into jam and increasing amounts are canned and quick frozen. Smaller quantities are used for the production of juices and syrups. About 50% of the strawberry crop is processed.

According to Franklin (13), strawberries can be substituted for citrus fruits in areas where the latter cannot be grown. Strawberries are higher in vitamin C content than citrus fruits.

With the advent of better varieties and cultural methods and particularly the availability of virus and nematode free stock, the yield potential for strawberries has been increased in the United States of America recently from 3500 lb./acre to 10,000 lb./acre (8).

As deflowering is reportedly one of the important cultural practices, a study was carried out at the Agricultural Research and Education Center (AREC) of the American University of Beirut, in the

Beqa'a Plain, Lebanon, to evaluate the effect of deflowering on the number of runners, crowns, trusses, and fruits produced/plant, size of fruit and yield of three strawberry varieties during the growing seasons of 1966 and 1967.

II. REVIEW OF LITERATURE

There is strong evidence that the cultivated strawberry has derived from a cross between two American species Fragaria chiloensis and Fragaria virginiana in Europe in a region where these two species had grown together in gardens for some years. The cultivated strawberry, containing 38 pairs of chromosomes, differs from the European strawberries Fragaria vesca and Fragaria elatior as the latter two species have 7 and 21 pairs of chromosomes respectively. The crosses between the cultivated and European species result in sterile hybrids. Steady improvement of the first varieties of cultivated strawberries led to numerous modern varieties (29).

From the standpoint of the production habit, there are three types of strawberries: spring bearing, true ever-bearing and semi-ever-bearing varieties. Spring bearing varieties produce all the fruit in spring and early summer. True everbearing varieties give a relatively slight crop in the spring but a heavy crop in the fall. Semi-ever-bearers produce more fruit in spring and a slight amount in the fall (20,29,35).

The yield of strawberries can be boosted by a number of cultural practices among which deflowering of newly set plants seems to be extremely important. The deflowering of strawberries for a period of time immediately after planting has as its objective the diversion of metabolites, plant food, nutrients and water from use in reproductive

to use in vegetative growth. In order to determine the extent to which this practice can increase yield, a number of investigations have been carried out.

According to Moore (21), Shoemaker (29) and, Guttridge (14) blossom buds of spring bearing strawberry varieties are initiated within the plant crown during the short days of the fall. These buds remain within the crown during the winter and emerge in the spring as days become longer. The plants dug for spring planting thus have blossom buds present within the crown which emerge shortly after planting. They state that the development of the negligible amount of fruit from these flowers results in a drain on the nutrient, synthesized carbohydrate and water resources of the plant before it is well established.

In everbearing strawberry varieties, Mason (20) and Shoemaker (29) stated that the blossom buds for the spring crop are initiated in the short days of the fall while the blossom buds for the fall crop are initiated during the summer. According to Bailey (3), to enhance the fall crop of everbearing strawberry varieties the grower should remove all blossoms from spring set plants which appear before midsummer subsequent to planting; thereafter a considerable amount of fruit can be expected from August until frost, though not as much will develop as with a good crop from a spring bearing variety.

As reproductive growth appears to be at the expense of vegetative growth, deflowering should have an effect on the number of runners developed and the general vigor and subsequent yield of strawberry plants. Rogers (24) found that deflowering in the first year

resulted in a 32% increase in the number of runners. All deblossomed plants grew larger than the non-deblossomed and fruiting plants and the deblossomed plants produced a considerably larger weight of runners than plants not deblossomed.

A much larger portion of the plants' energy, saved by not having to bear a crop, contributes to the production of runners. In a trial conducted by Robertson and Wood (23) on several strawberry varieties, it was found that runner production was stimulated by deblossoming. Deblossomed plants produced more and earlier runners than non-treated ones. The effect of deflowering was not the same for all varieties studied; some varieties produced more runners following deblossoming than others.

Scott and Marth (28) have emphasized that the removal of blossoms from newly set strawberry plants is more beneficial in the establishment of a vigorous planting than almost any other cultural operation. They found that deblossomed strawberries produced more runners and fruit than check plants. It was also shown by Scott (27) that strawberry mother plants with blossoms removed produced on the average twenty runners per plant which compared to three runners per plant from mother plants from which blossoms were not removed. Based on this finding, the investigator strongly recommended that blossom removal should be practiced because the removal of blossoms from newly set plants is the key toward establishing successful strawberry beds. Wyld (35) stated that mother plants, because of transplanting shock and loss of foliage and roots, are unable to produce many normal sized fruits, "It is better if the newly set plants, instead

of carrying food and water to the berries, solely concentrate on runner production since the number of mother plants is limited during the first season. This ensures the development of a sufficient population of plants to bear fruit". If fruits are permitted to develop on newly set plants, the runner production lags behind and decreases due to the weakness of the plants.

Many other authors such as Amstrong et al. (1), Biles (5), Childers (9), Darrow (10,11), Hill (15), Horn (16), Kaplin (17), Klingbeil (18), Naik (22), Talbert (32), Tomkins et al. (33) and Whitehead (34) have also emphasized the importance of deflowering in strawberries. All agreed that blossom clusters in newly set strawberry plants should be pinched off as soon as possible.

Darrow (11) has pointed out that the earliest formed runner plants produce the most fruit the following year because of having enough time for vegetative development. Removal of flower stems helps in getting early runners. Furthermore, if a very large number of plants is needed or if the variety used does not naturally develop many plants, the number of daughter plants can be increased materially by removing the flower stems as they appear. Several other authors such as Magill and Stacey (19), Robertson and Wood (23,2), etc., hold essentially the same opinion.

Despite the fact that blossom removal is generally recommended, sometimes owing to varietal differences and other variables, anticipated results are not obtainable. It was reported by Bell and Downess (4) that due to varietal differences plants of the Robinson variety which were deblossomed after planting produced essentially the same number

of runner plants and subsequent total yields as the control plants.

As for the length of time that deflowering should be practiced, Shoemaker and Teskey (30) found that strawberry varieties with an excessive plant forming habit may need to have the flower stems removed only once after the plants are established; but for varieties that tend to form few runners, the longer blossoms are removed after planting, the more runners are produced. According to Zych and Powell (36) and Shoemaker (29), the length of the deflowering time depends considerably upon the variety. Varieties that produce only one cluster per plant require a shorter time and fewer field operation to complete deflowering than those that produce several blossom clusters per plant.

Although blossom removal is a costly operation, the gain usually exceeds the costs. Dodge and Snyder (12) declared that much more will be gained by directing the vigor of the plant into growth than by producing a few fruits. Rogers et al. (25) have concluded that it usually pays to remove the blossoms in the season following planting as the small amount of fruit thus lost is more than repaid by the increased crop obtained in the next and later seasons.

III. MATERIALS AND METHODS

This investigation of the effect of deflowering of strawberries was undertaken during the two growing seasons, 1966 and 1967, at the Agricultural Research and Education Center of the American University of Beirut in the Beqa'a Plain, about 80 kilometers east of Beirut, Lebanon. According to Salib (26), the soil of the central Beqa'a Plain has a fine texture, is alkaline in reaction and is calcareous, is fairly low in total nitrogen (0.08-0.18%) and low to medium in organic matter content (2.03-4.62%). It is considered variable in available phosphorus (6.70-53.12 ppm), adequate in exchangeable potassium (0.68-1.36 m.e./100 gm of soil) and has a high cation exchange capacity (39.2-53.3 m.e./100 gm of soil) and a pH of about 8.

The land of the experimental area was fallow for the two years prior to planting. No fertilizer was added to the soil either before or after planting. The total area devoted to the trial was about 942 square meters.

Three varieties of strawberry, Solana, Shasta and Lassen were included in this study. Solana (California 35.93-11) was originated in Davis, California (7) by the California Agricultural Experiment Station. Introduced commercially in December 1957, the variety has a high fruit quality. The plant is adapted to warm winters, has good tolerance to salinity and characteristically has four or five leaflets instead of the normal three. Shasta (California 403.8) was originated

in Davis, California by the California Agricultural Experiment Station. It was introduced commercially in 1945. The plants have fair resistance to virus diseases and verticillium wilt. Lassen (California 544.2) was originated in Wheatland, California by the California Agricultural Experiment Station and was introduced commercially in 1945. The plants are long lived, resistant to virus diseases and have high yield potential (6).

