PROGRESS OF BREEDING INVESTIGATIONS WITH HEVEA BRASILIENSIS

THE PILMOOR CROSSES 1928—1931 SERIES

BY

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Summary

The yield and girth records of seven series of legitimate seedlings and of three series of illegitimate seedlings obtained during the years 1928—1931 are presented.

The yields of the best families of legitimate seedlings are greatly superior to those of the unselected seedlings. They are probably equal to the best proved clones, but it has not been shown that they are superior.

The yields of the best families of illegitimate seedlings are inferior to those of the best legitimate families.

The early yields of the first selection of clones made from these legitimate seedlings are given.

The relationship between the yields of the clone mother-trees and the clones made from them is discussed.

A note of the establishment and testing of new clones by the disbudding method is given.

(1) Introduction

When the programme of research to be undertaken by the Botanical Division of the Rubber Research Institute was first drafted in 1927, provision was made for a comprehensive investigation of the general problem of improvement in yield of *Hevea.*

At that time the two principal methods of effecting improvement in the quality or yield of an agricultural crop, namely, the vegetative method and the generative method, were given equal consideration.

Budgrafting from selected high-yielding trees and the development of seedling families by hand pollination between high-yielding individuals or between clones formed the two principal subjects of investigation.

Early work on breeding was limited by the lack of proved material on which work could be undertaken. The Rubber Research Institute was fortunate, however, in obtaining a small

experimental area on Pilmoor Estate, which had been planted at the end of 1924 by Sutcliffe and Sanderson, the scientific officers of the Rubber Growers' Association, with buddings from a number of high-yielding mother-trees selected on Pataling Estate (Sanderson and Sutcliffe 1929).

Tapping tests were commenced on the young buddings in January 1928 and on the basis of the results of these early tapping tests (Mann, Billington and Kaimal 1933) the most promising clones were selected for hand pollination work. Breeding work was undertaken by Mr. L. E. Morris, geneticist at the Rubber Research Institute and was continued on the Pilmoor Clones until 1931.

Early in 1932 it was considered necessary to review the programme of work of the Institute. Because of the depressed conditions in the industry it was decided to limit the scope of the research programme, to reduce staff and to continue only those investigations which were considered by the Board of the Institute to be of immediate importance to estates. It was considered that breeding must be regarded as long-term work which was unlikely to yield results of value or at least capable of practical application, for many years. For this reason genetical work was stopped in 1932 and was not resumed until 1937.

During the period 1932 to 1938 the experimental material developed by Morris and planted on the Experiment Station during the years 1928—1931 has been kept under observation. Growth measurements and yield records have been regularly maintained and the writer assumed responsibility for the further study of the material from the commencement of tapping tests.

Since the appointment of new members to the staff of the Botanical Division in 1937 it has been possible to resume breeding investigations and a new programme of work was initiated in 1937.

The present paper deals with the results of work on the seedling families established by Morris and upon clones made from these seedlings during the years 1930 to 1934.

(2) Experimental Methods

The methods of hand pollination employed, with full details of the technique, have been described by Morris (1929). The seedling crosses discussed in this paper are for the most part derived from pollinations made by him, and only a small number of the later pollinations were made by trained Asiatic assistants.

The seeds resulting from successful pollinations were germinated, planted in baskets and transferred to the field when they were from two to four months old. At the same time illegitimate

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seedlings of some of the clones used as parents in hand pollinations, and unselected estate seedlings, were planted out in the same fields for comparison with the first three series of crosses. A small number of budded stumps of proved clones were planted with the later series of crosses.

From twelve to eighteen months after planting, by which time the seedling crosses had become well established, clones were made from the majority of the trees by removing from three to six dormant buds from each tree and grafting them on to young seedlings established for this purpose in other experimental fields. To avoid interference with the development of the bark of the future tapping panels the buds were taken at heights above forty inches from the union. In this manner clones were prepared from the majority of the legitimate seedlings and the buddings of these clones reached the tapping stage soon after the mother-trees themselves received their first tapping tests.

(3) The Parent Clones

A description of some of the clones used as parents has already appeared in this *Journal* (Mann, Billington and Kaimal 1933). For convenience, brief descriptions of the more important characteristics of these clones are repeated here, and their yields are recorded in Table I.

THE PILMOOR CLONES

Clone A. 44. Buddings of this clone show moderately vigorous growth; the trunks are generally fluted with pronounced swellings near the dormant buds and uneven renewed bark. Early yields were very good but the annual increase in yield has been small.

Clone B. 58. A small tree with a slender erect stem and a rather narrow crown. A fair yielder only, but owing to the small size of the trees a higher stand per acre than is usual could be retained.

Clone B. 84. A large tree with a rather heavy crown. The early yields are not high, but the yield increases steadily and this clone is now included amongst the best proved clones. Bark characters and renewal are good, the bark being distinguished by an exceptionally heavy development of cork. This, together with a tapering stem and a very smooth union, makes it sometimes difficult to distinguish the trees of this clone from well-grown seedlings after the sixth year of age.

Clone D. 61. The mother-tree of this clone was badly affected with Brown Bast, and it was primarily to further the investigation of this disease that this clone was selected. The trunks show a tendency to burr formation and the yields though good at first show a slow rate of increase.

