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FLOWERS, FRUITLETS AND FRUIT DROP IN AVOCADO TREES

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SUMMARY

The various stages of abscission of buds, flowers and fruitlets were recorded in the early spring in 12 ‘Fuerte’ trees. Summer fruitlet abscission was recorded in 60 trees of each cultivar: ‘Ettinger’, ‘Fuerte’ and ‘Hass’ and winter fruit drop in 60 ‘Hass’ trees only. Total number of organs abscised was 0.230-1.277 million and the abscission process was independent of flowering intentsity. Total abscission balance for a ‘Fuerte’ tree showed that fruitset percentage was 1.5% but 99% of the fruitlets dropped and only 1% were picked. Thus only 0.015% of the flowers developed into mature fruits. No relationship was found between buds and flower abscission and yield. Increased production may be achieved by reducing summer drop in ‘Ettinger’ and ‘Hass’ or earlier drop in ‘Fuerte’. Total dry weight of abscised organs was only 15% of the crop. Therefore, the massive abscission is not the only factor determining avocado productivity.

KEY WORDS: *Persea americana*, abscission, yield.

INTRODUCTION

Low avocado yields may result from reduced flowering or increased drop of flowers and fruitlets. Even under normal flowering and fruitset, increased drop will result in low productivity. Shedding of flowers and fruitlets must affect productivity and therefore deserves special attention.

The relationship between amounts of flowers, fruitlets and various sizes of fruits shedded and productivity was investigated in the early 70’s. No other intensive research was done before or after, describing the various stages of drop in the avocado tree. Information about each of the drop stages may improve our understanding of affecting factors and therefore may improve productivity. Therefore we decided to bring forward the data of 30 years ago.

METHODS

The experimental plantation was planted in 1963 in Akko Experiment Station in the Western Galilee, Israel. ‘Ettinger’, ‘Hass’ and ‘Fuerte’ trees, 8 years old were used for collecting data. The plantation received standard agrotechniques and the productivity was good.

Since counting all kinds of drops along the season is extremely high labor consuming, a correlation was calculated between drop collected in bowls and total drop. Ten bowls of 20 cm diameter were placed under each experimental tree. The bowls were placed in two circles, one (4 bowls) and two (6 bowls) meters from the trunk. The bowls were

partially filled with water to avoid loss of flowers and fruitlets. In the same time all drop was collected by polyethylene sheets from 5 trees. In these trees bowls were also placed. The area of the 10 bowls was 0.31 m^2, about 1% of the total area of the tree. The correlation was calculated between the drop into the bowls and the total drop.

Until mid-June drops were collected every two days and classified according to: buds, groups of buds, flowers and fruitlets. Fruitlets were divided according to their length (above 0.5 cm). The survey was divided into three periods.

1. Abscission of buds, flowers and fruitlets

Measured in bowls in 12 ‘Fuerte’ trees uniform in their size and with medium-good productivity.

2. Abscission in summer

All fruitlets larger than 10 mm and fruits were counted from July to September 1970 and June to October 1971. The survey comprised 60 trees from each cultivar ‘Ettinger’, ‘Fuerte’ and ‘Hass’.

Fruit drop was analysed according to the total yield.

3. Abscission in winter

Since the ‘Ettinger’ and ‘Fuerte’ cultivars are harvested in the late autumn the survey was conducted on the ‘Hass’ only. All fruits were counted during two seasons (1971/2 and 1973/4). The second season had very strong wind storms. Each year the fruit of each tree was counted and weighted.

RESULTS

Abscission into bowls as compared to total drop.

Amount of drop based on bowls was high by 30-50% as compared to total drop collected by polyethylene sheets. The correlation between the count in the samples and the total count (Figures. 1, 2) was high for the buds (r= 0.60), and flowers (r=0.90 significant at p=0.01). For fruitlets 5 to 10 mm (r=0.22) or 10-20 mm (r=0.12) the correlation was much reduced, therefore the bowls were used only till the 5 mm fruitlets drop was over. Later, the whole amount of fruitlets and fruits was counted.

Abscission of buds, flowers and fruitlets

Despite the wide variation (230.000 to 1.277.000) of the various counts per tree, there was much similarity in the relative ratio of the various abscised organs in all trees. The abscission process did not depend on flowering intensity and the peak of abscission occurred in about the same time in all trees.