For planting purpose, only young plants with yellowish brown roots and a healthy appearance were selected; old plants with black and dead roots were discarded. The plants were set in the field on April 20, 1966. Before planting, the roots of the newly dug plants were kept immersed in water to keep them from drying out. The plants were set with the crowns even with the surface of the soil and the soil was firmed around the root system. As the removal of leaves is a common practice which aids in survival of the newly set plants, all but two leaves were removed. The experimental area was irrigated by means of sprinkler irrigation whenever the plants were in need of water.

Data were recorded for number of runners, crowns, trusses and fruits/plant, the size of the fruit and total yields. The experiment consisted of three treatments, one month deflowering, two months deflowering and no deflowering. The trial was laid out on a split plot design with six replications. Varieties were the main plots and treatments were the sub-plots.

The distance between mother plants within the row was 36 inches and that between rows was 42 inches. When runner plants were produced, they were spaced 12 inches apart in the row and 18 inches between rows.

The distance between mother plants and runner plants was 12 inches. Four runner plants were permitted to develop from each mother plant. A total of 960 plants were set in the area.

Hand hoeing was used to keep weeds out of the field. No herbicides were used for weed control. Disease or insect incidence was not observed during the growing periods.

Statistical methods appropriate to the split plot design, according to Snedecor (31), were used to analyze the data.

IV. RESULTS AND DISCUSSIONS

This experiment was conducted during the two year period, 1966-1967, at the A.R.E.C. to determine the effect of deflowering on the number of runners, crowns, trusses, and fruit per plant; size of fruit; and yield of three varieties of strawberries. Summaries of the results are presented in Tables 1-20. The results of individual plots, the analysis of variance for each character studied and the meteorological data regarding rainfall and average temperature are given in the Appendix (Tables 21-61). The L.S.D. values at the five and one percent levels are shown for those treatments and varieties found to be significant. The results of each harvest date were analyzed separately to see if there were any intra-seasonal fluctuations in yield, number of berries per plant and berry size.

Runner Development

It can be seen from Table 1 that deflowering exerted an effect on the number of runners produced. Plants deblossomed for two months produced more runners than either the one month deblossomed or untreated control plants. Among the strawberry varieties subjected to different deflowering treatments, Solana produced significantly more runners than Lassen or the control variety Shasta. The results suggest that the longer the deflowering period, the greater will be the number of runners obtained. In addition, there was a significant interaction

Table 1. Effect of deflowering and variety on the average number of runners/plot produced during the 1966 growing season.

Variety	Deflowering			Total	Variety mean
	One month	Two months	No deflowering		
Solana	127.50	136.17	118.33	382.00	127.33
Shasta	109.17	113.51	112.00	334.68	111.56
Lassen	107.50	116.83	96.17	320.50	106.83
Total	344.17	366.51	326.50		
Treatment mean	114.72	122.17	108.83		

	<u>LSD</u>	
	<u>5% level</u>	<u>1% level</u>
Deflowering	6.895	9.295
Variety	14.361	n.s.
Interaction	16.891	22.770

between variety and treatment, indicating that deflowering probably had a different effect on different varieties. Varietal differences also played a role in the number of runners produced. These findings are in agreement with the results reported by several other experimenters such as Moore (21), Robertson and Wood (23), Rogers (24), Rogers et al. (25), Scott (27) and Scott and Marth (28).

Crown Development

The results of different deflowering treatments on the numbers of crowns produced are summarized in Table 2. Differences between the mean numbers of crowns per plant for the various treatments were statistically significant. Plants deblossomed for one or two months produced significantly higher numbers of crowns than the control plants. On the other hand, neither the differences between the mean numbers of crowns of the three varieties nor the interaction between treatments and varieties were statistically significant. It can be said that the longer the plants were deflowered the greater was the effect on the development of crowns and that the response was similar for all varieties.

Table 2. Effect of deflowering and variety on the average number of crowns produced/plant during the 1966 growing season.

Variety	Deflowering			Total	Variety mean
	One month	Two months	No deflowering		
Solana	7.25	7.53	6.61	21.39	7.13
Shasta	6.43	7.08	6.11	19.62	6.54
Lassen	6.93	7.53	5.95	20.41	6.80
Total	20.61	22.14	18.67		
Treatment mean	6.87	7.38	6.22		

LSD

	<u>5% level</u>	<u>1% level</u>
Deflowering	0.540	0.728
Variety	n.s.	n.s.
Interaction	n.s.	n.s.

Truss Development

Deflowering for one month resulted in a significant increase and deflowering for two months resulted in a highly significant increase in the numbers of trusses produced. There were no significant differences between the numbers of trusses produced by the different varieties nor there was any significant interaction between varieties and deflowering treatment (Table 3). The number of trusses which developed is indication of plant vigor, probably obtained by deflowering, since robust plants produce more trusses than weak plants. Furthermore, when the trusses were examined, it was found that deblossomed plants tended to produce more branched trusses than the untreated plants. It is a matter of fact, that an increase in truss branching results in more fruit production.

Since there was no interaction between variety and treatment, deblossoming probably would have a similar effect on all varieties.

Berry Development

Regarding berry development data were collected on the amount of fruit/plot, number of berries/plant and berry size. Data on yield was recorded in every harvest while data on number of berries/plant and berry size were recorded in alternate harvests. Results are summarized for fruit/plot in Tables 4,7,8,11,12,15,16, and 19, berries/plant in Tables 5,9,13 and 17 and berry size in Tables 6,10,14 and 18. A summary of the yield for the whole season is presented in Table 20. The discussion of the results follows the tables.

Table 3. Effect of deflowering and variety on the average number of trusses produced/plant during 1967 growing season.

	Deflowering			Total	Variety mean
	One month	Two months	No deflowering		
Solana	6.08	6.78	5.48	18.34	6.11
Shasta	6.05	5.56	5.21	17.82	5.94
Lassen	5.96	6.26	5.60	17.82	5.94
Total	18.09	19.60	16.29		
Treatment mean	6.03	6.53	5.43		

LSD

	5% level	1% level
Deflowering	0.448	0.602
Variety	n.s.	n.s.
Interaction	n.s.	n.s.

Table 4. Effect of deflowering and variety on the average amount of fruit in Kg/plot produced on May 25, 1967.

Variety	Deflowering			Total	Variety mean
	One month	Two months	No deflowering		
Solana	1.39	1.24	1.36	3.99	1.33
Shasta	1.15	1.38	0.75	3.28	1.09
Lassen	0.86	1.19	1.12	3.17	1.05
Total	3.40	3.81	3.23		
Treatment mean	1.13	1.27	1.08		

LSD

	<u>5% level</u>	<u>1% level</u>
Deflowering	n.s.	n.s.
Variety	0.202	n.s.
Interaction	n.s.	n.s.

Table 5. Effect of deflowering and variety on the average number of berries/plant produced on May 25, 1967.

Variety	Deflowering			Total	Variety mean
	One month	Two months	No deflowering		
Solana	9.30	7.56	17.88	34.74	11.58
Shasta	10.88	5.81	4.91	21.60	7.20
Lassen	9.85	5.75	7.68	23.28	7.76
Total	30.03	19.12	30.47		
Treatment mean	10.01	6.37	10.15		

LSD

	<u>5% level</u>	<u>1% level</u>
Deflowering	2.068	2.802
Variety	n.s.	n.s.
Interaction	n.s.	n.s.

Table 6. Effect of deflowering and variety on the average berry size (in grams/berry) produced on May 25, 1967.

Variety	Deflowering			Total	Variety mean
	One month	Two months	No deflowering		
Solana	9.08	9.56	8.26	26.90	8.96
Shasta	9.91	13.45	9.10	32.46	10.82
Lassen	8.70	12.33	7.60	28.63	9.54
Total	27.69	35.34	24.96		
Treatment mean	9.233	11.78	8.32		

LSD

	<u>5% level</u>	<u>1% level</u>
Deflowering	1.687	2.274
Variety	n.s.	n.s.
Interaction	n.s.	n.s.