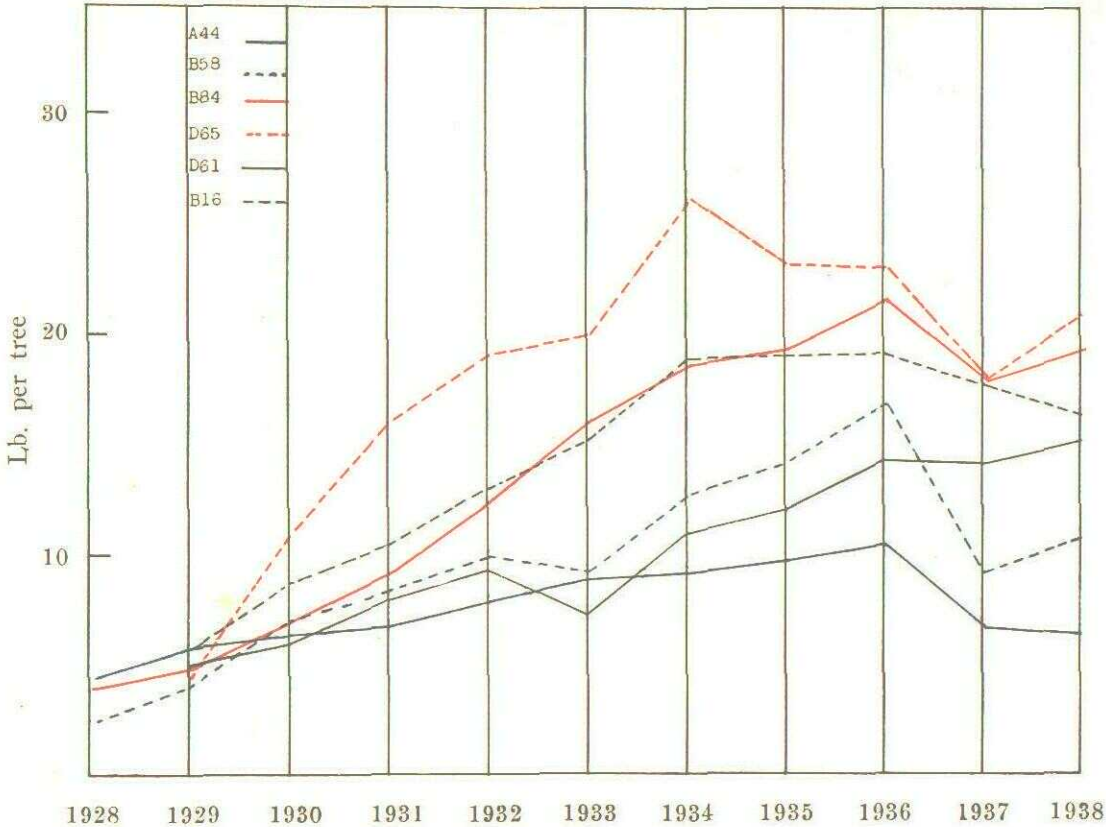
TABLE I

Yields and Girth Measurements of the Clones used as Parents of the Families of Legitimate and Illegitimate Seedlings

Clone	Where planted	Date of budding	No. of trees	Girth in inches 1938	Yield in lb. per tree per annum (160 tapping days)										
					1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938
A. 44	Pilmoor	11.1924	133	31.0	4.4	6.0	6.6	7.1	8.2	9.3	9.5	10.0	10.8	7.0	6.7
"	R.R.I.E.S.	11.1929	400	22.9	—	—	—	—	—	—	—	—	8.1	9.0	9.5
B. 84	Pilmoor	11.1924	40	41.8	3.8	5.2	7.1	9.2	12.3	15.9	18.5	19.2	21.5	17.7	19.4
"	R.R.I.E.S.	11.1929	400	23.4	—	—	—	—	—	—	—	—	5.8	8.5	9.2
D. 65	Pilmoor	11.1924	5	41.4	—	4.5	11.0	15.9	19.0	20.0	26.0	23.2	23.0	17.6	21.2
"	R.R.I.E.S.	11.1931	200	—	—	—	—	—	—	—	—	—	—	—	3.7
D. 61	Pilmoor	11.1924	35	31.7	—	5.1	6.3	8.2	9.5	7.1	10.9	11.8	14.2	13.9	15.1
"	R.R.I.E.S.	11.1931	20	19.1	—	—	—	—	—	—	—	—	—	4.8	7.5
B. 58	Pilmoor	11.1924	80	29.5	2.6	4.2	7.2	8.7	10.2	9.6	12.9	14.6	17.3	9.5	11.2
"	R.R.I.E.S.	11.1931	20	17.9	—	—	—	—	—	—	—	—	—	3.9	4.7
B. 16	Pilmoor	11.1924	92	34.3	—	5.5	8.7	11.4	13.0	15.1	18.6	19.1	19.2	17.5	16.4
"	R.R.I.E.S.	11.1931	20	18.7	—	—	—	—	—	—	—	—	—	4.4	8.0
B. 90	Pilmoor	11.1924	105	—	—	—	—	—	—	—	—	—	—	—	—
"	R.R.I.E.S.	11.1931	20	28.2	—	—	—	—	—	—	—	—	—	0.9	1.7
B. 65	Pilmoor	11.1924	27	33.6	—	—	—	—	—	6.0	8.6	9.4	11.4	8.1	11.2
A. 8	"	"	26	—	—	—	—	—	—	—	—	—	—	—	—
B. 50	"	"	68	—	—	—	—	—	—	5.0	5.8	5.8	6.4	6.3	—
B. 95	"	"	45	38.2		—	—	—	—	5.0	6.2	6.5	8.0	6.7	5.6
B. 11	"	"	15	—	—	—	—	—	—	—	—	12.8	15.8	17.3	—
C. 72	"	"	20	39.3	—	—	—	—	—	—	—	—	—	—	13.5
E. 95	"	"	15	—	—	—	—	—	—	—	—	7.1	7.0	6.5	—
Lun. N	Lunderston	3.1923	4	—	—	10.9	11.2	14.9	15.1	18.0	16.8	—	—	—	—
"	"	12.1931	329	24.8	—	—	—	—	—	—	—	—	—	—	6.3
"	R.R.I.E.S.	11.1931	20	23.8	—	—	—	—	—	—	—	—	—	7.4	9.0
Lun. B	Lunderston	3.1924	70	—	—	5.6	7.4	6.7	6.8	9.7	7.5	—	—	—	—
"	R.R.I.E.S.	11.1931	20	27.9	—	—	—	—	—	—	—	—	—	3.6	5.8
Lun. K	Lunderston	3.1923	50	—	—	6.4	8.6	8.6	8.8	11.2	9.7	—	—	—	—
"	R.R.I.E.S.	11.1931	20	22.3	—	—	—	—	—	—	—	—	—	3.5	4.1
G. 1	Glenshiel	11.1921	320	—	10.7	11.1	22.7	22.4	22.2	25.9	22.1	20.3	—	—	—
"	R.R.I.E.S.	12.1930	150	—							—	—	6.4	7.6	9.2

Note. In the column headed "No. of trees" the figures refer to the approximate number of trees under observation which is not necessarily the same as the number of trees tapped.