Abscission in ‘Fuerte’ lasted from the beginning of March to the beginning of June, 1971 (Figure 3). More than 98% of the total drop was classified as buds and flowers. The peak of drop was in mid April when the flowers abscised. The relationship between abscission and some meteorological factors showed that the buds and flowers drop was mostly affected by wind speed while fruitlets abscission was influenced by low temperatures and especially by relative humidity (Table 1). Buds and groups of buds

abscised in the second half of March, flowers in mid April and fruitlets up to 5 mm in the beginning of May.

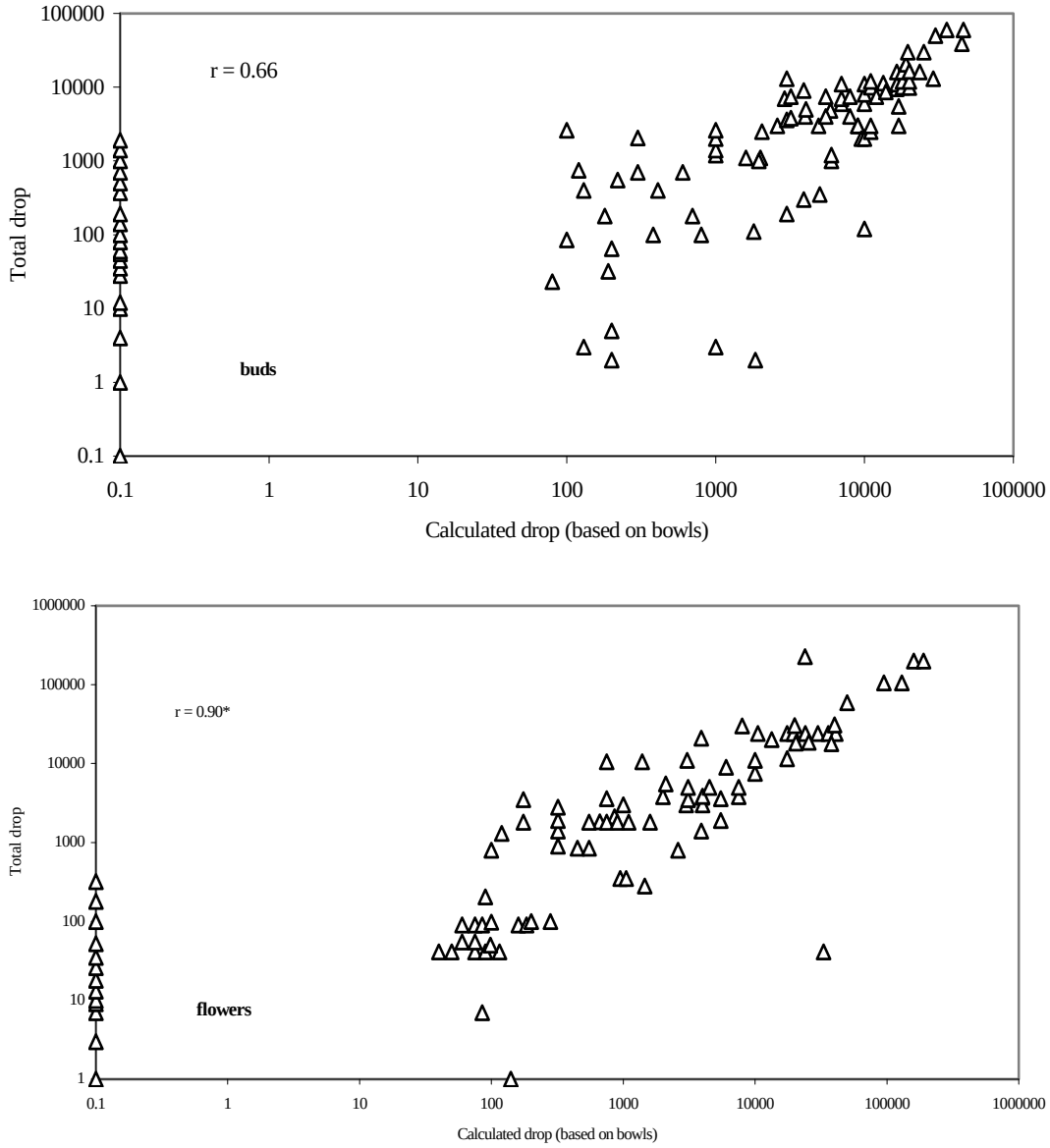

Figure 1. Relationship between calculated drop according to count in bowls and actual drop of buds and flowers in avocado cv. Fuerte (1971). Logarithmic scale, every observation is an average of 5 trees.

