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Effect of Slip Size, Slip Storage, and Time of Planting on Yield of Red Spanish Pineapple in Puerto Rico[1]

W. Pennock, and H. Gandía[2]

ABSTRACT

Premature and disperse fruiting of Red Spanish pineapple reduces yield, increases cost of harvesting and upsets bloom induction schedules. Slips of a mean weight of 160, 125, and 75 grams, stored for 0, 45 and 90 days and planted June 1, July 15 and August 31, 1970 did not fruit prematurely. The border planting made with the regular plantation slips in use that year, which had a mean weight of 544 grams, planted July 16, 1970, produced only premature fruit. Proper slip size was shown in the experiment to be a very important factor in influencing the time of natural fruiting and its effect was curvilinear. Each additional gram had a stronger effect in early blossoming as slip size increased. Storage of slips reduced fruit weight and delayed fruit harvest. The first 45 days in storage had a greater delaying action than the subsequent 45 days. Delayed planting also retarded fruiting. The delay of one day in planting retarded harvest by 0.3 day. Any factor that delayed fruit harvest also reduced fruit weight.

INTRODUCTION

June planting of pineapples in Puerto Rico is frequently postponed because of the necessity for assigning the limited available labor force to harvesting, a must priority. Bad weather may cause postponement and sometimes plantings are deliberately postponed at other times of the year to extend production of pineapples for the fresh fruit market.

In years past, slips intended for delayed June plantings, which had been

[1] Manuscript submitted to Editorial Board October 31, 1974.

[2] Formerly Horticulturist and Horticulturist, Department of Plant Breeding, Agricultural Experiment Station, Mayagüez Campus, University of Puerto Rico, Río Piedras, P. R.

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picked from the plants about three months after harvesting, were stored in large mounds in the open. At present, however, the slips are not removed at the proper time, but are permitted to remain growing on the plant until needed.

As a result, fields of Red Spanish pineapples have been planted frequently with slips 60 to 76 cm in length and 280 to 454 g in weight. Slips such as these not only are more expensive to harvest and plant, but their late removal from the plants reduces the bearing potential of the ratoon crop. A large percentage of such slips planted shortly after removal attain blooming size in time to be forced into premature bloom a few months after planting by natural climatic stimulus. This results in small sized, widely scattered fruits in advance of the crop schedule and in most instances it is uneconomical to harvest these fruits. In addition, these undesirable fruits may increase insect problems, particularly of sap-feeding beetles such as *Batrachedra comosae*, Dodge, *Carpophilus humeralis*, F., and *Haptoncus luteolus*, (Erichson).

The occurrence of a high proportion of premature blooming in commercial fields in Puerto Rico consequently led to the request that this problem be studied by scientists of this Station and thus to the establishment of this experiment.

The effect of slip size and planting date upon the pineapple fruiting cycle has been studied by several workers. In Puerto Rico Hendricksen and Iorns (2) reported that slips 12 or more inches (30.4 cm) long resulted in early fruiting. In Hawaii Johnson, (3), as well as Collins (1), agree that spring plantings are inferior to those made in autumn. In Martinique, according to Py (5), small Cayenne suckers planted in January bloomed at the same time as large suckers planted in August. Mitchell (4) reported on the effect of size and type of planting material as well as time of planting on fruit weight in Queensland.

MATERIALS AND METHODS

A 3 × 3 × 3 factorial experiment was established in 1970 in the Manat· pineapple area using propagating material of the Red Spanish variety The experiment consisted of 27 potential differences; three levels of slip size, three levels of slip storage, and three planting dates.

The three slip categories were determined by weighing and calculating the mean weight of slips from one hundred plants harvested at three different ages. Large slips were picked two months after fruit harvest and had a mean weight of 160 grams; medium-size slips were picked one month after fruit harvest and had a mean weight of 125 grams. Small slips were picked immediately following fruit harvest and had a mean weight of 75 grams. For actual planting, the large-sized slips had a range of from 150 to 170 grams in weight and averaged 33.3 cm in length. The medium-sized slips weighed from 117 to 123 grams and had a mean length of 26.1 cm. The small slips weighed from 70 to 80 grams and had a mean length of 18.8 cm. In an effort to confirm that large slips will produce premature fruits, two border rows were planted July 16 with some of the largest slips produced six months after fruit harvest. These had a mean weight of 544 grams.

The three levels of slip storage consisted of: 1) Fresh slips planted 2 to 3 days after picking, 2) slips stored for 45 days in ventilated bags in the shade. and 3) slips stored for 90 days in ventilated bags in the shade.

The three time level intervals of planting consisted of planting on June 1, July 16 and August 30, 1970. All 27 treatments were duplicated, totaling 54 plots, each with 24 plants. Planting was in the two-row system employed at present in Puerto Rico. Distance between rows was 51 cm and 28 cm between plants within the row, with 117 cm of space between each pair of rows. All plants were allowed to bloom in response to natural stimulus and all were harvested at the shipping green stage (approximately one week before the onset of color change).

The pineapple area is located in the north central costal plain, 80 meters above sea level slightly below parallel 18°30′ N. Rainfall there is about 1,500 mm fairly well distributed throughout the year. Temperature ranges between 23 and 27° C. The soil of the experimental area was a Bayamón sandy loam, (Typic Haplorthox, clayey oxidic, isohyperthermic).

RESULTS AND DISCUSSION

Very pronounced premature blooming and production occurred in the 204 border plants. As explained previously, this planting was made July 16, 1970 with large six-month-old slips having a mean weight of 544 grams. The first 23 blooms of these plants were observed eight months after planting and the first 25 fruits were harvested July 2, 1971 almost exactly one year after planting, with a peak harvest of 59.8 % in August 20, 1971. Some fruits were harvested thereafter on each of the succeeding months, the final harvest being made February 7, 1972, when the last 4 fruits were picked. Their total mean fruit weight was 1,600 g. This confirmed that large-size slips remaining too long on the mother plants produce small, premature fruits even when planted as late as July 6.

All three factors involved in this experiment, namely, slip size, planting date and slip storage, affected the time of natural flowering and consequently, the timing of fruit harvest.

Diagrammatic representations of the harvest patterns for each treatment, as well as for the means of different combinations of these treatments, are shown in figures 1 through 8. Each of these diagrams consists of

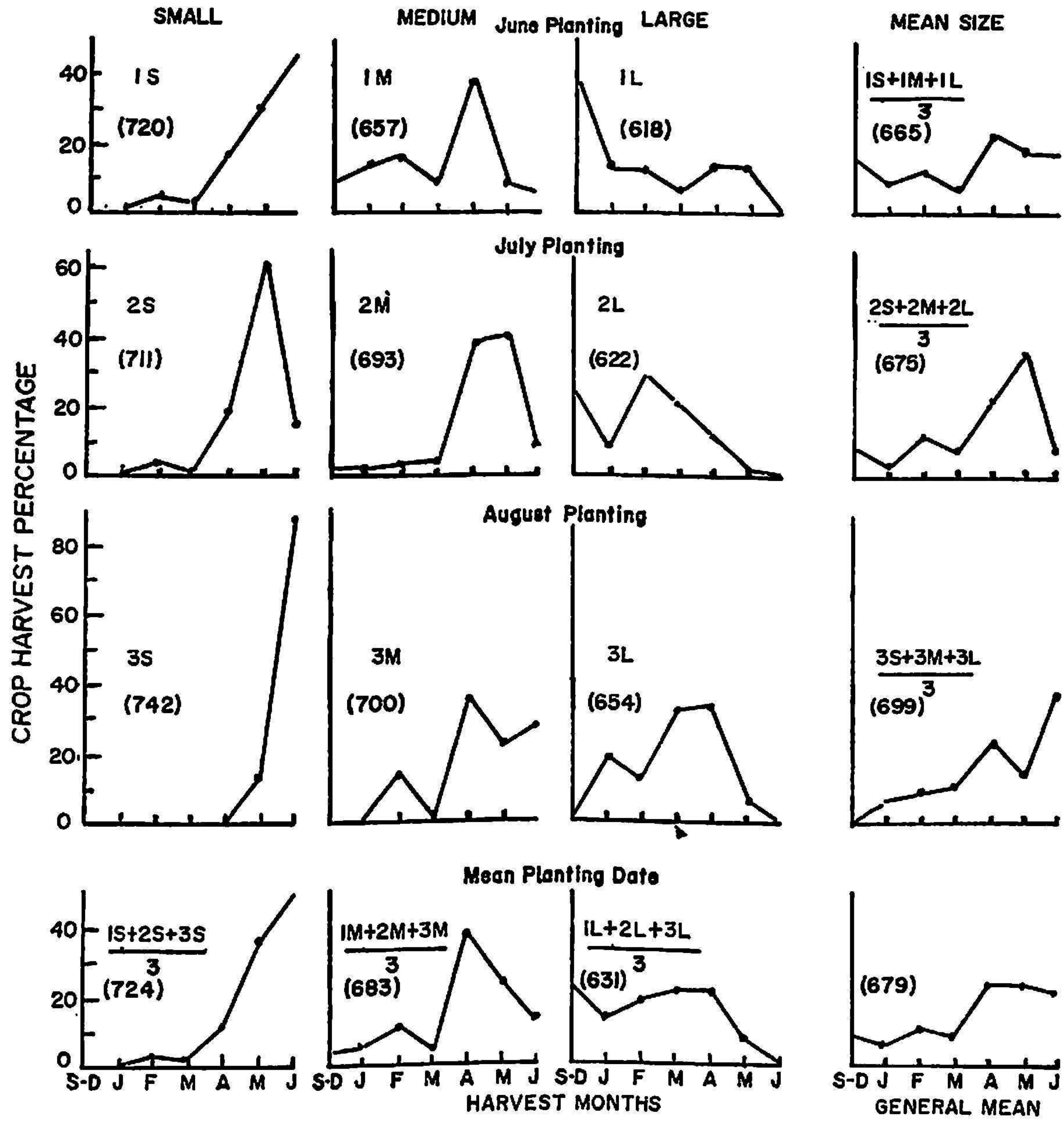

FIG. 1.—Effect of slip size and planting date on monthly harvest pattern of fresh non-stored slips. (Numbers in parenthesis are the mean harvest date indices.)

seven points joined by a line. For each of these points the time of harvest is shown by months on the horizontal axis whereas the corresponding percentage of the total crop produced at that time is shown on the vertical axis. For the sake of simplicity the first demarcation on the horizontal axis is composed of the period from September 16 to December 31 of 1971 and this is followed successively by each of the subsequent six months in 1972. In figure 1 are shown the different treatments carried out with fresh slips; figure 2 shows the pattern for treatments carried out with slips stored for 45 days, and figure 3 shows the pattern for treatments carried out with slips stored for 90 days.

