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SOME FACTORS INFLUENCING GRAFTING SUCCESS WITH AVOCADOS

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Experience with tip grafting avocados has shown that there are distinct seasonal differences in success. Grafts made during the winter and early spring months, especially in January, February, and early March, are nearly 100 per cent successful, while in late spring, summer, and early fall the percentages are often much lower. This is especially true with certain varieties. For example, results in the summer with Hass are often poor, but under the same conditions Fuerte may graft fairly well. Not only are the percentages lower in summer, but growth of many of the scions is poor compared with winter grafts.

Studies by Jones and Beaumont in Hawaii with macadamia and litchi (1, 3) suggested that the carbohydrate content of the scion wood may be a major factor influencing seasonal variation in grafting success with these plants. By girdling the branches to be used later as a source of scion wood they obtained an increase in grafting success approximately proportionate to the increase in starch content of the scions.

The work reported here has been concerned with the question of whether the seasonal variation in grafting success in avocado is related to fluctuations in carbohydrate content of the scion wood.

Another phase of the study involved determination of individual sugars, but only the totals of sugars and starch will be reported here, on the assumption that all of them are available to the scion in the formation of a graft union.

Sugars were determined by quantitative paper chromatography of cleared alcohol extracts. Reducing sugars were determined by developing the spots with triphenyl tetrazolium chloride, eluting with alcohol, and measuring the intensity of color. The sucrose spots were first eluted and then the color was developed with diphenylamine reagent. Starch was hydrolyzed by diastase and the resulting reducing sugars determined as described above.

RESULTS AND DISCUSSION

Sugars accounted for 60 to 75 per cent of the total carbohydrates. Two-thirds or more of the sugar was found to be in the form of glucose. Sucrose and fructose were present in moderate amounts in young shoots; they nearly disappeared during the summer months and reappeared the following winter. Traces of xylose were found in young

shoots.

Table 1.—Seasonal variation in grafting success with Hass avocado.

Month grafted	Growth flush	Total carbohydrates (per cent dry weight)	Graft take[a] (per cent)
Feb., 1958	Spring, 1957	6.3	90
Feb., 1958	Fall, 1957	9.9	90
May, 1958	Spring, 1957	4.6	45
May, 1958	Fall, 1957	7.6	40
Aug., 1958	Fall, 1957	5.0	65
Aug., 1958	Spring, 1958	7.1	65

[a] *Each value represents 20 grafts.*

Table 1 shows results of grafting at three times of year. The seasonal effect on grafting success is clearly apparent. The question arises as to the possible influence of the environment surrounding the grafts, which were held in an ordinary glasshouse subject to considerable temperature fluctuation. Experiments with sucrose treatment and scion wood storage discussed below (tables 4 and 5) indicate that seasonal fluctuations in the glasshouse environment do not account for the seasonal differences in grafting success observed in the present study.

Any consistent relationship between carbohydrate content and graft take appears to be lacking. Graft take decreased sharply from February to May, coincident with a decrease in carbohydrate content; but the take was higher in August than in May, although the carbohydrate content of the scions was similar at both periods. If the carbohydrate content of the scion wood influenced the graft take, the effect was masked by the influence of other factors.

One possibility is that the decrease in carbohydrates was partially responsible for the decrease in graft take, but that some other substance (or substances) was in low supply in May and was the limiting factor at that time.

Results of two other experiments indicated that accumulation of some material contributes to the seasonal variation in grafting success. One of these dealt with use of scion wood from a branch or shoot which had been girdled by removing a ring of bark at least six weeks before the scion wood was cut. The results (table 2) show that pre-girdling of the scion wood consistently gave an increase in per cent graft take during the summer months. This beneficial effect of pre-girdling, at certain times of year, is in agreement with results in Hawaii with macadamia and litchi (1, 3), in Florida with macadamia and sapodilla (2), and in California with macadamia (5) and eucalyptus (4).

Table 2.—Effects of girdling on graft take with Hass avocado.

Date grafted	Growth flush	Treatment	Total carbohydrates (per cent dry weight)	Graft take[a] (per cent)
Feb. 12, 1958	Spring, 1957	Main branch girdled 8 wks.	8.7	95
Feb. 12, 1958	Spring, 1957	Not girdled	6.3	90
May 15, 1958	Fall, 1957	Main branch girdled 5 mo.	8.2	60
May 15, 1958	Fall, 1957	Not girdled	7.6	40
Aug. 13, 1958	Fall, 1957	Shoot girdled 6 wks.	8.7	85
Aug. 13, 1958	Fall, 1957	Not girdled	5.1	65

[a] *Each value represents 20 grafts.*

Despite the increase in carbohydrates following girdling in every case, the grafting success again did not show a correlation with carbohydrate content. The data suggest that the effect of girdling on graft take may be partially due to carbohydrate accumulation and partially due to accumulation of something else.