Fig. 1. Yield of Pilmoor Clones. Lb. per tree per annum



Clone D. 65. In general appearance this tree is very like clone Bodjong Datar 5, but unlike that clone it branches at the normal time during the second year. Average vigour. The yields showed a rapid increase after the first year of tapping and this is now the highest yielding of the Pilmoor clones.

Clone B. 16. Average vigour of growth with a yield about equal to B. 84. It is however a quicker starter than B. 84, the yield of the latter not catching up until the eighth to ninth year of age. The liability of this clone to Brown Bast which causes very severe burring and distortion of the tapping panel renders it unsuitable for commercial use.

The six clones described above are those which have been most widely used as parents of the families of seedlings discussed in this paper. Their yields are shown in Fig. 1.

The other Pilmoor clones which have been used in a comparatively small number of crosses are described below.

Clone A. 8. A clone of average vigour. The stems are rather crooked and the bark is corky with a tendency for the cork layers to flake off in large pieces. The yields of this clone on test tapping were poor and the clone has never been in regular tapping.

Clone. B. 50. A vigorously-growing clone. A bumpy, fluted stem and corrugated renewed bark make this clone unsuitable for commercial use. The bark is corky like that of B. 84.

Clone B. 95. Very vigorous growth with straight erect stems and narrow fan-shaped crowns. The virgin bark and renewed bark are thin. Yields are moderate.

Clone B. 11. A very vigorous clone with a straight erect stem and a rather large crown. The virgin bark is thin but the renewed bark is smooth.

Clone C. 72. A vigorously-growing clone with a straight erect stem and a large spreading crown. Thick bark. The latex is very thick and has a tendency to pre-coagulation. Very susceptible to storm damage. So many of the trees were broken that most of the trees of this clone were cut out in 1930.

Clone E. 95. Trees of rather less than average vigour with wide fan-shaped crowns. The bark renewal is poor.

Clone B. 65. In vigour this clone is below the average, its early growth being very weak. The buddings have straight erect stems with narrow crowns. The virgin bark is thin and the renewal uneven. The bark is rather corky.

Clone B. 90. This clone was selected as a parent because of its exceptionally vigorous growth. Its yield is poor and its virgin bark and renewed bark are thin. The stems tend to be badly fluted. The original trees of this clone have never been in regular tapping.

THE LUNDERSTON CLONES

These clones were established on peat-clay soil on Lunderston Estate, Kuala Langat. The yields of the original trees and of later buddings are given in Table I.

Clone Lunderston N. This clone was established on Lunderston Estate in 1922 and the early yields were very good, reaching 18.0 lb. per tree in the 10th—11th year of age. These early yields are confirmed by the first yields of the second vegetative generation trees which came into tapping on the Experiment Station and on Lunderston Estate in 1937 and 1938. This is a moderately vigorous clone with a straight smooth stem, excellent bark characters and a rather large crown.

Clone Lunderston K. A clone of rather less than average vigour of growth, it forms a narrow fan-shaped crown. The bark renewal is good and the virgin bark is smooth. This clone is rather susceptible to damage by wind.

Clone Lunderston B. A very vigorous clone with a large fan-shaped crown, formed of many erect branches. The renewed bark is uneven but the virgin bark is smooth and of average thickness.

Glenshiel 1. This appeared to be the best of the Glenshiel Clones which were established on Glenshiel Estate in 1921. The early yields of the original trees were very good, reaching the satisfactory level of 22 pounds per tree in the eleventh year of age. This clone is of medium vigour with a nicely-balanced crown and rather sparse but vigorous foliage. It grows and yields extremely well on the alluvial clay soils of the coast districts.

Dry patches sometimes occur on the tapping panel of trees tapped alternate-daily on a half-circumference cut (S/2,d/2,100%). These are of a temporary nature and there is no need to take the trees out of tapping. The yields were recorded of all the trees in tapping including those with dry patches. Subsequent experience has shown that tapping every third day on half-circumference may prove a more satisfactory system for this clone (S/2,d/3,67%).

(4) Presentation of Results

For convenience in presentation the data discussed in this paper are divided into three parts which deal with;

I. Legitimate seedling families; that is families of seedlings of which both parents are known.

II. Illegitimate seedling families of which only one parent is known with certainty

III. New clones made from the legitimate seedlings.

I. Legitimate Seedling Families

Pollinations were made in seven consecutive flowering seasons. Although there are usually fewer flowers available in the secondary flowering seasons which occur during the months of July to September satisfactory results were none the less obtained.

The details of planting of the seven series of crosses (and of the illegitimate seedlings planted with them for comparison) are tabulated below.

Series	Field on the Experiment Station	Date of Planting.
1	4	Feb.—May 1929
2	16(North)	Oct.—Nov. 1929
3	16(South)	Feb.—Apr. 1930
4	25(1)	Oct.—Nov. 1930
5	25(1)	Mar.—Apr. 1931
6	14E(2)	Oct.—Nov. 1931
7	14E(2)	April 1932

In naming the parents of a cross the usual convention has been observed. For example, a family described as A. 44 × B. 84 would consist of trees obtained from fertilising the female flowers of A. 44 with the pollen of B. 84, whereas the reciprocal cross described as B. 84 × A. 44 would consist of trees obtained from fertilising the female flowers of B. 84 with the pollen of A. 44.

It is sometimes convenient to combine a family of crosses with those of its reciprocal cross. In such cases the combined families would be described as B. 84. A. 44 or A. 44. B. 84 (without the multiplication sign).

The girth and yields of the seven series of legitimate seedling families are set out in Tables II to VIII.

In all series the trees were tapped alternate-daily on a half-spiral cut (S/2,d/2,100%). Seedling trees were opened at 20 inches from the ground when they had reached a girth of 20 inches at that height and the budded trees when used as controls were opened at 40 inches from the union on reaching a girth of 18 inches. Trees were brought into tapping on reaching the required minimum girth in January and July of each tapping year.