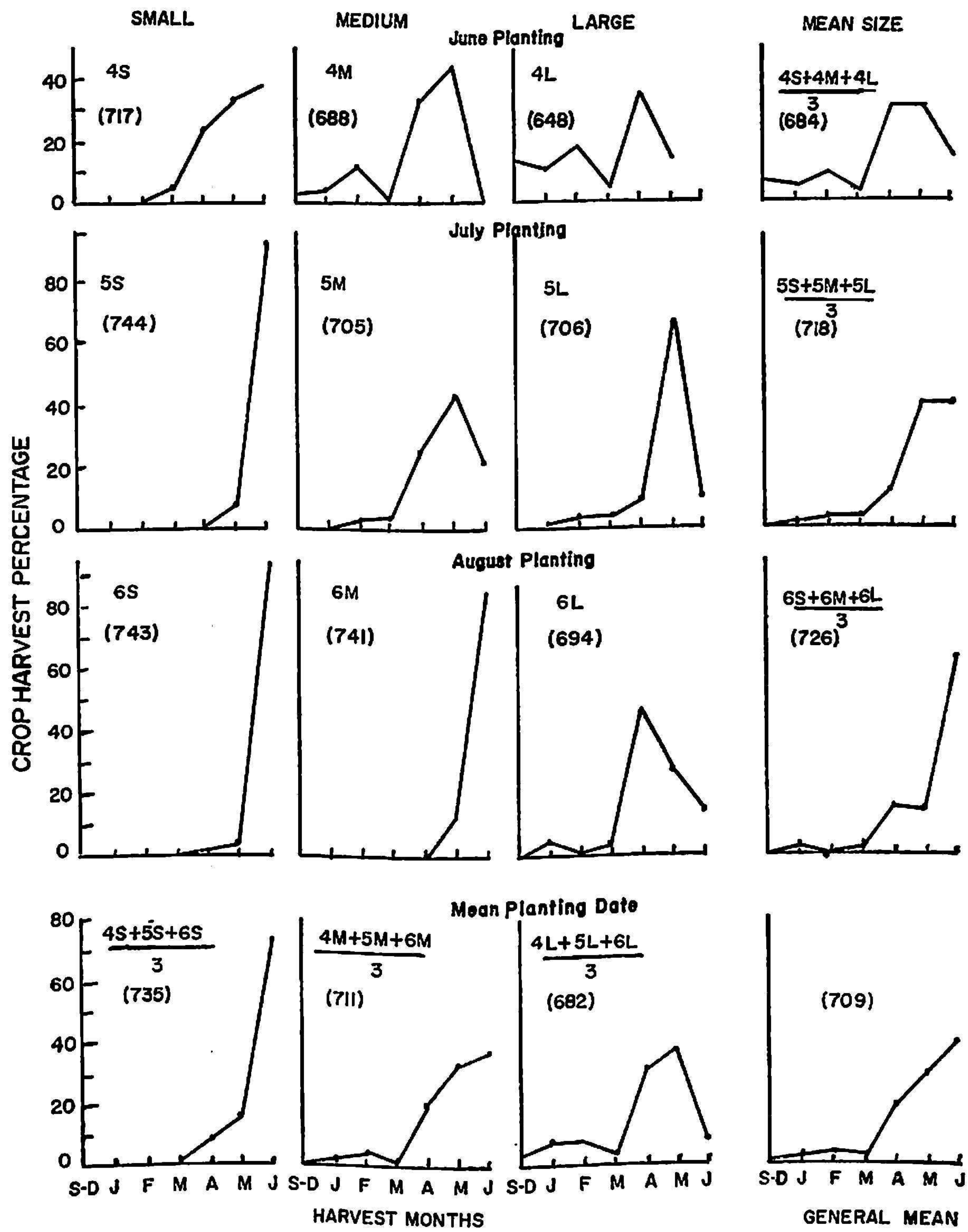

FIG. 2.—Effect of slip size and planting date on monthly harvest pattern of slips stored 45 days.

To permit more precise comparisons between the different graphs a mean harvest date index has been calculated for each treatment, as well as for the various combinations thereof, based on the number of days elapsed from June 1st., 1970 to each of the different seven harvest periods indicated

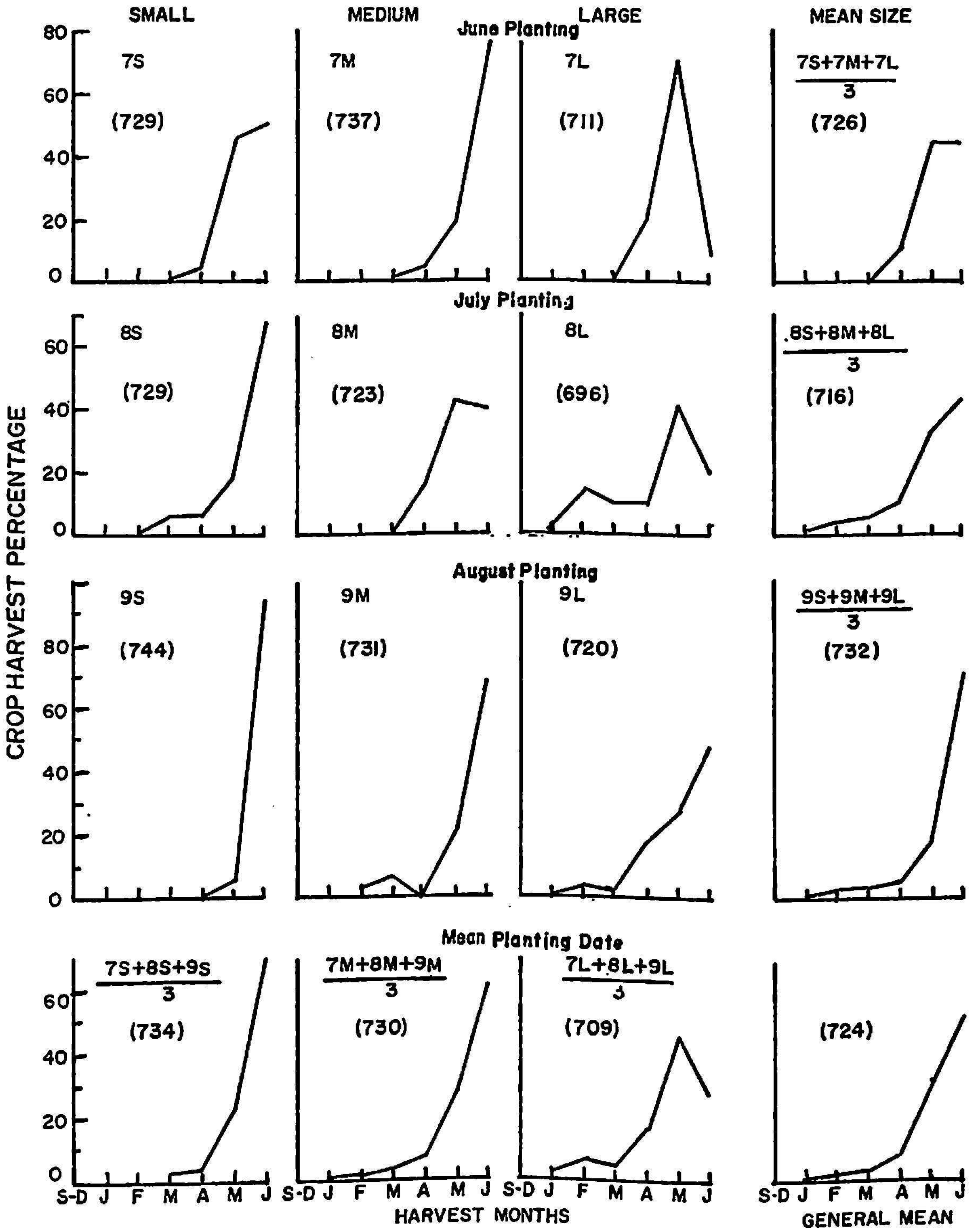

FIG. 3.—Effect of slip size and planting date on monthly harvest pattern of slips stored 90 days.

in the graphs. Thus, there were 563 days which elapsed between June 1st., 1970 to December 15, 1971, and 746 from June 1st, 1970 to June 15, 1972. The percentage of fruit harvested at each monthly period was multiplied by the number of days elapsed from June 1st to the middle of each month, the seven products of these multiplications were then added and were sub-