Table 7. Effect of deflowering and variety on the average amount of fruit in Kg/plot produced on May 29, 1967.

Variety	Deflowering			Total	Variety mean
	One month	Two months	No deflowering		
Solana	2.27	2.49	1.82	6.58	2.19
Shasta	1.80	1.77	1.33	4.90	1.63
Lassen	2.47	2.80	2.12	7.39	2.46
Total	6.54	7.06	5.27		
Treatment mean	2.18	2.35	1.75		

LSD

	<u>5% level</u>	<u>1% level</u>
Deflowering	0.285	0.386
Variety	0.439	0.624
Interaction	n.s.	n.s.

Table 8. Effect of deflowering and variety on the average amount of fruit in Kg/plot produced on June 1, 1967.

Variety	Deflowering			Total	Variety mean
	One month	Two months	No deflowering		
Solana	2.11	2.22	1.69	6.02	2.00
Shasta	1.33	1.72	1.27	4.32	1.44
Lassen	2.47	2.87	2.02	7.36	2.45
Total	5.91	6.81	4.98		
Treatment mean	1.97	2.27	1.66		

LSD

	5% level	1% level
Deflowering	0.252	0.341
Variety	0.185	0.253
Interaction	n.s.	n.s.

Table 9. Effect of deflowering and variety on the average number of berries/plant produced on June 1, 1967.

Variety	Deflowering			Total	Variety mean
	One month	Two months	No deflowering		
Solana	14.26	15.21	13.88	43.35	14.45
Shasta	9.50	12.45	10.21	32.16	10.72
Lassen	21.56	20.16	16.21	57.93	19.31
Total	45.32	47.82	40.30		
Treatment mean	15.10	15.94	13.43		

	<u>LSD</u>	
	<u>5% level</u>	<u>1% level</u>
Deflowering	2.04	n.s.
Variety	3.710	5.284
Interaction	n.s.	n.s.

Table 10. Effect of deflowering and variety on average berry size (in grams/berry) produced on June 1, 1967.

Variety	Deflowering			Total	Variety mean
	One month	Two months	No deflowering		
Solana	9.30	11.76	8.36	29.42	9.80
Shasta	8.73	8.55	7.41	24.69	8.23
Lassen	7.68	8.65	7.53	23.86	7.95
Total	25.71	28.96	23.30		
Treatment mean	8.57	9.65	7.76		

LSD

	<u>5% level</u>	<u>1% level</u>
Deflowering	1.009	1.361
Variety	1.442	n.s.
Interaction	n.s.	n.s.

Table 11. Effect of deflowering and variety on the average amount of fruit in Kg/plot produced on June 5, 1967.

Variety	Deflowering			Total	Variety mean
	One month	Two months	No deflowering		
Solana	2.92	3.04	2.57	8.53	2.84
Shasta	1.75	2.07	1.58	5.40	1.80
Lassen	3.00	3.42	2.35	8.77	2.92
Total	7.67	8.53	6.50		
Treatment mean	2.56	2.84	2.17		

LSD

	<u>5% level</u>	<u>1% level</u>
Deflowering	0.224	0.301
Variety	0.615	0.874
Interaction	n.s.	n.s.

Table 12. Effect of deflowering and variety on the average amount of fruit in Kg/plot produced on June 9, 1967.

Variety	Deflowering			Total	Variety mean
	One month	Two month	No deflowering		
Solana	2.25	2.18	1.85	6.28	2.09
Shasta	1.51	1.26	1.18	3.95	1.31
Lassen	2.82	2.36	2.21	7.39	2.46
Total	6.58	5.80	5.24		
Treatment mean	2.19	1.93	1.74		

LSD

	<u>5% level</u>	<u>1% level</u>
Deflowering	n.s.	n.s.
Variety	0.385	0.538
Interaction	n.s.	n.s.

13. Effect of deflowering and variety on the average number of berries/plant produced on June 9, 1967.

Variety	Deflowering			Total	Variety mean
	One month	Two months	No deflowering		
Solana	19.55	20.46	18.33	58.34	19.44
Shasta	9.76	9.40	9.98	29.14	9.71
Lassen	26.91	22.60	20.71	70.22	24.40
Total	56.22	52.46	49.02		
Treatment mean	18.74	17.48	16.34		

LSD

	<u>5% level</u>	<u>1% level</u>
Deflowering	n.s.	n.s.
Variety	5.142	7.310
Interaction	n.s.	n.s.

Table 14. Effect of deflowering and variety on the average berry size (in grams/berry) produced on June 9, 1967.

Variety	Deflowering			Total	Variety mean
	One month	Two months	No deflowering		
Solana	6.76	7.66	6.25	20.67	6.89
Shasta	7.71	7.66	6.21	21.58	7.19
Lassen	6.66	6.61	6.33	19.60	6.53
Total	21.13	21.93	18.79		
Treatment mean	7.04	7.31	6.26		

LSD

	<u>5% level</u>	<u>1% level</u>
Deflowering	n.s.	n.s.
Variety	n.s.	n.s.
Interaction	n.s.	n.s.

Table 15. Effect of deflowering and variety on the average amount of fruit in Kg/plot produced on June 13, 1967.

Variety	Deflowering			Total	Variety mean
	One month	Two months	No deflowering		
Solana	1.46	1.28	1.11	3.85	1.28
Shasta	1.11	1.26	0.95	3.32	1.10
Lassen	1.76	1.75	1.27	4.78	1.59
Total	4.33	4.29	3.33		
Treatment mean	1.44	1.43	1.11		

	<u>LSD</u>	
	<u>5% level</u>	<u>1% level</u>
Deflowering	0.169	0.228
Variety	0.249	0.355
Interaction	n.s.	n.s.

Table 16. Effect of deflowering and variety on the average amount of fruit in Kg/plot produced on June 16, 1967.

Variety	Deflowering			Total	Variety mean
	One month	Two months	No deflowering		
Solana	0.23	0.25	0.18	0.66	0.22
Shasta	0.23	0.18	0.17	0.58	0.29
Lassen	0.40	0.53	0.38	1.31	0.65
Total	0.86	0.96	0.73		
Treatment mean	0.28	0.32	0.24		

LSD

	<u>5% level</u>	<u>1% level</u>
Deflowering	n.s.	n.s.
Variety	0.064	0.091
Interaction	n.s.	n.s.

Table 17. Effect of deflowering and variety on the average number of berries/plant produced on June 16, 1967.

Variety	Deflowering			Total	Variety mean
	One month	Two months	No deflowering		
Solana	3.06	3.81	2.90	9.77	3.25
Shasta	3.46	3.68	2.88	10.02	3.34
Lassen	5.58	6.05	5.83	17.46	5.82
Total	12.10	13.54	11.61		
Treatment mean	4.03	4.51	3.87		

LSD

	<u>5% level</u>	<u>1% level</u>
Deflowering	n.s.	n.s.
Variety	1.010	1.436
Interaction	n.s.	n.s.

Table 18. Effect of deflowering and variety on average berry size (in grams/berry) produced on June 16, 1967.

Variety	Deflowering			Total	Variety mean
	One month	Two months	No deflowering		
Solana	4.18	4.71	3.73	12.62	4.20
Shasta	4.48	4.90	3.68	13.06	4.35
Lassen	4.81	4.68	4.06	13.55	4.51
Total	13.47	14.29	11.47		
Treatment mean	4.49	4.76	3.82		

LSD

	<u>5% level</u>	<u>1% level</u>
Deflowering	n.s.	n.s.
Variety	n.s.	n.s.
Interaction	n.s.	n.s.

Table 19. Effect of deflowering and variety on the average amount of fruit in Kg/plot produced on June 19, 1967.

Variety	Deflowering			Total	Variety mean
	One month	Two months	No deflowering		
Solana	0.14	0.12	0.09	0.35	0.11
Shasta	0.07	0.08	0.06	0.21	0.07
Lassen	0.13	0.10	0.10	0.33	0.11
Total	0.34	0.30	0.25		
Treatment mean	0.11	0.10	0.08		

LSD

	<u>5% level</u>	<u>1% level</u>
Deflowering	n.s.	n.s.
Variety	0.035	n.s.
Interaction	n.s.	n.s.