The numbers of trees measured and numbers tapped are given in italics under the girth and yield figures in the various Tables. In the yield columns, the first figures refer to the number of trees tappable from January to June and the second figures to the number tappable from July to December. The number of tappable trees shown includes all the trees which have reached tappable size even though they may have been taken out of tapping in consequence of wind damage or Brown Bast. The mean yield per tree is however estimated only from the trees actually tapped.

TABLE II

Legitimate Seedlings, First Series. Planted February—May 1929

Girth in inches at 40 inches from the ground and yield in lb. per tree per annum estimated on 160 tappings

Cross	Girth measurements: Girth in inches at 40 inches from ground level				Yield: Pounds dry rubber per tree				Storm Damage	Brown Bast
	1935	1936	1937	1938	1935	1936	1937	1938	1938	1938
A8 × A44	22.7	23.6	25.3	26.1	6.4	7.2	8.9	10.2	—	1
	7	*7*	*7*	*7*	*5*	*7*	*7*	*7*		
A8 × B58	20.7	22.6	24.8	26.4	2.9	5.6	7.4	10.1	—	—
	2	*2*	*2*	*2*	*2*	*2*	*2*	*2*		
B58 × A8	22.1	23.7	25.0	26.0	5.6	7.4	9.4	11.1	—	2
	19	*19*	*19*	*19*	*16*	*19*	*19*	*19*		
A44 × B58	22.9	24.5	26.0	26.8	6.8	9.3	12.1	14.0	—	—
	11	*11*	*11*	*11*	*11*	*11*	*11*	*11*		
B58 × A44	24.8	26.2	28.0	28.9	8.9	9.2	9.8	11.7	—	—
	2	*2*	*2*	*2*	*2*	*2*	*2*	*2*		
A44 × D61	24.0	26.2	28.2	29.5	7.9	9.9	11.8	13.0	—	3
	32	*32*	*32*	*32*	*30*	*30*	*32*	*32*		
D61 × A44	23.7	26.0	28.2	29.3	7.8	9.6	11.7	12.5	—	8
	47	*47*	*47*	*47*	*43*	*43*	*47*	*47*		
B58 × D61	20.3	22.6	24.6	25.5	3.1	5.7	7.8	10.2	—	—
	8	*8*	*8*	*8*	*5*	*7–8*	*8*	*8*		
B58 × B16	21.4	23.7	25.7	26.9	7.3	8.9	11.6	14.4	—	1
	10	*10*	*10*	*10*	*5*	*10*	*10*	*10*		
B16 × B58	16.6	18.7	20.1	20.7	4.3	6.9	10.0	12.1	—	—
	2	*2*	*2*	*2*	*1*	*1–2*	*2*	*2*		
A44 × B16	23.5	25.7	27.8	28.9	7.7	10.5	13.5	13.8	—	7
	27	*27*	*27*	*27*	*25*	*27*	*27*	*27*		
B16 × A44	24.2	26.2	28.2	29.1	7.8	9.7	17.0	20.6	—	1
	7	*7*	*7*	*6*	*7*	*7*	*7*	*7*		
B95 × A44	24.1	26.2	27.7	29.3	5.9	8.3	9.6	11.9	—	—
	9	*9*	*9*	*9*	*9*	*9*	*9*	*9*		
D61 × B16	16.3	18.1	19.5	20.6	4.7	7.7	8.2	8.3	—	1
	6	*6*	*6*	*6*	*3*	*4*	*5*	*5*		
B84 × A44	26.6	29.0	31.2	32.6	8.9	12.6	16.1	16.4	—	1
	8	*8*	*8*	*8*	*8*	*8*	*8*	*8*		
Unselected Seedlings	18.1	20.7	22.9	25.0	1.8	2.8	3.4	4.1	1	1
	69	*69*	*69*	*66*	*29*	*49–63*	*65–68*	*68*		
Mean. All Crosses					6.4	8.6	11.0	12.7		

Notes on the Seven Series of Crosses

First Series (Table II)

All the families in this series show yields greatly superior to the unselected seedlings.

The highest-yielding family is B. 84 × A. 44 which produced in the fourth tapping year four times as much as the unselected seedlings. There are only eight trees in this family and it is probable that its apparent value is exaggerated for, as will be seen in the later series, larger families of the same cross give less favourable results.

The families A. 44. D. 61 and A. 44. B. 16 both have good yields but their value is much reduced by the heavy incidence of Brown Bast.

Second Series (Table III)

B. 84. A. 44 is again the highest-yielding family and the most vigorous in growth.

The two small families C. 72 × B. 84 and B. 58 × C. 72 also show promise but there are insufficient trees for a valid judgment of their merits to be formed.

Third Series (Table IV)

The highest-yielding families are A. 44. B. 84, A. 44. B. 16, B. 84. B. 16 and A. 44 × Lun. N. There is a much larger number of trees in each of the first three families named than in the earlier series and there is very little difference in their yields in the third and fourth tapping years. The family B. 84. B. 16 was actually the highest yielder in the third tapping year but over the whole four tapping years the yields of the three families are almost identical.

To make the cross of A. 44 × Lunderston N it was necessary to take the male flower of the latter clone by car from Lunderston Estate to Pilmoor Estate. The pollen was used on the same day and successful pollinations were made without difficulty. The yields of this family, which occurs only in this series, are equal to those of the best of the other families of seedlings at the same age and the characters of both the virgin and renewed bark are exceptionally good.

Fourth Series (Table V)

The family A. 44. B. 84 is again the highest yielding and the most vigorous in the series. Of the remaining families B.50 × B.84, B. 58 × B. 84, and D. 65 × B. 84 are the best.