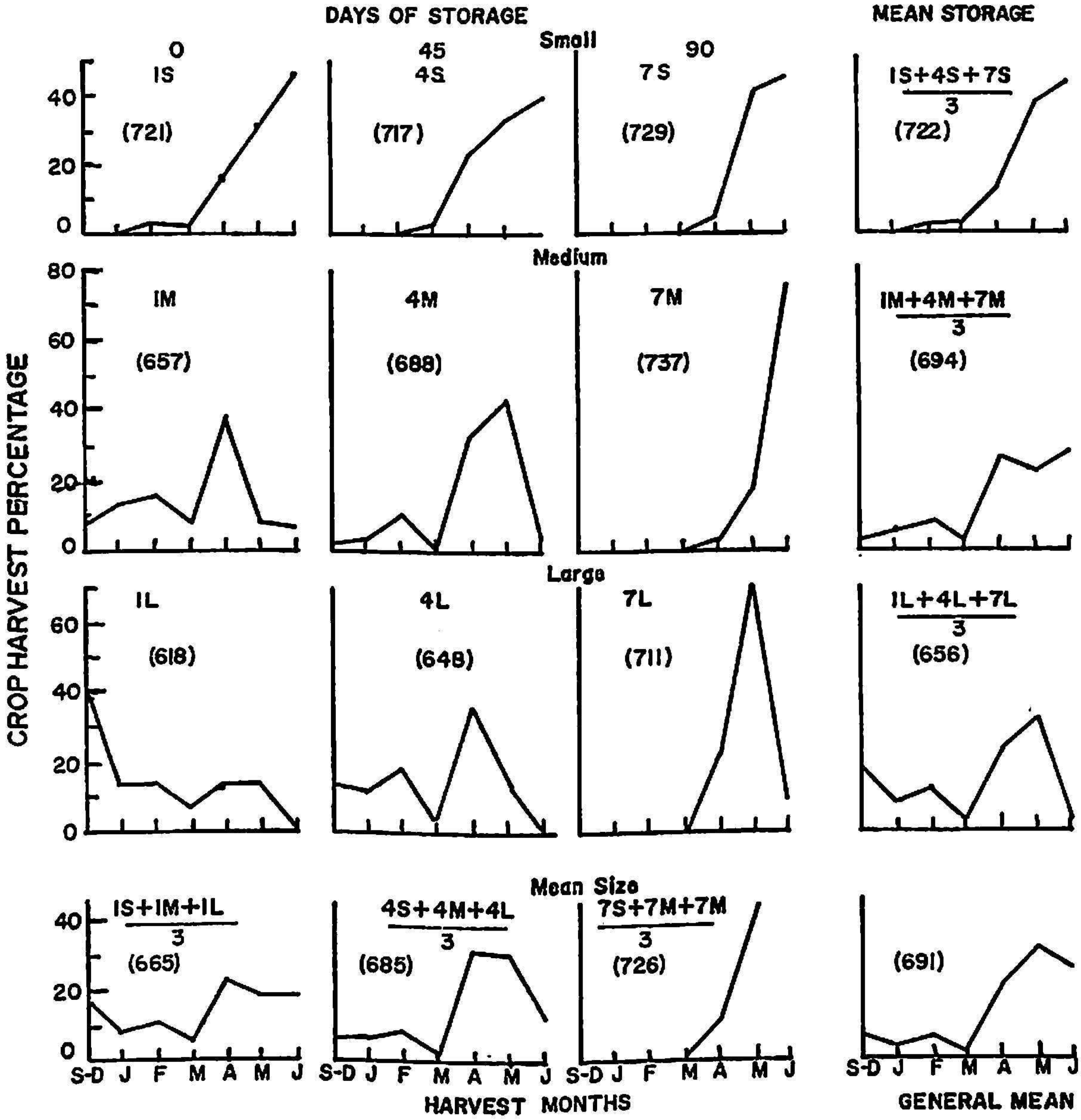

FIG. 4.—Effect of storage and slip size on monthly harvest pattern in the June planting.

sequently divided by the sum of the different percentages (which generally added to slightly less than 100). The quotient, therefore, amounted to the number of days elapsed from June 1st, 1970 to the weighted mean harvest date for all of the fruit in each treatment or combination of treatments. These harvest date indexes are shown in the lower part of the graphs of figures 1 through 8.

EFFECT OF SLIP SIZE ON HARVEST PATTERN

As may be appreciated from the indexes shown in the figures, as slip size decreased the mean harvest date was delayed. This delay was greatest in treatment 9S (fig. 3) where the use of small slips was combined with the

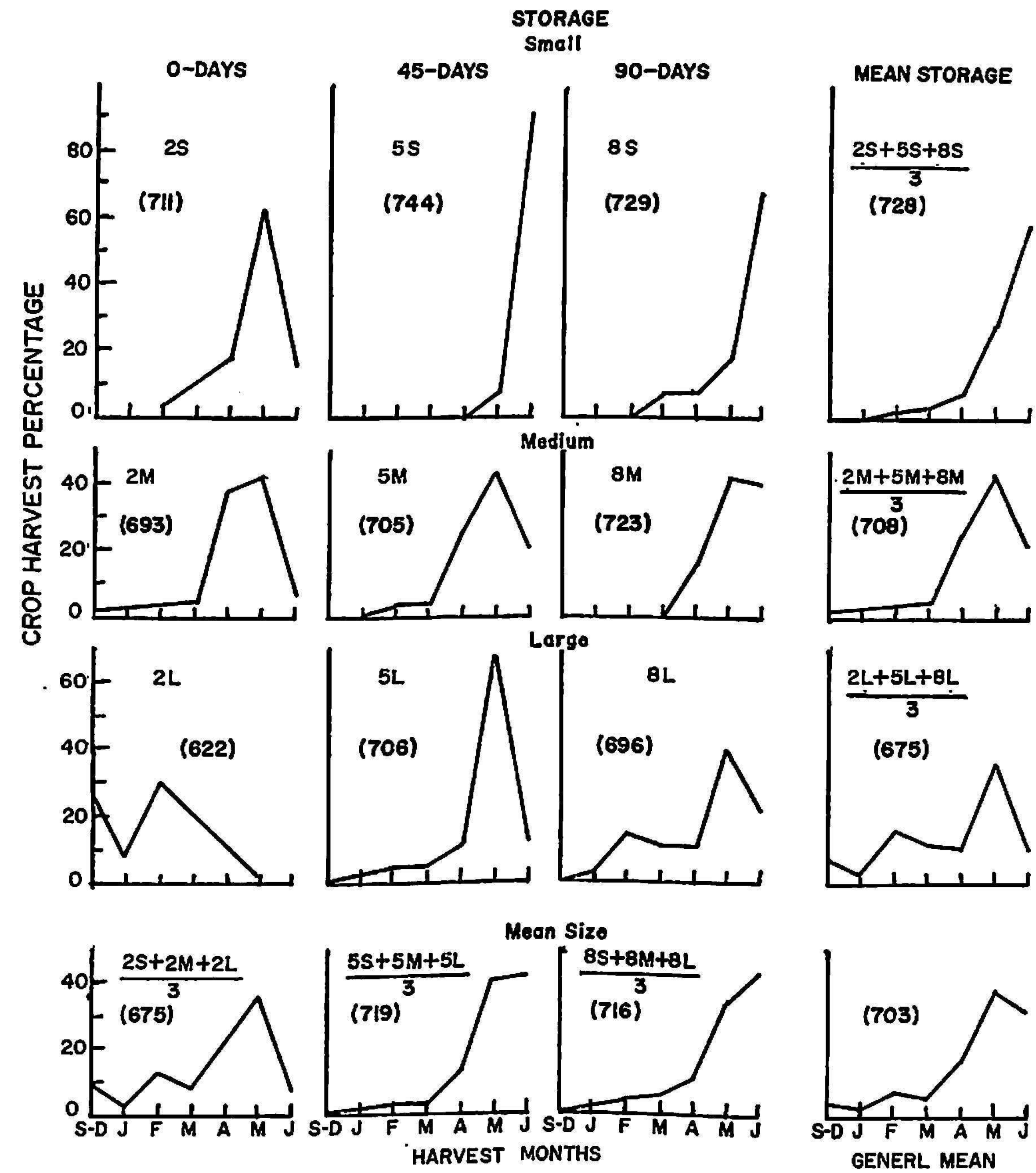

FIG. 5.—Effect of storage and slip side on monthly harvest pattern in the July planting. (Numbers in parenthesis are the mean harvest date indices.)

longest storage period of 90 days and the latest planting date of August 31. In this treatment 5.1 percent of the fruits were produced in May and the remaining 94.8 in June giving a mean harvest date index of 744. The earliest mean harvest date was obtained in treatment 1L (fig. 1) where the use of large slips was combined with zero storage and the earliest planting June 1. In this treatment, 39.9 percent was produced from September to December, 1971 and no fruit remained to be harvested after May 1972. Its mean harvest date index was 618.