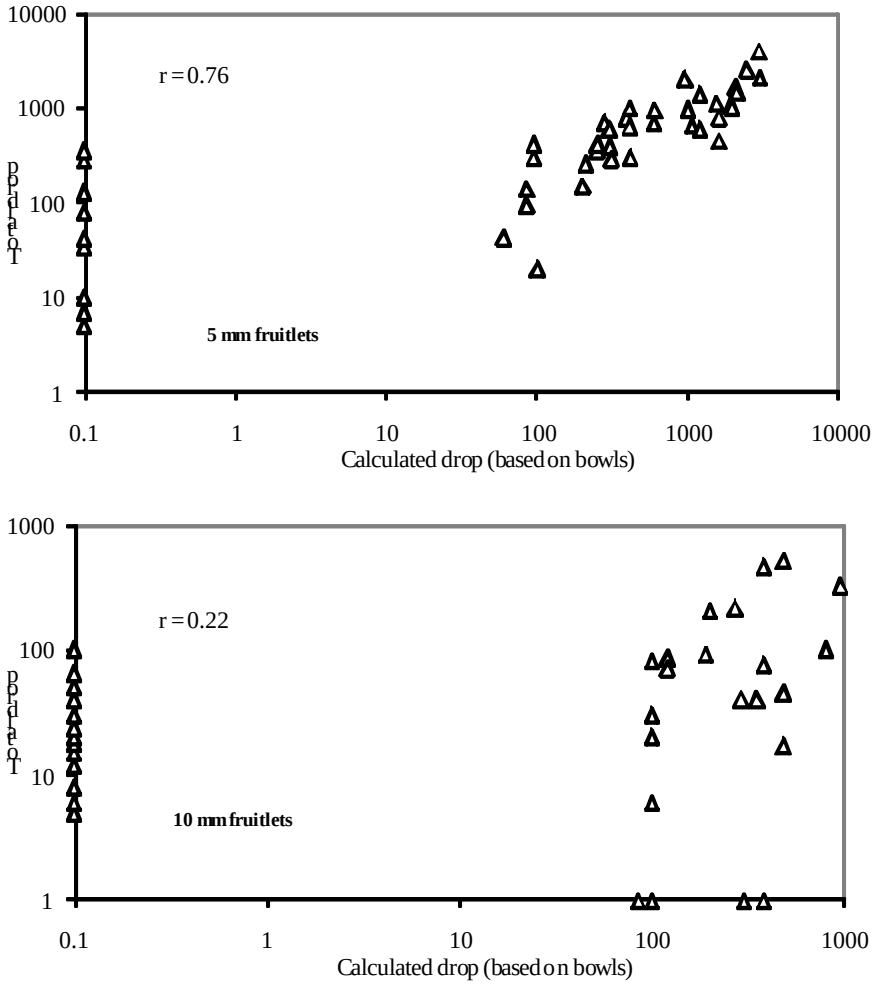

Figure 2. Relationship between calculate drop according to count in bowls ans actual drop of 5 and 10 mm fruitlets in avocado cv. Fuerte (1971). Logarithmic scale, every observation is an average of 5 trees.

Table 1. Correlation coefficients between several meteorological factors and abscission of buds, flowers and fruitlets**.**

Meteorological factor	**Abscised organ**		
	Buds	**Flowers**	**Fruitlets**
Wind velocity	0.42	0.29	0.27
Temperature Max.	-0.08	-0.27	0.72[Z]
Min.	-0.08	0.05	0.75[Z]
Relative humidity	-0.17	0.25	-0.87