TABLE III

Legitimate Seedlings, Second Series. Planted October—November 1929

Girth in inches at 40 inches from the ground and yield in lb. per tree per annum estimated on 160 tappings

Cross	Girth measurements: Girth in inches at 40 inches from ground level				Yield: Pounds dry rubber per tree				Storm Damage	Brown Bast
	1935	1936	1937	1938	1935	1936	1937	1938	1938	1938
A44 × B84	30.8	35.0	39.0	40.9	10.5	12.3	14.5	26.0	—	—
	1	*1*	*1*	*1*	*1*	*1*	*1*	*1*		
B84 × A44	22.8	25.0	27.0	28.2	6.1	9.5	13.3	14.4	1	—
	32	*31*	*31*	*31*	*31*	*31–32*	*32*	*32*		
A44 × D61	20.4	23.0	25.3	26.8	4.9	7.0	9.8	12.5	—	1
	16	*16*	*16*	*16*	*13–15*	*15*	*15*	*16*		
D61 × A44	19.5	21.7	23.5	24.8	4.8	6.3	8.5	10.3	—	—
	22	*22*	*22*	*22*	*18–19*	*19–20*	*21*	*21*		
A44 × B50	18.1	20.7	23.0	24.4	4.0	5.7	7.9	8.9	—	1
	21	*21*	*21*	*21*	*15–16*	*16–17*	*19*	*20*		
A44 × B58	18.8	21.0	22.6	24.0	4.5	6.5	9.2	11.6	—	—
	28	*28*	*28*	*28*	*22–25*	*25*	*27*	*27*		
B58 × A44	16.0	18.0	20.1	21.4	4.7	7.3	11.3	11.1	—	—
	27	*27*	*27*	*27*	*15–16*	*16–19*	*19*	*20*		
B50 × B58	17.0	19.0	21.5	22.9	3.3	4.7	6.9	7.3	—	—
	15	*15*	*15*	*15*	*9–12*	*12–13*	*14*	*14*		
B58 × B50	20.0	22.8	25.0	26.5	3.9	5.5	8.3	8.6	—	—
	10	*10*	*10*	*10*	*8–9*	*9–10*	*10*	*10*		
B50 × E95	21.1	24.6	26.7	29.1	5.0	5.5	6.7	6.8	—	—
	3	*3*	*3*	*3*	*2*	*2–3*	*3*	*3*		
B58 × B84	17.5	18.9	21.4	23.1	5.7	8.3	10.8	14.4	1	—
	15	*14*	*14*	*14*	*9*	*9–13*	*14*	*14*		
B58 × C72	21.4	24.5	26.2	28.5	4.7	9.0	15.1	13.9	—	—
	3	*3*	*3*	*3*	*3*	*3*	*3*	*3*		
B84 × D61	17.5	19.6	21.8	23.7	4.7	6.8	8.7	9.8	—	—
	17	*17*	*17*	*17*	*9–11*	*11–13*	*14*	*16*		
D61 × B84	19.9	21.5	23.8	25.5	4.2	7.0	10.0	11.9	—	1
	37	*37*	*37*	*37*	*28–30*	*30–32*	*32*	*34*		
C72 × B84	18.9	21.5	24.4	27.4	4.3	8.4	14.0	15.4	—	—
	6	*6*	*6*	*6*	*5*	*5*	*5*	*5*		
Unselected Seedlings	13.8	17.4	20.3	23.0	1.4	2.3	3.8	3.6	2	2
	244	*234*	*239*	*240*	*70–110*	*110–170*	*200*	*213–222*		
Mean. All Crosses					5.0	7.3	10.3	12.2		

Note: In 1935 tapped April—December only, but yields estimated on 160 tappings.

TABLE IV

Legitimate Seedlings, Third Series. Planted February—April 1930
Girth in inches at 40 inches from the ground and yield in lb. per tree per annum estimated on 160 tappings

Cross	Girth measurements: Girth in inches at 40 inches from ground level				Yield: Pounds dry rubber per tree				Storm Damage	Brown Bast
	1935	1936	1937	1938	1935	1936	1937	1938	1938	1938
A44 Selfed	5.6	7.4	9.6	11.4	—	6.3	7.8	9.3	—	—
	12	*12*	*12*	*12*	*0*	*0–1*	*1*	*1*		
A44 × B16	15.1	17.4	19.7	22.0	4.5	5.9	9.6	9.9	—	1
	106	*106*	*106*	*106*	*53–59*	*59–75*	*78*	*84–90*		
B16 × A44	21.4	23.7	25.7	27.3	5.7	7.8	11.4	13.1	1	1
	18	*17*	*18*	*17*	*16–18*	*18*	*18*	*18*		
A44 × D61	16.3	19.0	21.8	23.8	4.8	6.6	9.7	11.7	—	—
	58	*57*	*58*	*58*	*34–46*	*47–49*	*53*	*54*		
D61 × A44	14.5	16.9	19.7	21.9	4.5	5.6	7.9	9.9	—	1
	57	*57*	*57*	*57*	*29–34*	*34–39*	*43*	*47*		
A44 × B84	17.0	20.6	23.1	25.5	3.6	5.6	8.3	8.3	—	—
	10	*10*	*10*	*10*	*7*	*7–9*	*10*	*10*		
B84 × A44	17.6	20.6	23.4	25.3	5.8	7.1	10.2	13.2	—	1
	36	*36*	*36*	*36*	*24*	*24–30*	*30*	*30–31*		
A44 × Lun N	16.7	19.2	21.8	23.4	5.9	6.7	10.7	14.1	—	—
	17	*17*	*17*	*17*	*10–14*	*14–16*	*16*	*17*		
Lun K × Lun N	11.5	14.8	17.8	19.7	3.5	4.6	7.3	12.2	—	—
	3	*3*	*3*	*3*	*0–1*	*1–2*	*2*	*2*		
B58 × A44	12.6	14.9	17.1	18.8	3.8	6.1	10.5	8.8	—	—
	27	*27*	*27*	*27*	*9–13*	*13–16*	*16*	*17–18*		
B58 × B90	7.1	9.4	12.5	15.3	—	—	2.4	4.0	—	—
	6	*6*	*6*	*6*	*0*	*0*	*1*	*3*		
B58 × B16	14.6	17.6	20.8	22.3	5.1	9.1	14.5	13.9	—	—
	8	*8*	*8*	*8*	*4*	*4–5*	*5*	*7*		
B84 × B16	16.5	20.0	22.3	24.1	4.4	6.2	9.7	11.7	—	3
	34	*34*	*34*	*33*	*21–25*	*25–32*	*33*	*33–34*		
B16 × B84	20.0	23.7	26.5	28.5	4.2	8.7	15.3	12.9	—	—
	5	*5*	*5*	*5*	*5*	*5*	*5*	*5*		
D61 Selfed	6.5	9.0	11.1	12.6	—	—	—	5.0	—	—
	2	*2*	*2*	*2*	*0*	*0*	*0*	*0–1*		
D61 × B16	9.9	13.2	16.0	18.3	3.4	4.2	5.9	5.8	—	—
	13	*13*	*12*	*12*	*2*	*2–3*	*6*	*7–8*		
B16 × D61	10.2	12.5	14.9	17.2	1.2	2.0	5.0	4.7	—	—
	12	*12*	*12*	*12*	*1–3*	*3–4*	*4*	*6–7*		
D65 × A44	14.4	16.6	19.0	21.3	2.9	3.5	5.4	6.4	—	—
	5	*5*	*5*	*5*	*2–4*	*4*	*4*	*4–5*		
D65 × B16	13.1	15.2	18.0	19.9	4.4	4.4	7.4	9.5	—	—
	9	*9*	*9*	*9*	*1–5*	*5*	*7*	*7–8*		
Unselected Seedlings	13.3	17.1	20.0	22.8	1.2	2.4	4.2	3.8	2	—
	143	*138*	*141*	*142*	*41–62*	*62–97*	*104*	*113–121*		
Mean. All Crosses					4.0	5.5	8.9	10.0		