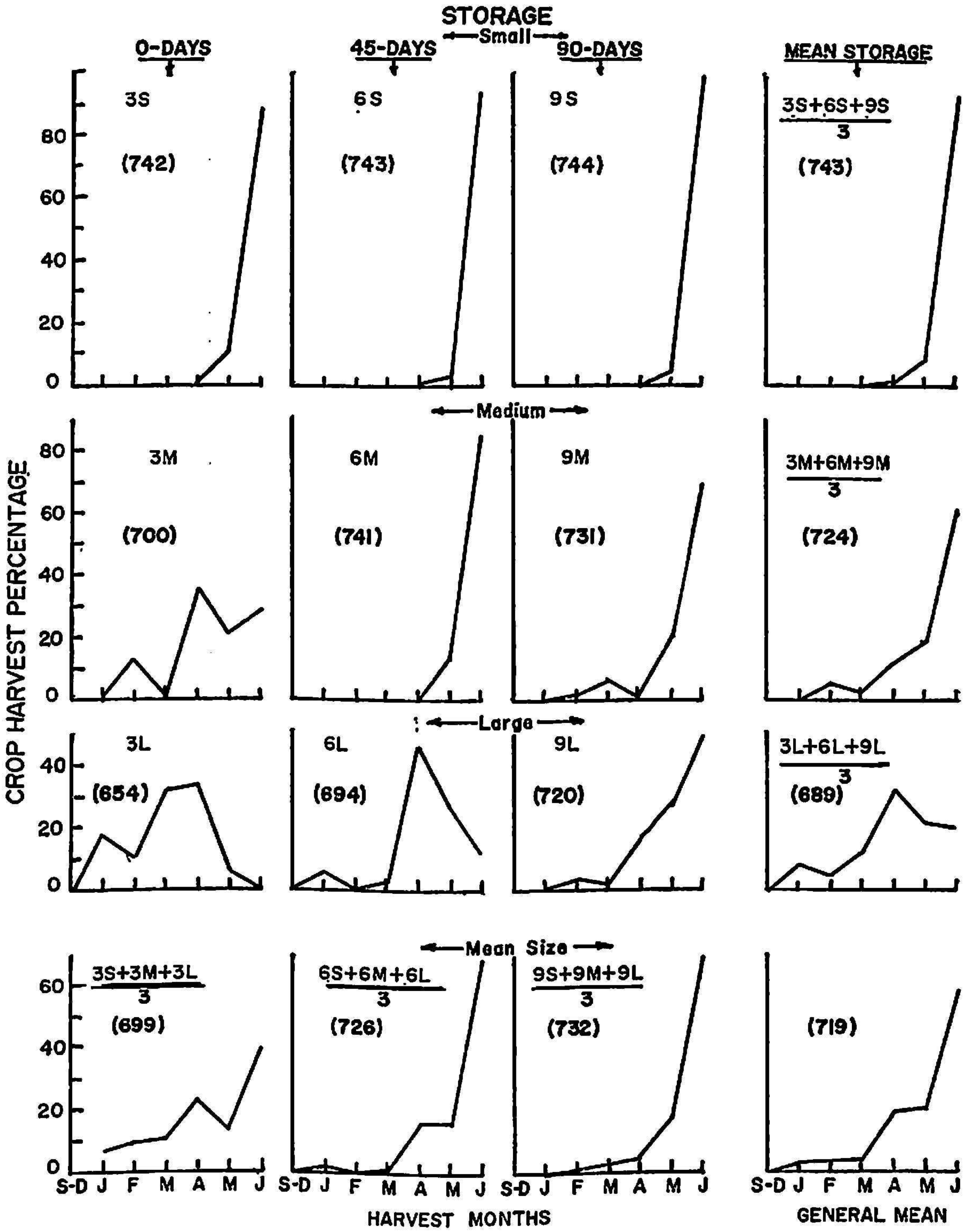

FIG. 6.—Effect of storage and slip size on monthly harvest pattern in the August planting.

The overall effect of slip size may best be appreciated in the fourth column of diagrams in figure 7 where the pattern representing the mean for all nine treatments using small slips, may be compared to that representing the mean for the nine treatments using medium size slips, as well

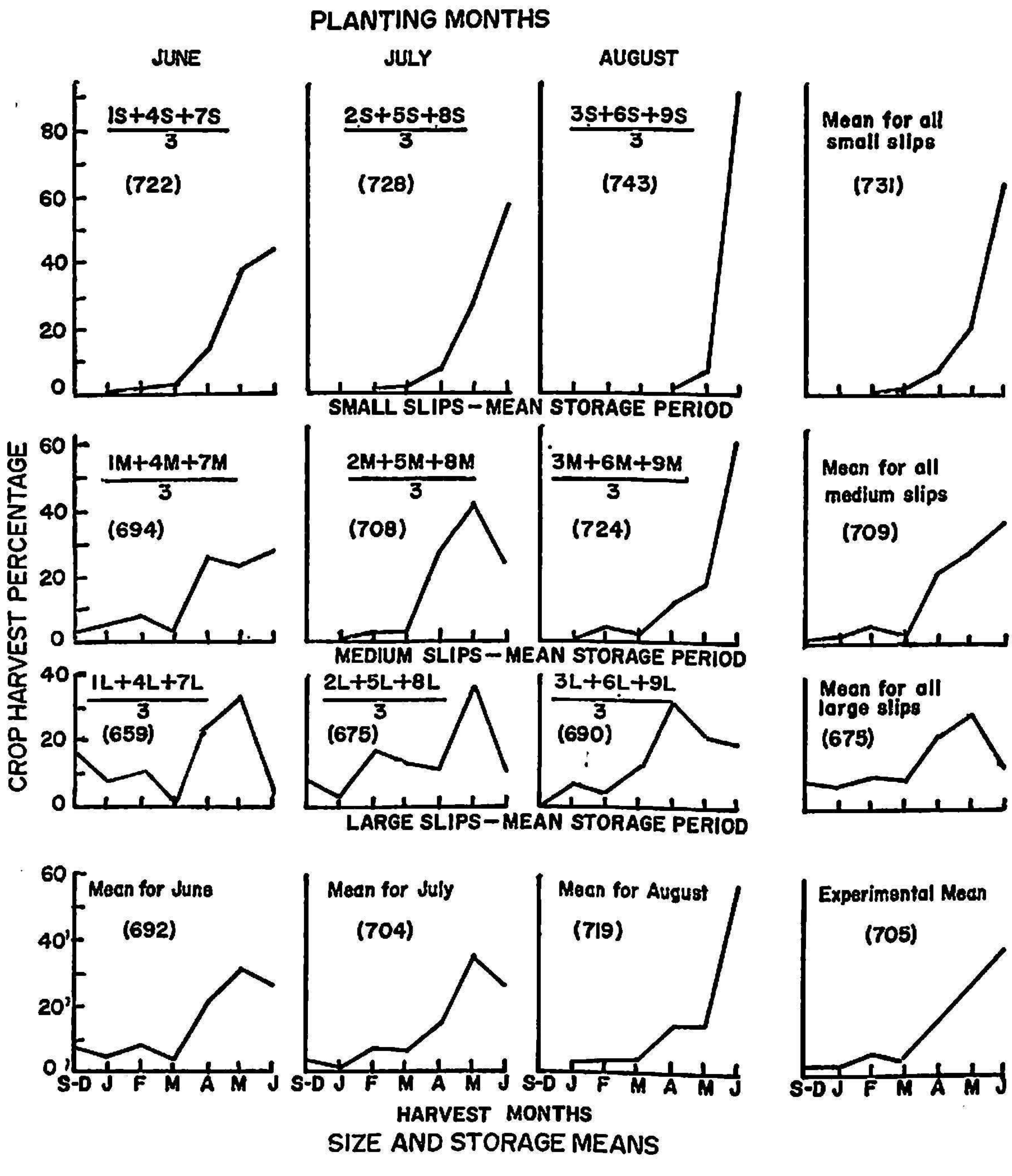

FIG. 7.—Effects of planting date and slip size on monthly harvest pattern for all storage treatments combined.

as the pattern representing the mean for all treatments using large size slips. As shown in this figure, the means for the small sized slip treatments had a mean harvest date index of 731 whereas the medium sized slip had an index of 709, and the large sized slips had an index of 675. The difference between the first two was 23 days and between the second two was 34 days making a total difference of 57 days between the small- and the large-sized slips.