Table 3 presents further evidence that the amount of some material in the scion influences grafting success. By doubling the length of the scion the graft take was doubled or increased 100 per cent.

Table 3.—Effect of scion length on graft take with Hass avocado.

Month grafted	Length of scions (inches)	Graft take (per cent)
May	3-3½	40
May	6-7	85
August	3-3½	65
August	6-7	100

Table 4.—Effect of glucose treatment on graft take with Hass avocado.

Month grafted	Treatment	Graft take (per cent)
February	Control	90
	Glucose	85
May	Control	40
	Glucose	70
Sept. (I)[a]	Control	60
	Glucose	95
	Water	45
Sept. (II)[a]	Control	60
	Glucose	85
	Water	26

[a] *I = Scion wood from spring growth flush. II = scion wood from growth flush of previous fall.*

The best evidence that the supply of carbohydrates is an important factor for grafting

success is shown in Table 4. In these experiments, the top of each grafted scion was wrapped with plastic tape to form a cup in which 0.3 M glucose solution was applied every 2 days for six weeks. The controls were scions with the tops sealed with asphalt emulsion as in the usual grafting procedure, and another set in which the scions were supplied with water instead of glucose. The scions treated with water gave consistently lower take than the untreated controls. The consistent and marked increase in success with scions which were supplied with glucose appears to be good evidence that lack of sufficient carbohydrate supply was a limiting factor in grafting success during the summer and early fall months.

Whether the accumulated material accounting for good graft take during the winter is carbohydrates or a combination of carbohydrates and other materials, the condition favorable for good take is retained for several months by scion wood cut in February and stored at low temperature. This was shown by experiments in 1957 and 1959 (tables 5 and 6). Scion wood was cut, defoliated, sealed in 1.5 mil polyethylene bags without any packing material, and placed at 40° F. After several months of storage, samples were removed for grafting. Scion material freshly cut from the trees was used for comparison. In 1957 the capacity for successful graft take was retained during 7½ months of storage. In addition to giving a higher percentage of successful grafts, growth from the stored scions was generally more vigorous that from scions freshly cut in May or September.

In May, 1959, as in 1957, the stored wood gave a high percentage of successful grafts. In contrast to the results in 1957, however, by late July, 1959, the stored wood had begun to deteriorate as evidenced by the less satisfactory graft take, by less vigorous shoot growth, and also by the partial or complete darkening of a few pieces in storage. Apparently the physiological condition of the scion wood or its balance of reserve materials was less favorable for prolonged storage in February, 1959, than in February, 1957. Grafting with freshly cut scion wood was particularly unsatisfactory in May of both years compared with both earlier (February) and later (July, August and September) grafting (tables 1, 4 and 6). A complete explanation for either the year-to-year difference in capacity for prolonged storage or the seasonal fluctuation in grafting success is not apparent from the presently available information.

The interpretation of results of analysis for available carbohydrates is complicated by the fact that changes in amount of cellulose and hemicellulose and in moisture content occur during the course of shoot development. This makes difficult the comparison of available carbohydrate content at various stages of growth, whether expressed as a per cent of dry weight or of fresh weight. Possibly in continuing this study, determination of the total amount of available carbohydrates per scion will help in the interpretation of data.

Table 5.—Graft take with Hass scion wood stored at 40° F. 1957.

Month grafted	Treatment	Number of grafts	Graft take (per cent)
May	3 months at 40° F.	25	84
	Freshly cut	20	65
September	7½ months at 40° F.	30	80
	Freshly cut	20	60

Table 6.—Graft take with Hass scion wood stored at 40° F. 1959.

Date grafted	Growth flush	Treatment	Number of grafts	Graft take (per cent)
Feb. 9	II—'58	Freshly cut	143	92
May 13	II—'58	Freshly cut	10	30
		3 months at 40° F.	10	90
July 28	I—'59	Freshly cut	100	78
	II—'58	5½ months at 40° F.	50	60
	I—'59	Freshly cut; pre-girdled	29	93

SUMMARY

Seasonal variation in graft take in the avocado appears to be related to quantitative changes in the supply of materials available in the scion for forming the graft union. There is evidence that the amount of carbohydrate available in the scion influences graft take, but the results also suggest that at certain times the supply of some other substance or substances may also play an important role in graft take.

Scion wood cut in late winter or early spring can be stored successfully at 40° F. Shoots cut in February apparently have a sufficient supply of reserve materials to give a high percentage of successful grafts, and these materials are retained in sufficient quantity for at least three months at 40° F.

The effects of pre-girdling on graft take may in some cases be due to accumulation of carbohydrates and in other cases to accumulation of some other substance or substances.

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