Table 20. Effect of deflowering and variety on total yield in Kg/plot produced in 1967.

Variety	Deflowering			Total	Variety mean
	One month	Two months	No deflowering		
Solana	12.80	12.86	10.78	36.44	12.14
Shasta	8.97	9.74	7.33	26.04	8.68
Lassen	13.96	15.05	11.60	40.61	13.53
Total	35.73	37.65	29.71		
Treatment mean	11.91	12.55	9.90		

LSD

	<u>5% level</u>	<u>1% level</u>
Deflowering	0.775	1.045
Variety	1.242	1.765
Interaction	n.s.	n.s.

The strawberry production season started on May 25 and ended on June 19. There were large intra-seasonal fluctuations in the amount of fruit/plot, numbers of berries/plant and berry size of the three strawberry varieties subjected to different treatments.

On the first date of harvest, strawberry plants deblossomed for two months produced fewer berries but the size of the berries was statistically larger than one month deblossomed and check plants. The results agree with those obtained by Bell and Downess (4) who found that the deblossomed plants of the Robinson strawberry produced in the first harvest fewer but larger berries than non-deblossomed plants.

It is apparent that deblossomed plants in general and two months deblossomed plants in particular produced statistically greater yields than control plants. It seems that plant energy saved by not fruiting the first season after planting was put into more fruit production. These results are similar to those of several experimenters and authors such as Darrow (10), Horn (16), Tomkins et al. (33), Wyld (35), Rogers et al. (25), Moore (21) and Bailey (3). Since two months deblossomed plants produced comparatively larger yields than one month deblossomed plants and statistically larger yields than control plants (Tables 7,8,11,15,20), the results suggest that deflowering should be continued as long as flower stalks appear on the newly set plants in the first year.

It is shown in various of the tables of the different dates of strawberry harvest that the berry size of deblossomed plants, in general, was larger during the first half of the production season (Tables 6,10), but dropped off noticeably towards the end (Tables 14,18).

The berry number was smaller at the beginning (Table 5), increased tremendously up to about two-thirds of the production season (Tables 9,13) and then dropped off (Table 17). According to Shoemaker (29) the order of cluster blooming influences berry size and berry numbers. The fruit of primary flowers ripen first and the largest berries are usually produced in the first good picking. Although the crop increases in later pickings due to fruit of numerous secondary and tertiary flowers ripening, the berries are smaller. Earliness, limited berry number and other unknown factors in the early development of flower buds may increase berry size at the first harvest. Besides this, the early formed fruits have more seeds per berry than later formed fruits. It is apparent from literature that the size of strawberry fruit is directly proportional to the number of seeds. Seeds increase individual berry size by providing essential hormones, especially auxins, that are needed for fruit development.

The yield, berry size and berry number were influenced materially by varietal potentials. It is evident from most of the tables (7,8,11,12,13,15,16,20) that Lassen was the highest yield producer but was closely followed by Solana. Shasta, the check variety, performed poorly in this trial. The outstanding performance of Lassen is confirmed by findings reported by Brooks and Olmo (6) that Lassen is a high yielding variety.

Regarding yield, berry number and berry size, the result of the various harvest dates indicate that there was no statistically significant interaction between treatment and variety. Also the interaction between treatment and variety for the yield of the whole season was non-significant. It appears that the effect of deflowering was the same on the three strawberry varieties under study. The results for the yield of the whole season followed the same trend as that for the various harvest dates.

From a comparison of the results with the environmental conditions of the Beqa'a Plain from 1964-65 to 1966-67, it appears that the strawberry plants were greatly influenced by unfavorable weather. The growing and picking season in 1966-67 was shortened by low temperatures accompanied by heavy precipitation (Table 61). Hence, further trials are recommended to screen out the best treatment and variety for the various characteristics studied at favorable and more representative weather conditions of the Plain.

V. SUMMARY AND CONCLUSIONS

The investigation pertaining to the effect of deflowering on runner development; crowns, trusses and fruit/plant; size of fruit; and yield of strawberries was carried out at the Agricultural Research and Education Center of the American University of Beirut located in the central Beqa'a Plain, Lebanon. This trial, in which the three strawberry varieties Solana, Shasta and Lassen were included, consisted of three treatments, one month deflowering, two months deflowering and no deflowering.

Strawberry plants deblossomed for two months produced the highest number of runners. One month deblossomed plants, though they outnumbered the check plants, did not produce a statistically significantly greater number of runners. Solana was found to produce the highest number of runners while Lassen and Shasta were relatively poor in runner development.

Both one month and two months deblossomed plants surpassed control plants in production of crowns as well as trusses. All of the strawberry varieties produced approximately the same numbers of crowns and trusses.

The strawberry yield was greatly influenced by the various treatments. Plants with two months deflowering produced considerably higher yields than control plants but only slightly more than one month deblossomed plants. Among the strawberry varieties, Lassen and Solana

were the higher yielders. Shasta, as the check variety, was the lowest yield producer in the trial. The berry size of treated plants and particularly of two months deblossomed plants was large in the first half of the picking period, but, towards the end of picking season, there were no pronounced differences between treated and check plants. Generally speaking, plants deblossomed for two months produced more berries of relatively larger size than one month deblossomed or check plants throughout the picking season. The findings of the experiment suggest that blossom removal is an indispensable economic operation. The newly set plants must be deblossomed after planting for at least two months in the first growing season. In addition, deblossoming is a good means of increasing runner plants of those strawberry varieties that tend to produce a limited number of runners for propagation purpose. To obtain berries of large size appealing to consumers eyes, deblossoming is an imperative cultural operation.

Since environmental conditions during 1966-67 were unfavorable for strawberry production, it is recommended that further trials be undertaken under more favorable conditions.

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APPENDIX

Table 21. Effect of deflowering and variety on the numbers of runners produced/plot during 1966 growing season.

Variety	Deflowering	Replications						Total
		1	2	3	4	5	6	
Solana	One month	139	119	118	129	132	128	765
	Two months	122	129	126	145	153	142	817
	No deflowering	110	111	120	118	120	131	710
Total		371	359	364	392	405	401	2292
Shasta	One month	106	105	137	115	94	98	655
	Two months	106	117	147	110	99	102	681
	No deflowering	120	108	128	110	100	106	672
Total		332	330	412	335	293	306	2008
Lassen	One month	103	119	98	101	107	117	645
	Two months	125	100	120	106	118	133	701
	No deflowering	83	107	101	83	90	113	577
Total		311	326	319	290	315	363	1923
TOTAL		1014	1015	1095	1017	1013	1070	6223

Table 22. Analysis of variance for numbers of runners produced/plot during the 1966 growing season.

Source of variation	D.F.	S.S.	M.S.	F value
Varieties	2	4148.923	2074.461	5.545 ^x
Replications	5	946.210	189.242	0.505
Error a	10	3741.077	374.107	
Deflowering	2	137.488	368.744	3.583 ^x
Defloweringxvariety	4	1560.299	390.014	3.792 ^x
Error b	30	3084.880	102.829	

x Denotes F values significant at the 5% level.

xx Denotes F values significant at the 1% level.

Table 23. Effect of deflowering and variety on the numbers of crowns produced/plant during the 1966 growing season.

Variety	Deflowering	Replications						Total
		1	2	3	4	5	6	
Solana	One month	5.6	7.6	7.6	8.0	7.7	7.0	43.5
	Two months	8.2	7.0	8.7	7.1	6.2	8.0	45.2
	No deflowering	6.5	6.0	7.6	6.0	6.6	7.0	39.7
Total		20.3	20.6	23.9	21.1	20.5	22.0	128.4
Shasta	One month	5.4	7.0	6.6	6.0	6.6	7.0	38.6
	Two months	7.8	6.6	8.0	6.0	7.0	7.1	42.5
	No deflowering	5.3	6.5	6.3	6.3	6.3	6.0	36.7
Total		18.5	20.1	20.9	18.3	19.9	20.1	117.8
Lassen	One month	8.6	6.3	6.3	5.7	7.9	6.8	41.6
	Two months	6.3	7.0	8.2	6.9	7.8	9.0	45.2
	No deflowering	7.0	5.0	6.3	5.6	6.0	5.8	35.7
Total		21.9	18.3	20.8	18.2	21.7	21.6	122.5
TOTAL		60.7	59.00	65.6	57.6	62.1	63.7	368.7

Table 24. Analysis of variance for numbers of crowns produced/plot during the 1966 growing season.