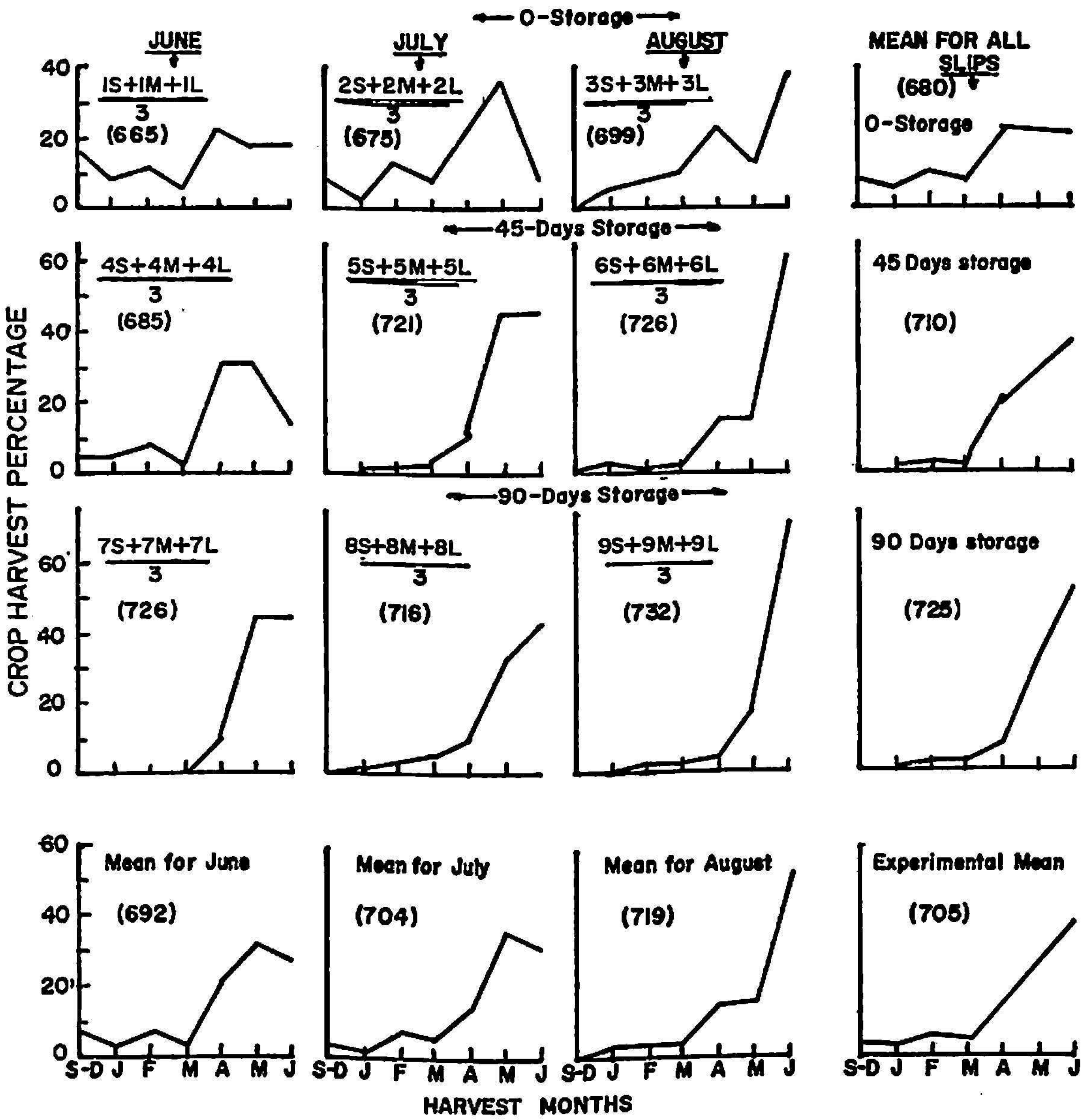

FIG. 8.—Effects of storage period and planting dates on monthly harvest pattern for all slip sizes combined.

EFFECT OF TIME OF PLANTING ON HARVEST PATTERN

Early planting resulted almost invariably in early harvesting, and late planting in late harvesting. As previously shown, the extreme in late harvesting for the experiment occurred in treatment 9S. As presented in figure 3, this concurred with the latest planting in August. Conversely the extreme in early harvesting occurred in treatment 1L, as shown in figure 1; this concurs with the earliest planting in June.

The overall effect of time of planting on crop timing may best be appreciated by comparing the diagrams of the mean of all treatments involving time of planting shown in the lower part of figure 7.

The index for all 9 treatments planted in June was 692, whereas those of the July planting had a harvest date index of 704, and those of the August planting of 719. As compared with June, the July planting delayed the mean harvest date by 12 days, whereas August planting as compared with July delayed the mean harvest date by 15 days. The total delay of the August planting as compared with the June planting was 27 days. Since there were 45-day differences between successive planting dates, the ratio of delay in harvest to delay in planting amounted to .266, .333 and .300 respectively. Apparently plants set out in the later plantings grew faster than those in earlier plantings, which compensated in part for the delay; thus, a one-day delay in planting brought about an actual delay in the mean harvest date of 0.3 days. This faster growth of late planting was doubtless associated with more favorable weather (possibly increase cloud cover) favoring early development following planting.

EFFECT OF SLIP STORAGE ON HARVEST PATTERN

Slip storage in general delayed the time of harvest. As previously indicated, the extreme in late harvesting occurred in treatment 9S (fig. 3) which consisted in part of slips stored for 90 days. The extreme of early harvesting pattern occurred in treatment 1L (fig. 1), which consisted in part of using fresh, non stored slips.

The overall effect of slip storage on harvest pattern may best be appreciated in the right hand column of diagrams shown in figure 8. The mean harvest date index for the nine treatments in which fresh slips were used was 680, whereas that of the nine treatments which used slips stored for 45 days was 710, while the mean for treatments using slips stored for 90 days was 725. The differences between these indexes were 30, 15, and 45, respectively. The ratio for the first 45 days of storage period was 0.666. The ratio for extending the storage period from 45 to 90 was 0.333 with a mean ratio of 0.5000. Thus, the first 45 days of storage provoked a greater delay in harvest than the second 45 days.

The influence of slip storage was evaluated separately from the influence of delay in planting date. This was accomplished by harvesting in advance the slips treated differently in storage periods. In actual practice, however, slip storage and delay in planting probably will occur simultaneously, so the two effects almost invariably will be additive. Slips stored for 45 days will also be delayed in planting by 45 days. The combined effect of a one-day planting delay and a one-day storage will retard harvest by 0.3 days for delay in planting and by .5 day because of storage, making a total of 0.8 day harvest retardation for the combination. This may be expressed in reciprocal terms wherein 1 day of retardation of harvest is obtained with 1¼ days of combined storage and planting delay.

FACTORS AFFECTING FRUIT WEIGHT

Figures 9 through 11 show the effect of the three experimental factors on fruit weight. Unlike the previous graphs, however, these consist of only three points joined by a line. Moreover, in every case the points represent the three levels of the experimental factors under study. The shape of the graph therefore shows how the factors affect fruit size. In the previous graph the entire graph was the result of one treatment and each graph was compared with the others. In figures 9 through 11 each point is the result of a treatment and the different points are compared, indicating whether they are greater or smaller by the slope of the line which joins them.

In general a very marked parallelism can be observed between the effects of the experimental factors on fruit weight with their previously discussed effect on mean retardation of the date of harvest. Any factor that delayed fruit harvest also reduced fruit weight. As discussed previously, as slip size was reduced the mean harvest date was delayed i.e., the harvest date index was increased. It may be observed similarly in figure 9 that, as slip size was reduced, from right to left, fruit size also was reduced. This effect is greatest in the August planting, followed by the July planting and least but still appreciable, in the June planting.

As noted above, delay in planting retarded the harvest date. It may be observed in figure 10 that as planting was delayed from June to July to August the fruit-weight lines slope downward almost invariably. This is particularly noticeable in the three points representing the experimental means.

Slip storage delayed fruit harvest and this delay was most notable in the first 45 days, as discussed previously. It may be observed in figure 11 that slip storage also decreased fruit size and the first 45 days of storage exerted a more pronounced effect than the second additional 45 days in the 90-day storage treatments.

The strong parallelism between the effect of the three treatment factors on both bearing pattern and fruit weight suggested further study using multiple regression. Correlation coefficients were first determined separately for the effect of five different factors on fruit size as follows:

X_1 (Slip weight in grams)	=	0.26374**
X_2 (Delay in time of planting in days)	=	−0.23005**
X_3 (Slip storage period in days)	=	−0.36716**
X_4 (Coded date of harvest for each fruit)	=	−0.65101**
X_5 (Day length at time of bloom induction in minutes)	=	0.36207**