[Z]Significant at $P \leq 0.01$

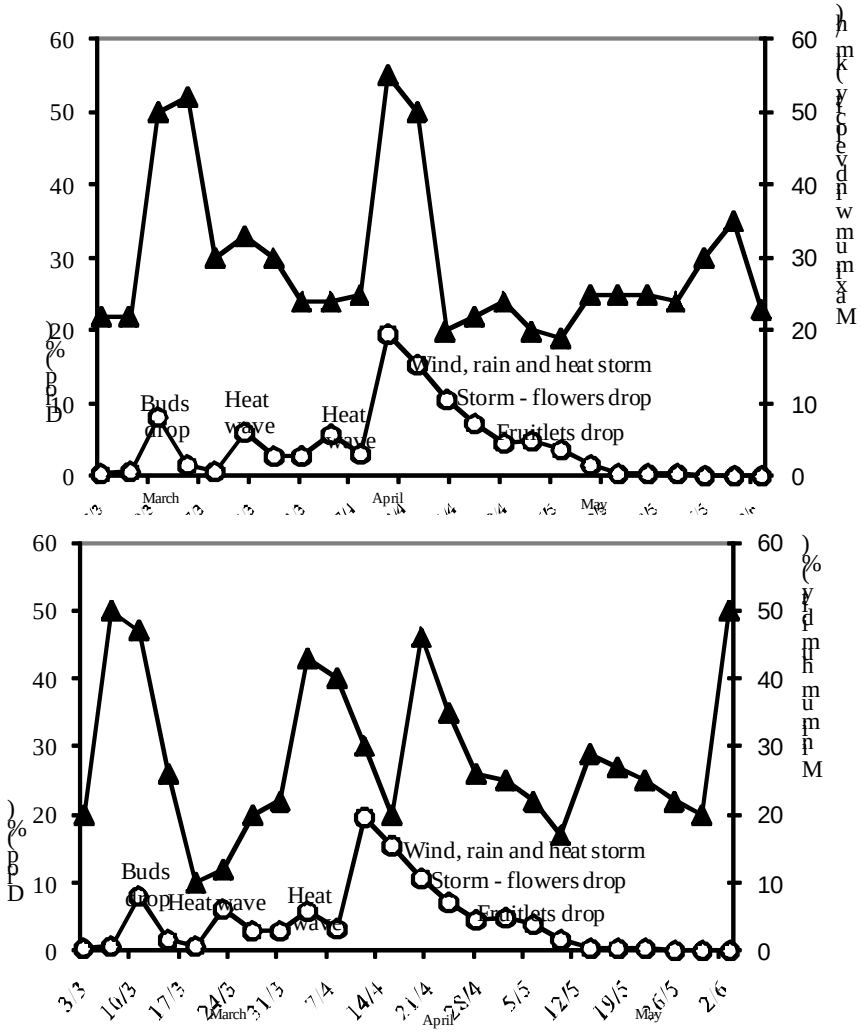

Figure 3. Spring abscission in avocado cv. Fuerte (average of 12 trees) in relation to minimum humidity (botton) and maximum wind velocity (top).

Abscission in summer

Summer abscission was much lower than the abscission in the early spring. It started in mid May but exhibited different patterns in the three cultivars observed (Figure 4). Abscission was relatively high in 'Ettinger' and 'Hass' but quite low in 'Fuerte', also, the waves of abscission varied. Most fruitlets abscised in June to July in 'Ettinger' but only towards the end of July and August in 'Hass' and 'Fuerte'. The early drop in 'Ettinger' was expressed also in the small size of the fruitlets (5 to 30 mm) as compared to 'Fuerte' and 'Hass' (Table 2).