Source of variation	D.F.	S.S.	M.S.	F value
Variation	2	3.13	1.565	3.206
Replication	5	3.90	0.980	2.008
Error a	10	4.88	0.488	
Deflowering	2	12.07	6.035	9.518 ^{XX}
Deflowering x variety	4	1.16	0.290	0.457
Error b	30	19.03	0.634	

Table 25. Effect of deflowering and variety on the numbers of trusses produced/plant during the 1967 growing season.

Variety	Deflowering	Replication						Total
		1	2	3	4	5	6	
Solana	One month	6.1	6.0	5.9	6.2	6.5	6.3	36.50
	Two months	7.0	6.6	6.0	7.0	7.0	7.1	40.70
	No deflowering	6.3	6.0	4.5	6.0	4.1	6.0	32.90
Total		18.9	18.6	16.4	19.2	17.6	19.4	110.10
Shasta	One month	5.4	7.0	4.3	6.0	6.6	7.0	36.30
	Two months	6.8	6.6	5.9	6.0	7.0	7.1	39.40
	No deflowering	5.3	4.1	3.6	6.0	6.3	6.0	31.30
Total		17.5	17.7	13.8	18.00	19.9	20.1	107.00
Lassen	One month	6.0	6.5	6.1	5.0	5.2	7.0	35.8
	Two months	5.4	6.0	5.1	6.9	7.0	7.2	36.6
	No deflowering	6.0	5.0	5.2	5.6	5.6	6.2	33.6
Total		17.4	17.5	16.4	17.5	17.8	20.4	107.00
TOTAL		53.8	53.8	46.6	54.7	55.3	59.9	324.10

Table 26. Analysis of variance for numbers of trusses produced/plant during the 1967 growing season.

Source of variation	D.F.	S.S.	M.S.	F value
Varieties	2	0.35	0.175	0.483
Replications	5	10.20	2.040	5.635 ^x
Error a	10	3.62	0.362	
Deflowering	2	11.02	5.510	12.725 ^{xx}
Deflowering x variety	4	0.97	0.242	0.558
Error b	30	13.01	0.433	

Table 27. Effect of deflowering and variety on the amount of fruit in Kg/plot produced on May 25, 1967.

Variety	Deflowering	Replication						Total
		1	2	3	4	5	6	
Solana	One month	0.578	1.420	1.750	1.800	1.360	1.485	8.393
	Two months	1.352	1.100	0.815	0.735	2.050	0.865	6.885
	No deflowering	1.175	0.800	1.000	1.700	1.075	2.450	8.200
Total		3.073	3.320	3.565	4.235	4.485	4.800	23.478
Shasta	One month	0.545	1.350	0.850	0.860	2.830	0.500	6.935
	Two months	0.895	0.800	1.600	1.100	0.900	3.000	8.295
	No deflowering	0.500	0.525	0.500	1.600	0.600	0.800	4.525
Total		1.940	2.675	2.950	3.560	4.330	4.300	19.755
Lassen	One month	0.690	1.000	1.800	0.600	0.500	0.600	5.190
	Two months	0.640	1.400	0.600	1.600	1.150	1.750	7.140
	No deflowering	1.870	0.700	0.650	0.650	2.100	0.750	6.720
Total		3.200	3.100	3.050	2.850	3.750	3.100	19.050
TOTAL		8.213	9.095	9.565	10.645	12.565	12.200	62.283

Table 28. Analysis of variance for the amount of fruit in Kg/plot produced on May 25, 1967.

Source of variance	D.F.	S.S.	M.S.	F value
Varieties	2	0.629	0.314	4.186 ^x
Replications	5	1.690	0.338	4.506 ^x
Error a	10	0.750	0.075	
Deflowering	2	0.234	0.117	0.175
Deflowering x variety	4	1.583	0.395	0.593
Error b	30	19.996	0.665	

Table 29. Effect of deflowering and variety on the number of berries/plant produced on May 25, 1967.

Variety	Deflowering	Replication						Total
		1	2	3	4	5	6	
Solana	One month	4.0	8.6	11.7	12.3	9.8	9.4	55.8
	Two months	8.8	7.6	5.3	4.5	13.0	6.2	45.4
	No deflowering	7.6	5.5	6.4	10.1	7.4	70.3	107.3
Total		20.4	21.7	23.4	26.9	30.2	85.9	208.5
Shasta	One month	2.8	8.7	5.0	4.9	21.6	22.3	65.3
	Two months	4.9	4.5	9.6	7.1	4.2	4.6	34.9
	No deflowering	3.2	3.1	3.1	7.2	6.5	6.4	29.5
Total		10.9	16.3	17.7	19.2	32.3	33.3	129.7
Lassen	One month	6.1	7.5	14.7	14.2	6.3	10.3	59.1
	Two months	5.3	11.0	4.9	3.3	6.4	3.6	34.5
	No deflowering	14.7	5.1	4.8	5.6	11.5	4.4	46.1
Total		26.1	23.6	24.4	23.1	24.2	18.3	139.7
TOTAL		57.4	61.6	65.5	69.2	86.7	137.5	477.9

Table 30. Analysis of variance for the number of berries/plant produced on May 25, 1967.

Source of variation	D.F.	S.S.	M.S.	F value
Varieties	2	204.50	102.25	1.430
Replications	5	502.96	100.59	1.407
Error a	10	714.91	71.49	
Deflowering	2	165.22	82.61	8.788 ^{XX}
Deflowering x variety	4	37.56	9.39	0.998
Error b	30	281.81	9.40	

Table 31. Effect of deflowering and variety on berry size (in grams/berry) produced on May 25, 1967.

Variety	Deflowering	Replications						Total
		1	2	3	4	5	6	
Solana	One month	8.8	10.2	9.3	9.0	8.6	8.6	54.5
	Two months	9.3	9.0	9.5	10.0	9.8	9.8	57.4
	No deflowering	9.5	8.9	9.7	10.4	9.0	2.1	49.6
Total		27.6	28.1	28.5	29.4	27.4	20.5	161.5
Shasta	One month	12.1	9.6	10.6	10.8	8.1	8.3	59.5
	Two months	19.3	11.9	10.3	13.7	18.8	6.7	80.7
	No deflowering	8.9	10.2	9.8	9.5	8.5	7.7	54.6
Total		40.3	31.7	30.7	34.0	35.4	22.7	194.8
Lassen	One month	7.0	8.2	7.6	7.0	11.9	10.5	52.2
	Two months	7.5	9.7	18.3	11.3	11.1	16.1	74.0
	No deflowering	7.1	8.4	7.5	7.2	4.9	10.5	45.6
Total		21.6	26.3	33.4	25.5	27.9	37.1	171.8
TOTAL		89.5	86.1	92.6	88.9	90.7	80.3	528.1

Table 32. Analysis of variance for berry size (in grams/berry) produced on May 25, 1967.

Source of variation	D.F.	S.S.	M.S.	F value
Varieties	2	32.29	16.14	1.378
Replications	5	10.49	2.09	0.178
Error a	10	117.19	11.71	
Deflowering	2	115.87	57.93	9.481 ^{XX}
Deflowering x variety	4	27.09	6.77	1.108
Error b	30	185.16	6.17	

Table 33. Effect of deflowering and variety on the amount of fruit in Kg/plot produced on May 29, 1967.