Note: In 1935 tapped April—December only, but yields estimated on 160 tappings.

TABLE V

Legitimate Seedlings, Fourth Series. Planted October—November 1930

Girth in inches at 40 inches from the ground and yield in lb. per tree per annum estimated on 160 tappings

Cross	Girth measurements: Girth in inches at 40 inches from ground level			Yield: Pounds dry rubber per tree			Storm Damage	Brown Bast
	1936	1937	1938	1936	1937	1938	1938	1938
A44 Selfed	14.0	16.1	16.6	5.9	4.5	4.3	1	—
	9	*9*	*9*	*1*	*4–6*	*6*		
B84 Selfed	4.7	7.2	8.9	—	—	—	—	—
	1	*1*	*1*	—	—	—		
A44 × B84	20.2	23.6	25.3	5.6	9.9	9.7	1	3
	47	*47*	*47*	*38–41*	*44*	*44*		
B84 × A44	19.9	23.2	25.0	5.1	8.5	9.3	2	6
	46	*46*	*45*	*36–43*	*45–46*	*46*		
A44 × B65	18.1	21.4	23.6	3.4	5.9	6.4	—	—
	6	*6*	*6*	*3–4*	*6*	*6*		
B65 × A44	16.5	19.2	21.1	2.4	4.8	5.4	—	—
	9	*9*	*9*	*3–5*	*9*	*9*		
B50 × B84	20.0	23.7	25.6	4.0	8.3	8.9	—	1
	18	*18*	*18*	*11–14*	*15–17*	*17*		
B58 × B84	17.4	20.7	23.3	3.7	7.6	8.8	1	
	24	*23*	*23*	*10–14*	*23*	*23*		
B58 × B65	19.1	22.1	22.8	4.3	5.9	6.4	—	—
	2	*2*	*2*	*1*	*2*	*2*		
D65 × B84	17.4	21.4	23.5	3.0	7.3	8.9	—	—
	9	*9*	*9*	*4–6*	*8*	*8*		
Mean. All Crosses				3.9	7.3	8.0	—	—

FIFTH SERIES (TABLE VI)

Budded stumps of A. 44, B. 84 and D. 65 were planted in this field at the same time as the seedlings.

Eight out of the ten families in this series were obtained from crosses with D. 65, the highest-yielding Pilmoor clone. All the families have lower yields than the buddings of A. 44 and it would seem that D. 65 does not transmit its high yielding qualities to its seedlings or if it does that these qualities do not manifest themselves during the first three tapping years.

TABLE VI

Legitimate Seedlings, Fifth Series. Planted March—April 1931

Girth in inches at 40 inches from the ground and yield in lb. per tree per annum estimated on 160 tappings

Cross	Girth measurements: Girth in inches at 40 inches from ground level			Yield: Pounds dry rubber per tree			Storm Damage	Brown Bast
	1936	1937	1938	1936	1937	1938	1938	1938
A44 × D65	13.4	17.2	19.7	2.1	4.9	5.6	—	—
	27	*27*	*27*	*4–8*	*14–20*	*20–22*		
B58 × D65	11.2	15.1	18.0	1.7	4.2	3.9	—	—
	35	*35*	*35*	*1–3*	*5–9*	*10–15*		
D65 × B58	13.1	16.9	18.7	—	3.6	4.3	—	—
	1	*1*	*1*	—	*0–1*	*1*		
B84 × D65	16.1	20.2	22.9	3.2	7.8	8.8	—	2
	33	*33*	*33*	*9–20*	*23–28*	*28–30*		
D65 × B84	17.3	21.6	24.3	2.0	4.8	5.9	—	—
	7	*7*	*7*	*0–7*	*7*	*7*		
B84 × Lun B	15.8	21.0	24.3	2.7	6.1	6.3	—	—
	6	*6*	*6*	*1–2*	*3–4*	*5–6*		
B90 × B16	12.2	16.4	19.5	1.2	3.4	4.5	1	—
	20	*20*	*19*	*2–4*	*6–11*	*11–16*		
B16 × D65	12.9	17.7	20.9	—	2.6	4.8	—	—
	1	*1*	*1*	—	*0–1*	*1*		
B11 × D65	11.5	16.0	18.8	—	1.7	1.8	—	—
	7	*7*	*7*	—	*1–3*	*4–6*		
D65 × D61	11.4	16.2	19.2	—	2.3	3.8	—	—
	3	*3*	*3*	—	*1*	*1–3*		
Buddings								
A44	15.0	18.6	20.2	4.3	7.4	8.6	2	—
	43	*43*	*45*	*4–5*	*15–19*	*31–36*		
B84	14.4	18.5	20.4	2.3	4.4	4.6	—	—
	38	*37*	*38*	*3–7*	*11*	*20–25*		
D65	13.8	18.1	20.8	1.9	3.8	5.3	—	1
	16	*16*	*16*	*0–3*	*5–7*	*9–11*		

SIXTH SERIES (TABLE VII)

This series contains three large families raised from D. 61 crossed with B. 58, D. 65 and B. 16. The weak growth of D. 61

has been transmitted to all three families, this being particularly marked in the cross D. 61 × B. 16.