For these analyses the date of harvest was coded by simply counting

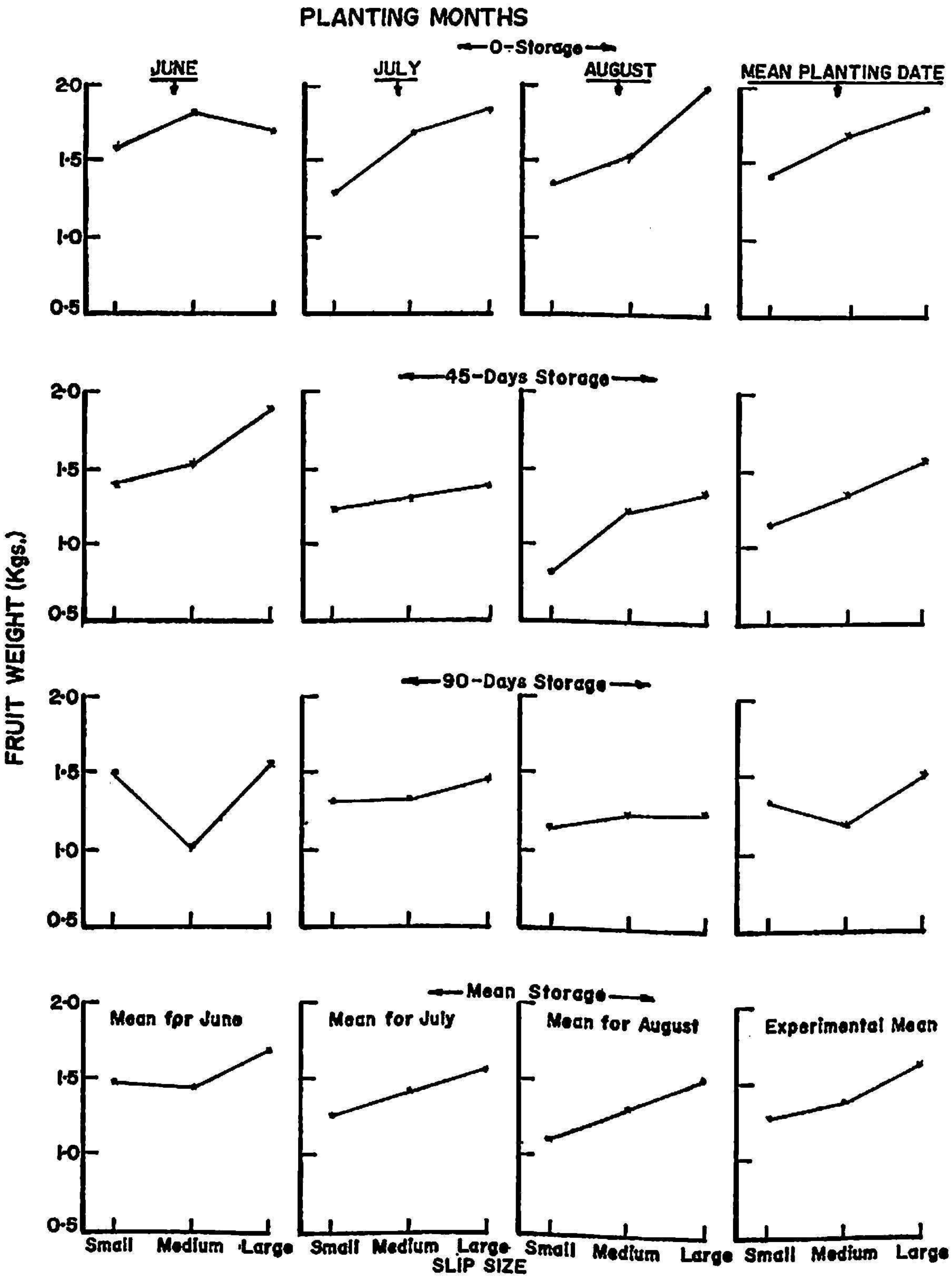

FIG. 9.—Effect of slip size on fruit weight.

the days from the start of the experiment on June 1st to the date of harvest of each pineapple fruit. The natural bloom induction date is calculated for Red Spanish pineapples in Puerto Rico as occurring 150 days before harvest at the shipping green stage (1 week before the onset of color change).

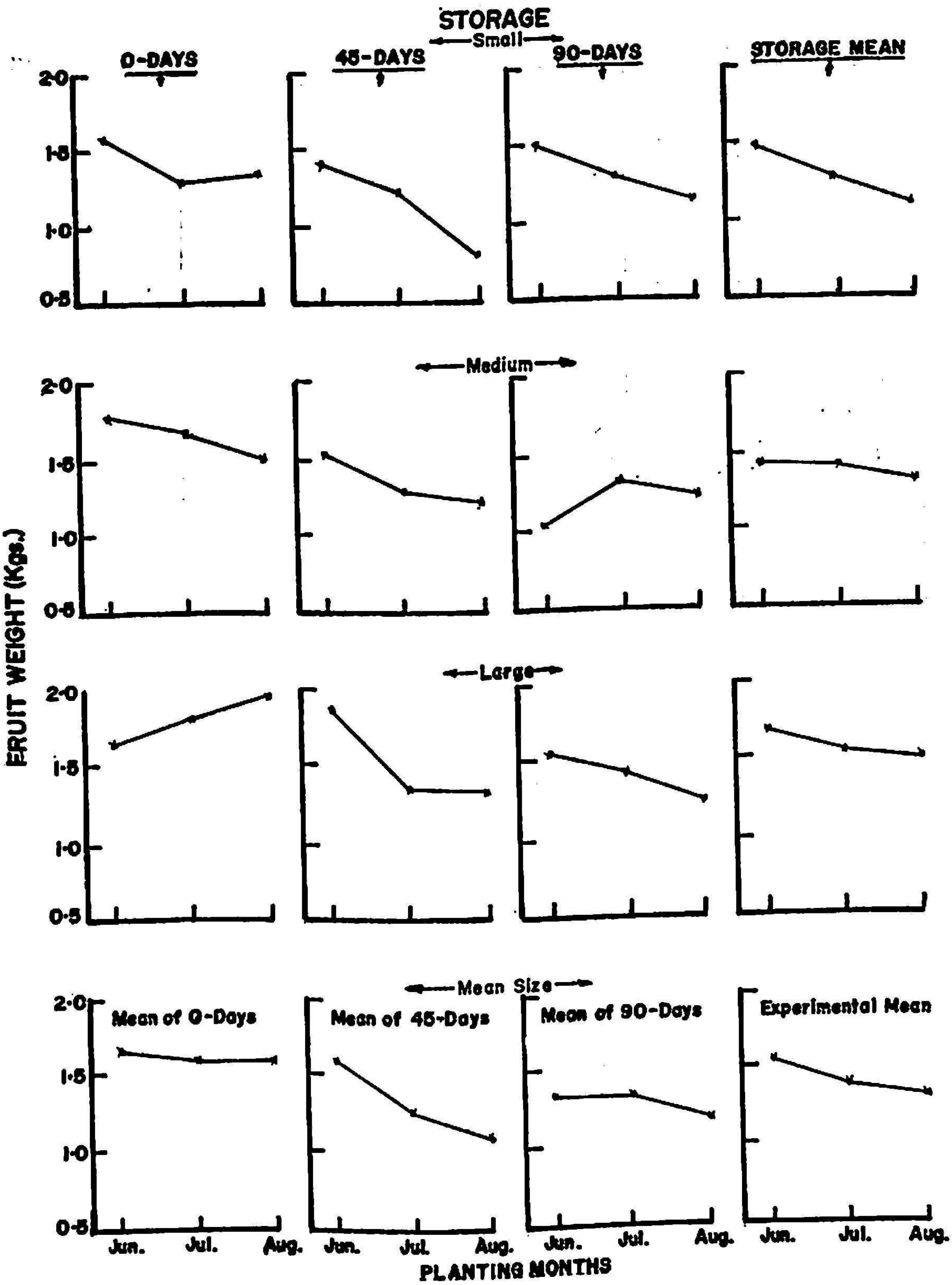

Fig. 10.—Effect of planting date on fruit weight.

The rationale for including day length at the time of bloom induction as a possible factor affecting fruit size consists of regarding day length as a measure of critical plant size, combined with internal vigor and general responsiveness to bloom induction. Therefore the longer the day at the time

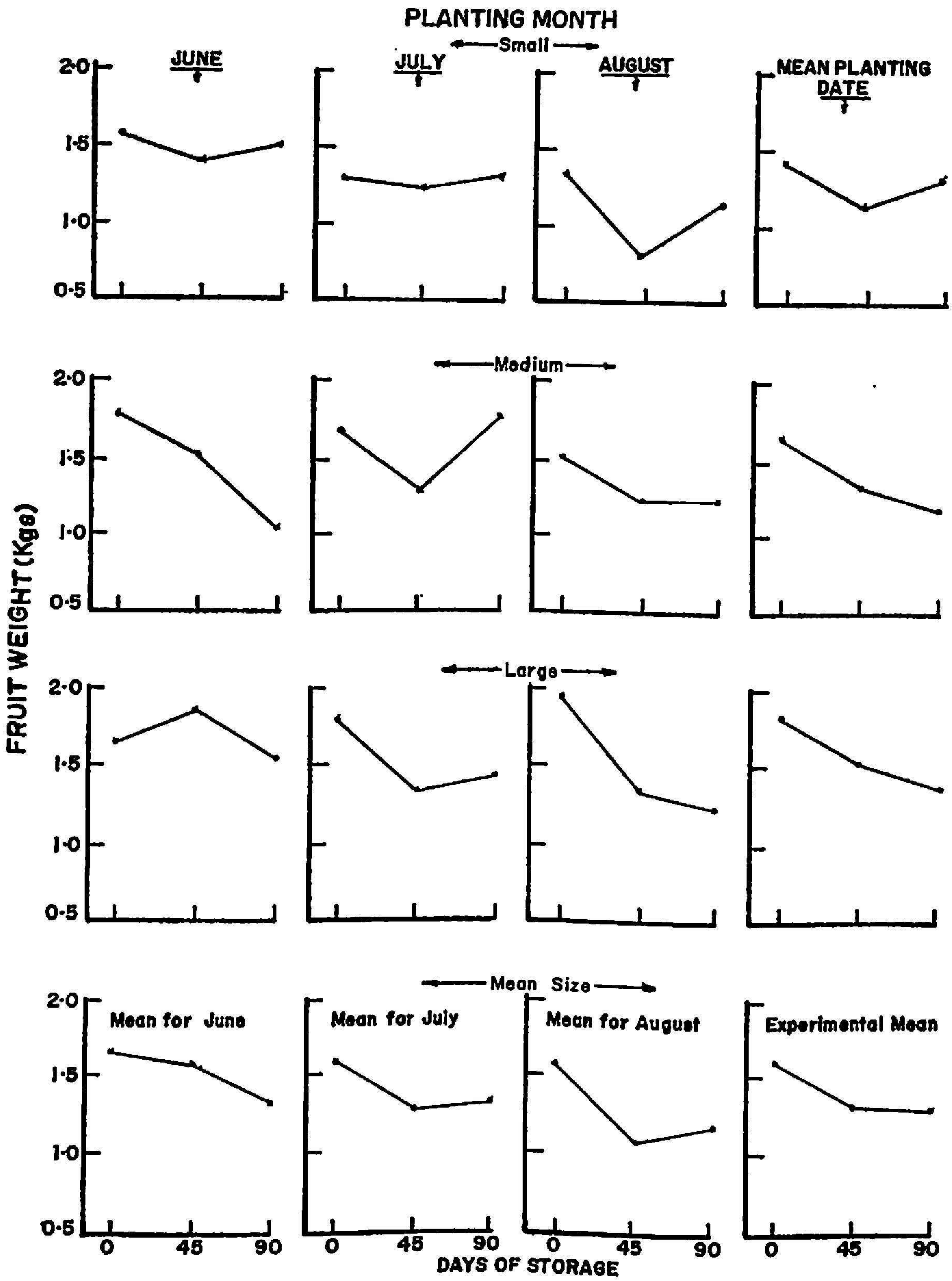

FIG. 11.—Effect of slip storage on fruit weight.

of bloom induction, the larger the plant and the greater its predisposition to shift from vegetative to reproductive development. Larger fruit will be produced with increased plant size and vigor. As may be observed in the foregoing, factor X_4, the coded date of harvest, had the highest correlation coefficient; this was followed, respectively by X_3, slip storage period; by X_5, day length at time of bloom induction; by X_1, slip weight; and finally by X_2, delay in time of planting. All these coefficients were highly significant.