Variety	Deflowering	Replications						Total
		1	2	3	4	5	6	
Solana	One month	2.480	1.750	2.360	2.050	2.620	2.400	13.660
	Two months	3.200	2.005	3.400	2.100	2.130	2.100	14.935
	No deflowering	1.875	1.755	2.420	1.600	1.670	1.600	10.920
Total		7.555	5.510	8.180	5.750	6.420	6.100	39.515
Shasta	One month	1.870	1.800	1.600	1.750	1.475	2.310	10.805
	Two months	2.005	1.850	2.085	1.450	1.400	1.850	10.640
	No deflowering	0.960	1.800	1.370	1.450	1.305	1.100	7.985
Total		4.835	5.450	5.055	4.650	4.180	5.260	29.430
Lassen	One month	2.675	1.950	2.550	2.530	2.720	2.450	14.875
	Two months	2.110	1.510	2.755	4.450	3.100	2.900	16.825
	No deflowering	2.120	2.355	2.150	2.390	2.000	1.750	12.765
Total		6.905	5.815	7.455	9.370	7.820	7.100	44.465
TOTAL		19.295	16.775	20.690	19.770	18.420	18.450	113.410

Table 34. Analysis of variance for the amount of fruit in kg/plot produced on May 29, 1967.

Source of variation	D.F.	S.S.	M.S.	F value
Varieties	2	6.52	3.26	9.314 ^{XX}
Replications	5	0.96	0.19	0.542
Error a	10	3.56	0.35	
Deflowering	2	3.39	1.69	9.941 ^{XX}
Deflowering x variety	4	0.24	0.06	0.352
Error b	30	5.35	0.17	

Table 35. Effect of deflowering and variety on the amount of fruit in Kg/plot produced on June 1, 1967.

Variety	Deflowering	Replications						Total
		1	2	3	4	5	6	
Solana	One month	2.850	2.450	2.100	1.450	1.810	2.000	12.660
	Two months	2.950	2.250	2.600	1.575	1.950	2.050	13.375
	No deflowering	2.650	1.100	1.650	1.450	1.800	1.500	10.150
Total		8.450	5.800	6.35	4.475	5.560	5.550	36.185
Shasta	One month	1.600	2.000	1.500	1.100	0.800	1.000	8.000
	Two months	1.775	2.000	2.200	2.100	0.900	1.350	10.325
	No deflowering	1.365	1.750	1.200	1.850	0.500	1.000	7.665
Total		4.740	5.750	4.900	5.050	2.200	3.350	25.990
Lassen	One month	2.550	2.975	2.350	2.600	2.950	1.450	14.875
	Two months	1.650	3.255	3.120	3.900	2.950	2.400	17.275
	No deflowering	2.150	1.405	2.250	2.750	2.100	1.500	12.155
Total		6.350	7.635	7.720	9.250	8.000	5.350	44.305
TOTAL		19.540	19.185	18.970	18.775	15.760	14.250	106.480

Table 36. Analysis of variance for the amount of fruit in Kg/plot produced on May 25, 1967.

Source of variation	D.F.	S.S.	M.S.	F value
Varieties	2	9.36	4.68	7.548 ^{XX}
Replications	5	2.67	0.53	0.854
Error a	10	6.21	0.62	
Deflowering	2	3.36	1.68	12.000 ^{XX}
Deflowering x variety	4	0.48	0.12	0.857
Error b	30	4.21	0.14	

Table 37. Effect of deflowering and variety on the number of berries/plant produced on June 1, 1967.

Variety	Deflowering	Replications						Total
		1	2	3	4	5	6	
Solana	One month	17.7	8.5	16.2	11.9	13.8	17.5	85.6
	Two months	13.0	17.0	17.9	12.0	13.7	17.7	91.3
	No deflowering	18.6	14.1	13.9	10.7	13.7	12.5	83.3
Total		49.3	39.6	48.0	34.6	41.0	47.7	260.2
Shasta	One month	11.1	13.5	10.6	7.8	6.2	7.8	57.0
	Two months	9.6	14.1	17.5	16.6	8.0	8.9	74.7
	No deflowering	13.9	13.0	8.1	14.8	4.0	7.5	61.3
Total		34.6	40.6	36.2	39.2	18.2	24.2	193.0
Lassen	One month	19.0	23.0	21.3	29.2	17.1	19.8	129.4
	Two months	13.5	25.0	25.5	23.8	19.7	13.5	121.0
	No deflowering	17.6	13.0	20.0	22.5	10.9	13.3	97.3
Total		50.1	61.0	66.8	75.5	47.7	46.6	347.7
TOTAL		134.0	141.2	151.0	149.3	106.9	118.5	800.9

Table 38. Analysis of variance for the number of berries/plant produced on June 1, 1967.

Source of variation	D.F.	S.S.	M.S.	F. value
Varieties	2	668.59	334.295	13.397 ^{XX}
Replications	5	172.00	34.400	1.378
Error a	10	249.52	24.952	
Deflowering	2	78.61	39.305	4.366 ^X
Deflowering x variety	4	67.83	16.957	1.883
Error b	30	274.37	9.001	

Table 39. Effect of deflowering and variety on berry size (in grams/berry) produced on June 1, 1967.

Variety	Deflowering	Replications						Total
		1	2	3	4	5	6	
Solana	One month	10.0	8.0	8.0	12.5	8.1	9.2	55.8
	Two months	14.1	9.0	9.0	13.2	8.8	16.5	70.6
	No deflowering	8.8	10.0	7.3	8.4	8.2	7.5	50.2
Total		32.9	27.0	24.3	34.1	25.1	33.2	176.6
Shasta	One month	8.9	8.1	8.7	8.7	8.0	10.0	52.4
	Two months	8.8	8.8	7.8	9.6	7.6	8.7	51.3
	No deflowering	7.9	9.5	4.1	7.7	7.0	8.3	44.5
Total		25.6	26.4	20.6	26.0	22.6	27.0	148.2
Lassen	One month	8.3	6.7	6.8	8.3	9.3	6.7	46.1
	Two months	7.6	8.0	7.6	8.6	13.1	7.0	51.9
	No deflowering	7.6	7.9	7.0	7.6	7.6	7.5	45.2
Total		23.5	22.6	21.4	24.5	30.0	21.2	143.2
TOTAL		82.0	76.0	66.3	84.6	77.7	81.4	468.0

Table 40. Analysis of variance for berry size (in grams/berry) produced on June 1, 1967.

Source of variation	D.F.	S.S.	M.S.	F value
Varieties	2	36.05	18.02	4.799 ^X
Replications	5	23.56	4.71	1.249
Error a	10	37.74	3.77	
Deflowering	2	32.16	16.08	7.309 ^{XX}
Deflowering x variety	4	15.39	3.84	1.745
Error b	30	66.62	2.20	

Table 41. Effect of deflowering and variety on the amount of fruit in Kg/plot produced on June 5, 1967.

Variety	Deflowering	Replications						Total
		1	2	3	4	5	6	
Solana	One month	2.550	3.350	2.880	2.975	3.100	2.750	17.575
	Two months	2.900	4.000	2.400	2.650	3.250	3.080	18.280
	No deflowering	3.000	3.230	1.950	2.480	2.450	2.330	15.440
Total		8.450	10.580	7.230	8.105	8.800	8.130	51.295
Shasta	One month	1.300	1.650	2.220	1.500	1.700	2.150	10.520
	Two months	1.750	1.950	2.990	1.490	1.800	2.450	12.430
	No deflowering	2.050	1.300	1.620	1.500	1.800	1.250	9.520
Total		5.100	4.900	6.830	4.490	5.300	5.850	32.470
Lassen	One month	4.000	2.740	1.860	3.250	3.100	3.100	18.050
	Two months	4.250	3.050	2.300	3.500	4.110	3.335	20.545
	No deflowering	2.750	1.950	1.770	2.600	2.230	2.800	14.100
Total		11.000	7.740	5.930	9.350	9.440	9.235	52.695
TOTAL		24.550	23.220	19.990	21.945	23.540	23.215	136.460

Table 42. Analysis of variance for the amount of fruit in Kg/plot produced on June 5, 1967.

Source of variation	D.F.	S.S.	M.S.	F value
Varieties	2	14.18	7.090	10.305 ^{XX}
Replications	5	1.40	0.280	0.406
Error a	10	6.88	0.688	
Deflowering	2	4.17	2.088	18.810 ^{XX}
Deflowering x variety	4	0.80	0.201	1.810
Error b	30	3.34	0.111	

Table 43. Effect of deflowering and variety on the amount of fruit in Kg/plot produced on June 9, 1967.