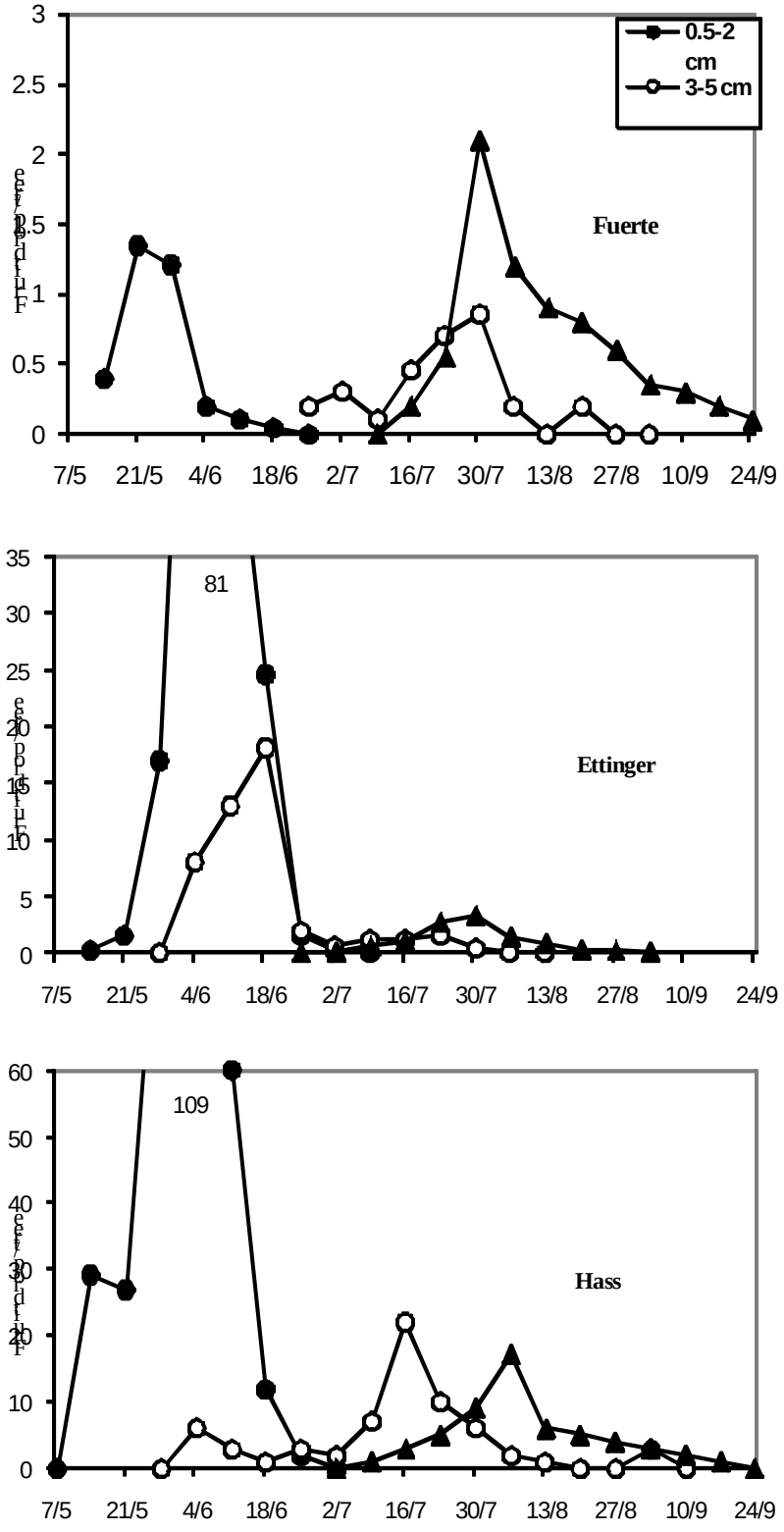

Figure 4. Fruitlets and fruits dropped according to size in ‘Fuerte’, ‘Ettinger’ and ‘Hass’. Average of 60 trees in each avocado cultivar (1971).

Abscission in winter

The massive fruit drop ended by the end of June despite cv. 'Hass' trees which continued to abscise also in July and August. The winter drop is mainly a result of difficult weather as stormy winds. The winter drop in 'Hass' showed that in 1971/2 19 fruits per tree dropped, which is 6% of the total harvest while in 1973/4 a most stormy winter, an average of 104 fruits per tree dropped, about 39% of the total harvest.

The relationship between abscission and production

No relationship was found (r=0.01) between the total number of organs dropped and the past or future yield. Maximal number of organs per tree was 1.277.000 and its yield 144 fruits while the minimum was 230.000 *vs*. 201 fruits. The relationship between fruitlets dropped and fruitset percentage was low (r^2=0.22, Figure 5) while that of fruits abscised and harvested was high (r^2=0.59). At the late abscission stages, the end of the summer, there was a direct relationship between fruit drop (above 30 mm) and harvested yield. The higher the yield the higher the fruit drop (Tables 3,4).

The total abscission balance was calculated for a 'Fuerte' tree (Table 5). Fruitset percentage from the total number of flowers was 1.5%, however 99% of the fruitlets dropped and only 1% harvested. Total dry weight of all dropped organs was only 15% of the fruits harvested.

Table 2. Relative fruit abscission (%) of 'Ettinger', 'Fuerte' and 'Hass' fruits according to their size (abscission + harvest = 100%).