Four multiple regression analyses were performed which gave the following equations:

$$(1)\quad Y = 2.93245 + 0.0064759X_1 - 0.004445X_2 - 0.0074732X_3$$
$$(2)\quad Y = 9.22909 + 0.0002743X_1 - 0.0014645X_2 - 0.0035684X_4$$
$$(3)\quad Y = 0.32554 + 0.0053317X_1 - 0.0040297X_2 - 0.0064529X_3 + 0.0039386X_5$$
$$(4)\quad Y = 24.3490 - 0.0016187X_1 - 0.0000845X_2 - 0.0034265X_3 - 0.0162314X_4 - 0.0137886X_5$$

TABLE 1.—*F values of the additional reductions of the sum of squares for error due to inclusion in the equation of days of harvest* (X_4) *and day length at time of harvest* (X_5)

Equation	Sums of squares for error after fitting equation	Factors included	Reduction in ss. for error due to added factor	F
1	445.44	X_1, X_2, X_3		
2	332.48	X_1, X_2, X_3, X_4	112.96	388.73**
3	271.60	X_1, X_2, X_3, X_4, X_5	60.87	256.17**
1	445.44	X_1, X_2, X_3		
3	432.16	X_1, X_2, X_3, X_5	13.28	35.17**
4	271.60	X_1, X_2, X_3, X_4, X_5	160.56	675.69**

These analyses had the following coefficients for multiple correlation:

Equation 1—0.52147**
" 2—0.54188**
" 3—0.67570**
" 4—0.74570**

All were highly significant and increased in magnitude as the additional factors were included. We therefore determined the F values of the additional reductions of the sum of squares for error due to the inclusion of coded days of harvest (X_4) and day length at time of harvest (X_5) both separately and together. These comparisons and F values are presented in table 1.

As may be observed in the tabulation all of the F values were highly significant indicating that despite some possible interrelationship between them each of the different factors contributes some additional effect independent of the others.

Irrespective of theoretical interpretations, it will undoubtedly be commercially advantageous to combine slip size and time of planting of a fairly large proportion of the total acreage so as to obtain large plants ready for bloom induction between June 1 and the September 23 equinox. This would permit treating for chemical bloom induction starting in May or early June to coincide with or slightly precede natural bloom induction. This would not only advance part of the crop, so as to start harvests in November, but would also produce large sized fruits.

To determine more precisely the quantitative effect of the experimentally controlled factors on date of harvest further regression analyses were performed. Correlation coefficients were first obtained separately for each of four independent variables with date of harvest, and thereafter multiple correlation was performed using these variables. Equation 5 was thus obtained.

The correlation coefficients were all highly significant and were as follows:

b_{X_1} (slip weight in grams) = 0.502053**
$b_{(X_1)^2}$ (slip weight squared) = −0.005202**
b_{X_2} (planting delay in days) = 0.353951**
b_{X_3} (slip storage in days) = 0.508334**

Equation 5 is as follows:

$$Y = 685.8069 + 0.5020X_1 - 0.0052(X_1)^2 + 0.3539X_2 + 0.5083X_3$$

Where Y = coded date of harvest and the independent variables are as shown above. This equation had a coefficient of determination of 0.4479.

The high significance of the coefficient for the square of the slip weight suggested that the relationship with this variable is curvilinear. The influence of the squared term in advancing the harvest date exceeds and surpasses at a relatively low value of slip weight the delay in harvest date due to the linear influence of slip weight. This preponderance of the squared term increases more and more as the slips continue to increase in weight.

Figure 12 consists of the five curves of coded date of harvest on slip weight obtained from this equation for the experimental plantings June 1, July 15 and August 31 planting with fresh slips and two proposed earlier and later plantings on January 14 and November 28, respectively. To present an overall picture of the pineapple blooming and harvesting calendar the three curves in which the actual planting dates were used were extended far beyond the experimental range to include the period when premature blooming would be expected to occur.

These values may be obtained from the point of intersection of the three curves with the vernal equinox. These slip weights are 268 grams or more for the June planting; 276 grams or more for the July planting; and 282 grams or more for the August planting. These slip sizes are considerably smaller than those used in the border plantings which had a mean weight of 544 grams. The present curves can, however, serve as a basis for discussion and tentative recommendations. Figure 12 presents in graphic form the main essentials of the natural bloom induction and fruit harvest calendars for Red Spanish pineapple in Puerto Rico. To this end the vertical axis is variously marked off to indicate both the date of fruit harvest on the left as well as the corresponding mean date of natural bloom induction on the

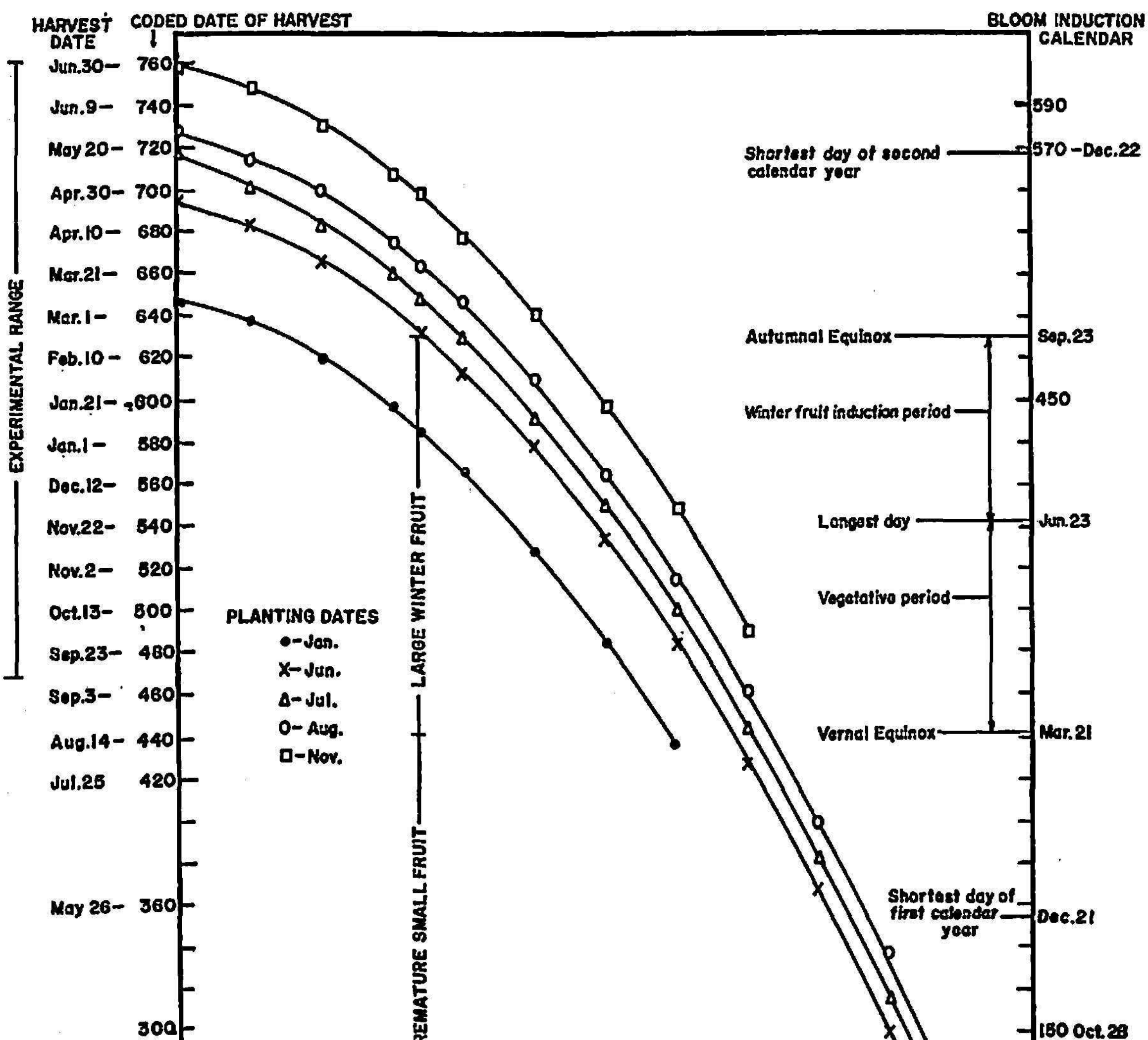

FIG. 12.—Graphic representation of the main essentials of natural bloom induction and fruit harvest calendars from plants obtained from non-stored Red Spanish pineapple in Puerto Rico.

right. Both are also expressed numerically in terms of number of days following initial planting on June 1st.