Variety	Deflowering	Replications						Total
		1	2	3	4	5	6	
Solana	One month	2.700	1.800	2.700	2.250	2.400	1.650	13.500
	Two months	2.200	1.150	3.000	2.000	2.250	2.475	13.075
	No deflowering	1.800	1.800	1.500	1.500	1.900	2.850	11.100
Total		6.700	4.750	6.950	5.750	6.550	6.975	37.675
Shasta	One month	1.100	1.450	1.500	1.400	1.550	2.085	9.085
	Two months	1.150	1.550	1.570	1.320	0.900	1.100	7.590
	No deflowering	0.900	1.700	1.200	1.300	0.900	1.100	7.100
Total		3.150	4.000	4.270	4.020	3.350	4.285	23.775
Lassen	One month	2.300	3.750	3.000	3.400	2.450	2.050	16.950
	Two months	2.150	1.700	2.750	2.000	3.000	2.600	14.200
	No deflowering	1.700	3.050	2.750	2.600	0.950	2.250	13.300
Total		6.150	8.500	8.500	8.000	6.400	6.900	44.450
TOTAL		16.000	17.950	19.720	17.770	16.300	18.160	105.900

Table 44. Analysis of variance for the amount of fruit in Kg/plot produced on June 9, 1967.

Source of variation	D.F.	S.S.	M.S.	F value
Varieties	2	12.322	6.161	22.650 ^{XX}
Replications	5	1.020	0.204	0.992
Error a	10	2.728	0.272	
Deflowering	2	1.810	0.905	3.255
Deflowering x variety	4	0.318	0.795	2.859
Error b	30	8.362	0.278	

Table 45. Effect of deflowering and variety on the number of berries/plant produced on June 9, 1967.

Variety	Deflowering	Replications						Total
		1	2	3	4	5	6	
Solana	One month	14.6	14.7	25.5	16.8	21.5	24.4	117.3
	Two months	22.1	14.0	24.6	16.0	20.9	25.2	122.8
	No deflowering	13.5	12.2	28.0	15.0	16.2	25.1	110.0
Total		50.2	40.9	78.1	47.8	58.6	74.5	350.1
Shasta	One month	6.5	16.8	18.1	6.0	5.2	6.0	58.6
	Two months	12.5	10.4	16.8	6.2	5.2	5.3	56.4
	No deflowering	9.4	12.2	13.0	6.0	5.1	14.2	59.9
Total		28.4	39.4	47.9	18.2	15.5	25.5	174.9
Lassen	One month	24.4	30.2	28.1	29.5	31.0	18.3	161.5
	Two months	22.7	15.6	24.0	20.2	34.5	19.0	136.0
	No deflowering	18.6	29.2	22.6	22.5	12.3	19.1	124.3
Total		65.5	75.0	74.7	72.2	77.8	56.4	421.8
TOTAL		144.3	155.3	200.7	138.2	151.9	156.4	946.8

Table 46. Analysis of variance for the number of berries/plant produced on June 9, 1967.

Source of variation	D.F.	S.S.	M.S.	F value
Varieties	2	1792.51	896.25	18.726 ^{XX}
Replications	5	272.20	54.44	1.137
Error a	10	478.66	47.86	
Deflowering	2	51.85	25.92	1.466
Deflowering x variety	4	83.54	20.88	1.181
Error b	30	530.28	17.67	

Table 47. Effect of deflowering and variety on berry size (in grams/berry) produced on June 9, 1967.

Variety	Deflowering	Replications						Total
		1	2	3	4	5	6	
Solana	One month	7.2	6.8	7.3	5.7	6.9	6.7	40.6
	Two months	6.2	9.1	6.0	7.9	10.8	6.0	46.0
	No deflowering	8.2	5.1	5.5	5.5	7.3	5.9	37.5
Total		21.6	21.0	18.8	19.1	25.0	18.6	124.1
Shasta	One month	10.5	5.3	5.1	6.0	5.2	14.2	46.3
	Two months	5.7	9.2	14.4	6.2	5.2	5.3	46.0
	No deflowering	5.9	8.6	5.7	6.0	5.1	6.0	37.3
Total		22.1	23.1	25.2	18.2	15.5	25.5	129.6
Lassen	One month	5.8	7.7	7.5	7.2	4.9	6.9	40.0
	Two months	5.9	6.7	7.1	6.1	5.4	8.5	39.7
	No deflowering	5.6	6.5	6.6	7.2	4.8	7.3	38.0
Total		17.3	20.9	21.2	20.5	15.1	22.7	117.7
TOTAL		61.0	65.0	65.2	57.8	55.6	66.8	371.4

Table 48. Analysis of variance for berry size (in grams/berry) produced on June 9, 1967.

Source of variation	D.F.	S.S.	M.S.	F value
Varieties	2	3.94	1.970	0.510
Replications	5	11.32	2.264	0.587
Error a	10	38.56	3.856	
Deflowering	2	10.73	5.356	1.149
Deflowering x variety	4	4.54	1.135	0.243
Error b	30	140.09	4.660	

Table 49. Effect of deflowering and variety on the amount of fruit in Kg/plot produced on June 13, 1967.

Variety	Deflowering	Replications						Total
		1	2	3	4	5	6	
Solana	One month	1.500	1.500	1.300	1.650	1.400	1.450	9.800
	Two months	1.350	1.500	1.350	1.500	0.800	1.200	7.700
	No deflowering	1.150	1.200	1.300	1.150	1.200	0.700	6.700
Total		4.000	4.200	3.950	4.300	3.400	3.350	23.200
Shasta	One month	1.100	0.800	1.900	1.250	0.800	0.850	6.700
	Two months	0.750	1.900	1.900	1.000	1.050	1.000	7.600
	No deflowering	0.800	1.100	1.200	0.700	0.850	1.100	5.750
Total		2.650	3.800	5.000	2.950	2.700	2.950	20.050
Lassen	One month	1.850	1.950	1.500	1.750	2.000	1.550	10.600
	Two months	1.550	1.950	1.750	1.500	2.100	1.700	10.550
	No deflowering	1.000	1.950	1.500	1.200	1.100	1.000	7.650
Total		4.400	5.850	4.750	4.450	5.100	4.250	28.800
TOTAL		11.050	13.850	13.700	11.700	11.200	10.550	72.05

Table 50. Analysis of variance for the amount of fruit in kg/plot produced on June 13, 1967.

Source of variation	D.F.	S.S.	M.S.	F value
Varieties	2	2.18	1.090	9.561 ^{XX}
Replications	5	1.11	0.222	1.947
Error a	10	1.14	0.114	
Deflowering	2	1.28	0.640	9.696 ^{XX}
Deflowering x variety	4	0.32	0.080	1.212
Error b	30	1.98	0.066	

Table 51. Effect of deflowering and variety on the amount of fruit in Kg/plot produced on June 16, 1967.

Variety	Deflowering	Replications						Total
		1	2	3	4	5	6	
Solana	One month	0.150	0.150	0.250	0.300	0.375	0.150	1.375
	Two months	0.200	0.200	0.350	0.350	0.250	0.200	1.550
	No deflowering	0.170	0.250	0.160	0.250	0.200	0.100	1.130
Total		0.520	0.600	0.760	0.900	0.825	0.450	4.055
Shasta	One month	0.350	0.200	0.200	0.200	0.150	0.280	1.380
	Two months	0.100	0.200	0.200	0.200	0.250	0.150	1.100
	No deflowering	0.150	0.200	0.200	0.200	0.100	0.200	1.050
Total		0.600	0.600	0.600	0.600	0.500	0.630	3.530
Lassen	One month	0.450	0.250	0.400	0.480	0.600	0.250	2.430
	Two months	0.400	0.700	0.500	0.480	0.650	0.450	3.180
	No deflowering	0.200	0.700	0.460	0.350	0.150	0.450	2.310
Total		1.050	1.650	1.360	1.310	1.400	1.150	7.920
TOTAL		2.170	2.850	2.720	2.810	2.725	2.230	15.505

Table 52. Analysis of variance for the amount of fruit in Kg/plot produced on June 16, 1967.