Cultivar	Fruit length (cm)	1970	1971
Ettinger	3	6.5	20.0
	5	3.2	5.1
	7	9.6	5.1
	9	5.5	3.0
	Total drop	24.8	33.2
	Harvested	75.2	66.8
Fuerte	3	0.2	0.2
	5	1.0	1.8
	7	1.7	2.0
	9	1.5	1.6
	11	0.2	0.7
	Total drop	4.6	6.3
	Harvested	95.4	93.7
Hass	3	1.4	3.7
	5	3.5	12.8
	7	4.6	10.8
	9	1.0	6.9
	Total drop	10.5	34.2
	Harvested	89.5	65.8

DISCUSSION

Total amount of buds, flowers and fruitlets were similar to those previously reported (Cameron *et al.*, 1952). Despite the fact that uniform productive trees were selected, a five fold difference was found among the trees. Tree to tree variation is known to be extremely variable in avocados (Jones *et al*., 1957). Therefore, the final number of fruits can not be directly related to the number of flowers, and a "natural" variation of 5% in the absolute number of flowers means a difference of 12-60.000 flowers per tree while only 300 fruits per tree are estimated as a good crop. It can be assumed that internal factors (alternate bearing) and external factors (climate, agrotechniques, etc.) are affecting abscission and therefore the lack of interaction between it and the harvested crop. It may be concluded that despite the general interest we have in flowering, abscission and production balance, it is difficult to use them as a quantitative model to determine production or to compare various agrotechniques.

Table 3. Correlation coefficient (r) between abscission of various organs and previous or future yield.

Organ abscissed	Previous yield 1970/1	Future yield 1971/2
Buds	0.01	0.53
Flowers	0.07	0.41
Fruitlets smaller than 10 mm	0.34	0.45
Fruits 10-30 mm	0	0.25
Fruits larger than 30 mm	0.16	0.76[Z]

[Z] Significant at $P \leq 0.01$

Table 4. Relationship between abscission and yield.

Cultivar	Fruits harvested per tree	Fruits abscised in 1970		Fruits abscissed in 1971	
		Number	%	Number	%
Ettinger	less than 150	37	21.8	22	15.1
	150-250	84	25.9	41	17.8
	250 and more	116	24.5	38	10.0
Fuerte	less than 150	2	2.1	7	8.8
	150 and more	3	1.2	17	8.5
Hass	less than 250	2	1.6	1	4.0
	250-450	71	20.2	131	28.9
	450 and more	107	10.6	204	21.3

[z] Counts were made in July-September 1970 and June-October 1971.
[y] Abscission percentage was calculated according to the actual yield of the trees, where total fruit drop + harvest = 100%.

At a later stage, after fruitset, a much better relationship can be found between set percentage and final crop. Hence, the stages of fruitlet and fruit drop are highly important for the purpose of increasing avocado production. In order to reduce fruit drop, the variation in abscission of the various cultivars should be taken into account:

Table 5. Calculated abscission balance of a 'Fuerte' tree. Average of 12 trees, 1971.

Organ abscised	Number	%	Dry weight (kg)	D.W. (%)
Buds	165.730	21.268	0.343	0.80
Flowers	601.272	77.161	2.774	6.44
Total	767.002	98.429	3.117	7.24
Fruitlets				
< 3 mm	10.732	1.377	0.980	2.28
4-5	886	0.114	0,120	0.28
6-10	445	0.057	0.267	0.62
11-20	44	0.006	0.062	0.14
Total	12.107	1.554	1.429	3.32
Fruits				
< 2-3 cm	1		0.017	0.04
3-5	3		0.097	0.23
5-7	6		0.314	0.73
7-9	3		0.316	0.73
9-11	2		0.368	0.86
Total	15	0.002	1.112	2.59
Harvested	120	0.015	37.400	86.85
Grand total	779.244	100.000	43.058	100.000

Note: Other parts of the inflorescence abscised weighted 1.146 kg per tree.

'Hass' fruits are abscised most summer months especially in July-August. This is reported also by Adato (1974). Avoiding this abscission may increase production up to 35% (without taking into consideration fruit drop resulting by winter storms). It seems that the cv. Hass suffers from over-production and therefore is thinning itself. Such reduction in the number of fruits results in increasing fruit size of the fruits remaining on the tree and its better export adaptation.

In 'Ettinger', summer abscission is low and most of it occurs in June. Avoiding this drop may increase production up to 30%.

'Fuerte'on the contrary is well known for its reduced production. Summer fruit drop reduces harvest fruit only by 5-7%. It can not be attributed to the general low productivity of 'Fuerte' as compared to the other cultivars, since even in high yielding 'Fuerte' trees summer abscission is low. Reducing the abscission in this cultivar should be done in the early stages of flowering and fruit set. Means to reduce hot and dry wind damage in the early spring may give best results in 'Fuerte'.

Since the total dry weight of abscised organs is 15% only of the total crop and since despite the tremendous abscission, the trees carried significant number of fruits, it can be concluded that the large amounts of abscised organs are not the only factor determining avocado low productivity.

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