Budded stumps of Avros 50 were planted in this field at the same time as the seedling families.

With the exception of the three trees of B. 84 × B. 58 the yields of all the families in this series are only slightly higher than that of Avros 50. Since the yield of Avros 50 is surpassed by that of the best proved clones these crosses must be considered inferior to the best families of the earlier series.

TABLE VII

Legitimate Seedlings, Sixth Series. Planted October—November 1931

Girth in inches at 40 inches from the ground and yield in lb. per tree per annum estimated on 160 tappings

Cross	Girth measurements			Yield			Storm Damage	Brown Bast
	Girth in inches at 40 inches from ground level			Pounds dry rubber per tree				
	1936	1937	1938	1936	1937	1938	1938	1938
D61 × B58	15.9	19.0	21.4	4.1	5.5	7.3	1	3
	133	*136*	*136*	*81*	*96–107*	*124*		
B58 × D61	15.8	19.1	21.7	1.9	3.0	7.3	—	—
	1	*1*	*1*	*1*	*1*	*1*		
D61 × D65	16.6	20.6	23.6	3.4	5.3	7.9	2	3
	76	*79*	*79*	*52*	*67–77*	*78*		
D61 × B16	12.6	15.4	18.1	3.0	3.9	6.9	—	1
	50	*55*	*55*	*8*	*17–30*	*40*		
B84 × B58	20.0	23.9	27.3	4.5	9.1	15.0	—	—
	3	*3*	*3*	*3*	*3*	*3*		
Avros 50 (Control)	19.6	22.6	25.8	2.8	4.0	6.1	1	—
	89	*90*	*90*	*66*	*80*	*85–86*		

Note: In 1936 tapped from July only, but the yields are estimated on 160 tappings.

SEVENTH SERIES (TABLE VIII)

This series is included to complete the first programme of pollinations made in the years 1928—1931. It is too soon to judge the value of these crosses, but a yield of 8.2 lb. per tree in the cross B. 84 × G. 1 at an average age of six years and three months may be regarded as satisfactory on the poor soil of this Field.

TABLE VIII

Legitimate Seedlings, Seventh Series. Planted April 1932

Girth in inches at 40 inches from the ground and yield in lb. per tree per annum estimated on 160 tappings

Cross	Girth measurements			Yield			Storm Damage	Brown Bast
	Girth in inches at 40 inches from ground level			Pounds dry rubber per tree				
	1936	1937	1938	1936	1937	1938	1938	1938
D61 × G1	10.1	13.7	16.7	—	2.8	5.7	—	—
	45	*46*	*46*	—	*10–16*	*28*		
B84 × G1	12.1	15.6	18.3	2.2	4.4	8.2	—	—
	19	*20*	*20*	*5*	*8–12*	*13*		
B58 × G1	9.7	14.0	16.7	—	2.0	3.0	—	—
	6	*6*	*6*	—	*1*	*4–5*		

Note: In 1936 tapped from July only, but yields estimated on 160 tappings.

Discussion

The clones used as parents are all known to be high yielders, at any rate during the first few years of tapping, and the seedling families raised from them have given yields very greatly in excess of the unselected seedlings planted amongst the crosses. There is however great variation in the yields of trees of the same family and also between different families.

Study of Tables II to VIII shows that the highest-yielding families are for the most part those which possess as one or both of their parents clones A. 44, B. 16 and B. 84, and that with the exception of A. 44 × Lun. N, the best of the larger families are from combinations of two of these three clones. The yields of these three families are summarised in Table IX.

A comparison of the yields between the families in the third series is interesting. In the first tapping year the two highest-yielding families were those with A. 44 as a parent, the cross with B. 84 being a higher yielder than that with B. 16. Clone A. 44 is known to be a precocious clone and this characteristic appears in its seedlings.

TABLE IX

Summary of the yields of the Legitimate Seedling Families derived from Crosses between Clones A44, B16 and B84

Series	Date of Planting	Family	Yield in lb. per tree per annum for each tapping year				Storm Damage	Brown Bast
			1st year	2nd year	3rd year	4th year	1938	1938
1	Feb.—May 1929	A44 . B84	8.9	12.6	16.1	16.4	—	1
			8	*8*	*8*	*8*		
1	"	A44 . B16	7.7	10.3	14.2	15.1	—	8
			32	*34*	*34*	*34*		
2	Oct.—Nov. 1929	A44 . B84	6.4	9.6	13.4	14.8	1	—
			32	*32–33*	*33*	*33*		
3	Feb.—Apr. 1930	A44 . B84	5.3	6.8	9.7	12.0	—	1
			31	*31–39*	*40*	*40–41*		
3	"	A44 . B16	4.8	6.3	9.9	10.4	1	2
			69–77	*77–93*	*96*	*102–108*		
3	"	B84 . B16	4.4	6.5	10.5	11.9	—	3
			26–30	*30–37*	*38*	*38–39*		
4	Oct.—Nov. 1930	A44 . B84	5.3	9.2	9.5	—	3	9
			74–84	*89–90*	*90*	—		

The early yields of buddings of clones B. 84 and B. 16 are both low in comparison with those of clone A. 44 and the yields of crosses between B. 84 and B. 16 are lower at first than the crosses between either clone and A. 44. By the third year of tapping the yield of the family A. 44. B. 84 exceeded that of the other two families. The two outstanding characteristics of A. 44, the high initial yield and the slow rate of increase, appear in its progeny, but modified by the influence of the other parent. The degree of modification is greater with B. 16 than with B. 84, the family A. 44. B. 84 having in this respect a closer resemblance to A. 44 than the family A. 44. B. 16.

The secondary characters of A. 44 are poor. The fluted stem and uneven bark and renewal of this clone appear in many of its seedlings, though in the majority of cases the trees showing these characteristics do not possess them in a degree that is likely to cause serious interference with tapping.

The corky bark of B. 84 is transmitted in varying degrees to its seedlings which produce a development of cork which ranges from the usual rather smooth bark characteristic of *Hevea* to a heavy development of corky bark.