Source of variation	D.F.	S.S.	M.S.	F value
Varieties	2	0.64	0.3200	40 ^{xx}
Replications	5	0.05	0.0700	1.250
Error a	10	0.08	0.0080	
Deflowering	2	0.05	0.0250	2.032
Deflowering x variety	4	0.05	0.0125	1.016
Error b	30	0.37	0.0123	

Table 53. Effect of deflowering and variety on the number of berries/plant produced on June 16, 1967.

Variety Deflowering	Replications						Total
	1	2	3	4	5	6	
Solana One month	1.6	3.9	3.0	4.3	3.1	2.5	18.4
Solana Two months	2.6	3.2	4.5	4.9	2.5	5.2	22.9
Solana No deflowering	2.8	2.6	2.4	3.5	4.2	1.9	17.4
Total	7.0	9.7	9.9	12.7	9.8	9.6	58.7
Shasta One month	5.1	3.9	2.5	2.9	1.5	4.9	20.8
Shasta Two months	2.3	5.2	3.1	3.6	6.1	1.8	22.1
Shasta No deflowering	3.2	2.8	3.1	2.7	1.3	4.2	17.3
Total	10.6	11.9	8.7	9.2	8.9	10.9	60.2
Lassen One month	5.5	8.3	6.2	6.1	2.5	3.9	33.5
Lassen Two months	6.6	4.5	5.9	6.8	8.3	4.2	36.2
Lassen No deflowering	3.6	8.4	5.4	3.8	7.5	1.8	30.5
Total	15.7	21.2	17.5	16.7	18.3	10.9	100.3
TOTAL	33.3	42.8	36.1	38.6	37.0	31.4	219.2

Table 54. Analysis of variance for the number of berries/plant produced on June 16, 1967.

Source of variation	D.F.	S.S.	M.S.	F value
Varieties	2	61.87	30.935	16.640 ^{XX}
Replications	5	8.98	1.796	0.966
Error a	10	18.59	1.859	
Deflowering	2	7.22	3.610	1.398
Deflowering x variety	4	0.50	0.125	0.048
Error b	30	77.44	2.581	

Table 55. Effect of deflowering and variety on berry size (in grams/berry) produced on June 16, 1967.

Variety	Deflowering	Replications						Total
		1	2	3	4	5	6	
Solana	One month	5.5	3.4	4.1	4.3	3.9	3.9	25.1
	Two months	4.6	3.9	7.1	4.4	6.0	2.3	28.3
	No deflowering	3.7	3.9	3.8	4.3	3.5	3.2	22.4
Total		13.8	11.2	15.0	13.0	13.4	9.4	75.8
Shasta	One month	4.2	4.2	4.8	4.2	6.0	3.5	26.9
	Two months	2.7	4.3	5.9	4.5	7.0	5.0	29.4
	No deflowering	2.9	4.4	3.9	3.4	4.7	2.9	22.1
Total		9.7	12.9	14.6	12.1	17.7	11.4	78.4
Lassen	One month	5.0	4.3	5.6	4.8	4.8	4.4	28.9
	Two months	3.7	5.0	5.8	4.2	5.0	4.4	28.1
	No deflowering	3.3	5.1	5.2	4.3	3.7	2.8	24.4
Total		12.0	14.4	16.6	13.3	13.5	11.6	81.4
TOTAL		35.5	38.5	46.2	38.4	44.6	32.4	235.6

Table 56. Analysis of variance for berry size (in grams/berry) produced on June 16, 1967.

Source of variation	D.F.	S.S.	M.S.	F value
Varieties	2	0.87	0.435	0.450
Replications	5	15.47	3.094	3.202
Error a	10	9.66	0.966	
Deflowering	2	8.40	0.420	0.698
Deflowering x variety	4	1.03	0.257	0.427
Error b	30	18.04	0.601	

Table 57. Effect of deflowering and variety on the amount of fruit in Kg/plot produced on June 19, 1967.

Variety	Deflowering	Replications						Total
		1	2	3	4	5	6	
Solana	One month	0.100	0.100	0.250	0.150	0.150	0.100	0.850
	Two months	0.100	0.085	0.200	0.150	0.750	0.100	0.710
	No deflowering	0.105	0.100	0.070	0.115	0.100	0.050	0.540
Total		0.305	0.285	0.520	0.415	0.525	0.250	2.100
Shasta	One month	0.110	0.075	0.050	0.050	0.100	0.050	0.435
	Two months	0.110	0.022	0.150	0.050	0.030	0.100	0.462
	No deflowering	0.080	0.150	0.065	0.010	0.050	0.050	0.405
Total		0.300	0.247	0.265	0.110	0.180	0.200	1.302
Lassen	One month	0.150	0.200	0.080	0.150	0.100	0.100	0.780
	Two months	0.150	0.120	0.080	0.050	0.110	0.100	0.610
	No deflowering	0.100	0.080	0.080	0.150	0.120	0.100	0.630
Total		0.400	0.400	0.240	0.350	0.330	0.300	2.020
TOTAL		1.005	0.932	1.025	0.875	0.835	0.750	5.422

Table 58. Analysis of variance for the amount of fruit in Kg/plot produced on June 19, 1967.

Source of variation	D.F.	S.S.	M.S.	F value
Varieties	2	0.021	0.0105	4.200 ^x
Replications	5	0.006	0.0012	0.480
Error a	10	0.025	0.0025	
Deflowering	2	0.007	0.0035	0.174
Deflowering x variety	4	0.005	0.0012	0.059
Error b	30	0.604	0.0201	

Table 59. Effect of deflowering and variety on the fruit of whole season in Kg/plot produced in 1967.

Variety Deflowering	Replications						Total
	1	2	3	4	5	6	
Solana One month	12.905	12.520	13.590	12.625	13.215	11.950	76.310
Solana Two months	14.220	12.290	14.115	11.060	13.430	12.070	77.185
Solana No deflowering	11.925	10.235	10.430	10.145	10.395	11.580	64.710
Total	39.050	35.045	38.135	33.830	37.040	35.605	218.705
Shasta One month	7.775	9.325	9.820	8.110	9.405	9.225	53.860
Shasta Two months	8.535	10.272	12.695	8.710	7.230	11.000	58.442
Shasta No deflowering	6.805	8.525	7.355	8.610	6.105	6.600	44.000
Total	23.315	28.122	29.870	25.430	22.740	26.825	156.303
Lassen One month	14.665	14.815	13.540	14.760	14.430	11.550	83.760
Lassen Two months	12.900	13.725	13.835	17.480	17.170	15.235	90.345
Lassen No deflowering	11.890	12.190	11.600	12.690	10.650	10.600	69.620
Total	39.455	40.730	38.975	44.930	42.250	37.385	243.725
TOTAL	101.820	103.897	106.980	104.170	102.030	99.815	618.732

Table 60. Analysis of variance for the fruit of whole season in Kg/plot produced in 1967.

Source of variation	D.F.	S.S.	M.S.	F value
Varieties	2	225.24	112.620	40.135 ^{XX}
Replications	5	2.85	0.570	0.203
Error a	10	28.06	2.806	
Deflowering	2	68.63	34.315	26.355 ^{XX}
Deflowering x variety	4	3.69	0.922	0.708
Error b	30	39.08	1.302	

Table 61. Average temperature and rainfall at the AREC from September 1964 to August 1967^x

Month	Rainfall (mm)			Temperature (C°)		
	1964-65	1965-66	1966-67	1964-65	1965-66	1966-67
September	0.0	23.2	0.9	20.2	20.2	20.2
October	0.0	46.8	28.0	17.8	13.2	16.1
November	167.2	24.8	11.0	12.4	10.0	14.1
December	22.1	155.7	187.8	6.8	6.7	7.3
January	114.6	70.9	139.3	4.2	5.7	3.6
February	102.2	68.7	85.1	5.6	6.4	4.1
March	46.3	96.7	167.1	8.2	7.1	5.9
April	59.1	0.0	20.5	9.3	11.8	10.5
May	3.0	2.0	34.5	14.1	14.5	15.1
June	3.0	0.0	0.0	20.7	19.6	17.8
July	0.0	---	0.0	22.5	22.9	20.7
August	0.0	---	0.0	23.8	23.7	---
Total	517.5	489.4	674.2			

^x Data collected by F.M. Maloaf and R. Soroush at the Agricultural Research and Education Center Beqa'a Plain, Lebanon.