All Red Spanish pineapple plants in Puerto Rico allowed to bloom naturally on or before the first vernal equinox after planting will produce small premature fruit. Thereafter, plants which are induced to bloom between the vernal and autumnal equinoxes will generally produce large fruit. Very few plants will undergo natural bloom induction between March 21 and June 23 and this is regarded as the early spring vegetative period. Between June 23 and the autumnal equinox, however, some limited, yet appreciable bloom induction occurs. This corresponds to fruit of large size which will be harvested in winter. This is regarded as the late spring-summer bloom induction period for winter fruit. In any case, however, the entire spring-summer period between equinoxes is the most advantageous period for carrying out chemical bloom induction treatments because plants of adequate size which are successfully treated during this period will produce large fruit during a period of relative fruit scarcity and high prices. Planting should therefore be performed using the proper combination of slip size and planting date so that plants of adequately large size for bloom induction treatment may be obtained during this late spring-summer period. To reduce the possibility of premature blooming of some of the plants, however, planting should be aimed at achieving adequate plant size for chemical bloom induction on or after June 23, to coincide with the winter fruit induction period thereby providing a safety margin consisting of the 94-day vegetative period. This should provide a fairly ample period of time for those slips of a given weight which may undergo bloom induction in advance of the mean values indicated by the curves.

Equation 5 also permits calculating the equivalent curves for coded date of harvest on planting delay throughout the calendar year for different slip sizes. Curves were therefore calculated for plantings made on the 15th of each month of the year. The point of intersection of these curves with the date line for June 23 of the bloom induction calendar permitted determination of the corresponding slip weight on the horizontal axis. These slip weights constitute the largest slips which may be planted on that date without incurring in possible premature bloom. In a similar manner the minimum slip sizes may be calculated from the intersection of these curves with the date line of December 21 on the second year of the bloom induction calendar. In the case of smallest slip size, however, because of reduced plant survival with the very smallest, a minimum permisible limit of 125 grams might be considered. This lower limit is imposed on the first ten months of the year but for November and December the minimum derived from the curve is slightly higher than 125 grams.

Table 2 shows, in terms of slip weight in grams, the smallest and largest permissible sizes of fresh slips for planting on the 15th day of each month of the year as read from these latter curves. Also shown are the age of the corresponding plants at the expected time of natural bloom induction. Chemical treatment for obtaining near coincidental blooming of the entire planting should preferably be applied a few weeks before the expected date of natural bloom induction. In this way large fruit sizes are obtained and the harvesting of any planting can be concentrated into a 3-week period thereby reducing costs. In contrast, naturally induced plants have highly dispersed fruiting and require harvesting over a period of several months. In order to obtain early harvests, say in September, October and November, it will

TABLE 2.—*Tentative recommendations in terms of minimum and maximum sizes for planting fresh slips during different months of the year in Puerto Rico*

Planting date	Smallest size	Largest size	Plant age at expected time of natural bloom induction	
			Largest size	Smallest size
	Grams	*Grams*	*Months*	
January 15	125	194	17	20
February 15	125	200	16	19
March 15	125	210	15	18
April 15	125	215	14	17
May 15	125	220	13	16
June 15	125	228	12	15
July 15	125	231	11	14
August 15	125	237	10	13
September 15	125	243	9	12
October 15	125	248	8	11
November 15	133	252	7	10
December 15	140	260	6	9

doubtless pay to treat the earliest plantings having the largest plants in April, May and June, one to 3 months in advance of their mean expected date of natural bloom induction. In this way harvesting can be apportioned over a 10-month period from September to June. Large fruit sizes would be obtained during the first 7 months.

Table 2 also presents tentative recommendations in terms of minimum and maximum slip sizes which may be planted during the different months of the year. This wide range of slip size is not intended to be included in any single planting, but indicates instead the different options which are possible for different plantings which can be made in the same month. Thus fresh slips in a January 15th planting which average 125 grams will be expected to reach natural bloom induction size on or about September 13, about 605 days after planting; whereas slips which average 194 grams planted on the same date will be expected to reach bloom induction size on or about June 23rd, about 523 days after planting. The outstanding and decisive recommendation which can be drawn from the experiment is that the slip size for any individual planting should be kept within the narrowest limits possible. In fact, slip size has been shown to be so important in determining both fruit size and time of harvest that undoubtedly it would be profitable for the grower to utilize a machine capable of classifying slips according to weight.

It should be emphasized that in the range of slip sizes recommended for planting each month in table 2, the largest slips will invariably give the earliest harvests and the largest fruit. In seeking to obtain large fruit size one cannot, however, continue to plant the largest permissible slips every month as most of the fruit then would come in early. Moreover the use of such large slips would undoubtedly reduce the ratoon crop of the mother plants. It would appear most practical 1) to use large slips in the early calendar months (when the largest permissible slips are still fairly small), 2) use sizes close to the mid-range during most months and 3) use small slips in the late months of the year. This procedure would permit spreading out the crop and still keeping slip size within reasonable limits both because of economy in planting operations as well as avoiding reduced fruit size in the ratoon crop of the mother plants. Early plantings with large slips of permissable size should be sufficiently numerous to encompass about one-third of the yearly crop. This would provide sufficient plants for chemical treatments to induce flowering in April, May, June and July.

The slip sizes shown in table 2 apply, of course, to fresh slips. In the event that slips become available at a time when they cannot be planted, or if they are too large for planting for fear of premature blooming, they may be stored and planted later. In equation 5 it is evident that one day of slip storage has a retarding effect of 0.5083 day on the date of harvest. The delay in planting, however, has already been taken into account in establishing the different curves for fresh slips from which the slip sizes in table 2 are derived. Calculations for the uses of stored slips based on these tables need only take the effect of storage into account. The effect of slip size is curvilinear, and as may be seen in figure 12 with each successive increase of 25 grams of slip weight beyond 125 grams the date of harvest is progressively advanced by an increasing number of days. When the slip weight in the June planting is increased from 125 to 150 grams, the number of days to harvest is thus reduced from 667 to 644 days, a difference of 23 days or 0.92 day per gram. If one wishes to calculate slip storage period in terms of its equivalent as hypothetical weight loss, the calculation will have to take slip size into consideration. Calculation table 3 is included to facilitate this, listing seven slip-size categories and the corresponding decrease in days to harvest per gram of weight increase in size. The additional weight needed to compensate for each day of storage is also shown for each of these seven categories. These were obtained by dividing 0.5083 by the number of days listed in the preceding column.

For example, if there were slips weighing 250 grams available on January 15th, these should not be used because of premature bloom. Such slips after 30 days of storage would behave as if they weighed 7.8 grams less (.26×30 = 7.8). After 60 days their behavior would be the equivalent of slips suffering a loss of 15.6 grams; after 90 days a loss of 23.4 grams and after 120 days a loss of 31.2 grams. Such slips could therefore be planted on May 15 when there would be no fear of premature bloom because their behavior would correspond to that of slips weighing 219 grams.

TABLE 3.—*Slip size categories and corresponding decrease in days from planting between June and August to harvest per gram of increased slip weight as well as the hypothetical weight loss equivalent for each day of storage*

Slip size category	Decrease in days to harvest per gram of weight increase	Hypothetical slip weight loss equivalent for each day of storage
Grams	*Days*	*Grams*
125–150	.92	.55
150–175	1.20	.42
176–200	1.44	.35
200–225	1.72	.30
226–250	1.96	.26
250–275	2.24	.23
276–300	2.48	.20

RESUMEN

Un estudio factorial 3 × 3 × 3 usando tres categorías por tamaño de hijuelos, tres períodos de almacenamiento y tres épocas sucesivas de siembra se llevó a cabo en la zona piñera de Manatí. El peso menor de los hijuelos ("slips") procedentes del pedúnculo fué de 75 gramos, los medianos fueron de 125 g. y los grandes de 160 g. Los niveles de almacenamiento variaron entre frescos, 45 y 90 días. Las siembras se hicieron el primero de junio de 1970, el 15 de julio de 1970 y el 31 de agosto de 1970.

Los tres factores, a saber, el tamaño de los hijuelos, los días de almacenamiento y la época de siembra, tuvieron influencia en la floración y por lo tanto en el patrón de la cosecha. Con el aumento en el peso de los hijuelos la floración fué más temprana, y por consiguiente la cosecha. Por el contrario, el almacenamiento, así como también la siembra tardía, las atrasaron.

Los tres factores también tuvieron efectos pareoidos significativos en el peso de las frutas. También por medio de cálculos de regresión se comprobó que la época de florescencia y el largo del día al ésta ocurrir, estaban íntimamente correlacionados con el tamaño de la fruta. Por lo tanto, se sugiere que se manipule el tamaño de los hijuelos a sembrarse conforme a la época de siembra de suerte que se pueda obtener el patrón más ventajoso para cosechar, si ésta fuera gobernada por floración natural. Esto automáticamente propiciaría la producción de frutas grandes durante la mayor parte

de la cosecha, la cual sería provocada en forma escalonada durante 10 meses mediante tratamiento químico aplicado poco antes de la inducción floral natural.

Se incluye un cuadro con recomendaciones tentativas del peso recomendable de los hijuelos a sembrarse en cada mes del año. También se recomienda utilizar hijuelos más grandes según se indica en la tabla durante los primeros 3 meses del año; utilizar hijuelos de tamaño intermedio a los indicados durante los 6 meses siguientes y utilizar los tamaños más pequeños indicados durante los últimos 3 meses del año. Mediante este procedimiento se ha de extender la cosecha y a la vez se ha de mantener el tamaño de los hijuelos dentro de los límites más favorables.

Se incluye también otro cuadro, el cual permite calcular el equivalente para cada día de almacenamiento como si fuera pérdida en peso. Esto permitiría utilizar hijuelos excesivamente grandes en una fecha posterior sin incurrir en el peligro de que florezcan prematuramente.

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