Reference has already been made to the disappointing results from using D. 65 as a parent. This is clearly shown by comparing

its ability with that of B. 58 to transmit its high yielding capacity to its seedlings.

Series	Cross	Yield in lb. per tree per annum			
		1st year	2nd year	3rd year	4th year
3	B.58.B.16	5.1	9.1	14.5	13.9
3	D.65.B.16	4.4	4.4	7.4	9.5
3	B.58.A.44	3.0	6.1	10.5	8.8
3	D.65.A.44	2.9	3.5	5.4	6.4
6	B.58.D.61	4.1	5.5	7.3	—
6	D.65D.61	3.4	5.3	7.9	—

D. 65, when crossed with A. 44, B. 16 and D. 61, is inferior to B. 58 as a producer of high-yielding seedlings.

In this respect the behaviour of this clone is complementary to that of Avros 157 (d'Angremond 1935). The latter is a poor yielder and has never been used commercially, yet when crossed with several other clones it produced exceptionally high-yielding families. The reverse appears to be the case with clone D. 65, the highest yielding of the Pilmoor clones, the seedlings of which have given comparatively poor yields up to the end of the third tapping year. Buddings of D. 65 are known to give only moderate yields during the early periods of tapping and it is possible that the later yields of the seedlings of this clone may show big increases. But until the future trend of the yield curves of these families is known seedlings of D. 65 should not be used in commercial planting.

B. 58 is usually a weak-growing clone, and the average girth of the seedlings derived from this clone is below normal. B. 58 × B. 16 has the highest yield per tree of the families in the Third Series (Table IV), but its value as a family is not great since by the end of 1937 when the trees were 7½ years old only five out of the eight trees planted were large enough to tap. Though the yield per tree is high, the yield per acre would be disappointingly low during the early years of tapping. A similar weakness of growth can be observed in the B. 58 × A. 44 family of which only 16 out of 27 trees were tappable at the same age.

Self-pollinated seedlings

Self-pollination with the Pilmoor clones has proved very difficult, and very few trees have been raised by this means. The girth and yield of the few trees obtained will be found in Tables IV and V.

The growth has been so poor that the trees would be worthless commercially. It is remarkable that the one self-pollinated seedling tree of B. 84, one of the strongest-growing clones on the Experiment Station, has succeeded in attaining a girth of only

8.9 inches in eight years, approximately one-third of the girth of the other seedling crosses of which B. 84 is a parent.

Of the remaining families there is little to be said. For the most part they are inferior in yield to those already described and even when the yields appear to be high, *e.g.* the families C. 72 × B. 84 and B. 58 × C. 72 in Series 3, they are usually obtained from too small a number of trees to be convincing.

Wide differences in yield are found among the individual trees of each family and the co-efficient of variation which has been calculated for some of the larger families averages about 50 per cent. Though high, the coefficient is lower than that of families of illegitimate clonal seedlings and unselected seedlings (Table X).

TABLE X

Coefficient of Variation (V). Yields per tree in 1937

Series	Family	V%	Series	Family	V%	Series	Family	V%
1	D.61.A.44	44	1	B.58.ill.	54	1	Unselected seedlings	55
3	D.61.A.44	59	1	A.44.ill.	56	2	,, ,,	69
3	B.16.A.44	49	2	B.84.ill.	57	3	,, ,,	63
4	B.84.A.44	44	2	B.58.ill.	66			
6	D.61 D.65	49	2	A.44.ill.	58			
6	D.61.B.58	55						
	Mean	50			58			62

It is by no means easy to make from the material available an accurate comparison of the yields of the seedling families with the yields of the best clones, since no budded controls were planted with the first four series of crosses. Such buddings as are to be found in these fields were planted as late supplies and are useless for comparative purposes.

In the fifth and sixth series budded stumps of A. 44, B. 84, D. 65 and Avros 50 were planted at the same time as the seedlings. Our experience in Field 17 on the Experiment Station and elsewhere in Malaya has shown that buddings interplanted with seedlings are incapable of giving normal results because of the severe competition in growth between buddings and seedling trees. Clones B. 84 and D. 65 are both slow growers during the first year from

budding. That this slow early growth made the buddings of these two clones unable to compete with the surrounding seedling trees in later years is shown by the small proportion of trees which had reached tappable size by 1938 (Table VI). On the other hand A. 44, owing to its more rapid early growth, did not suffer so severely in competition with the seedlings, and by 1938 there was approximately the same proportion of tappable trees of A. 44 as in the families of crosses. In the fifth series, A. 44 gives a higher yield than any of the legitimate seedling families.

In the sixth series Avros 50 has made good growth and its yield in 1938, the third tapping year, is only a little behind that of the best families of seedling trees. Since Avros 50 is in point of yield only a second-class clone, there can be little doubt that the best proved clones would yield more than any of the families of crosses in this series.

The legitimate seedling families of the fifth and sixth series are almost certainly inferior in yield to those of the first four series for none of these families is derived from combinations of the four best parent clones A. 44, B. 16, B. 84 and Lun. N.

It is however possible to make an indirect comparison between the yield of the best family of crosses in the first three series with A. 44 in the fifth series. The relevant data have been extracted from the tables and are presented below.

Mean Yield in lb. per tree in third tapping year

Series	Cross	No. of trees	Yield
5	B.84.D.65	35	8.2
5	A.44 buddings	32	8.6
4	B.84.D.65	8	8.9
4	B.84.A.44	88	9.5
3	"	41	9.7
2	"	33	13.4
1	"	8	16.1

In the fifth series the yield of the cross B. 84. D. 65 is equal to 95 per cent of that of the buddings of A. 44. In the fourth series the yield of the trees of the same cross is equal to 94 per cent of that of the B. 84. A. 44 family. From this it would appear that the yields of the buddings of A. 44 and the yields of the legitimate seedlings of B. 84. A. 44 are approximately equal. The higher yields of the family B. 84. A. 44 in the first two series should probably be attributed to the better soil in the fields in which they are planted.

In its third year of tapping in the Clone Trial Experiment in Field 5, A. 44 has the second highest yield being equal to P. B. 186 and inferior only to Tjirandji 1.

Field 5. Clone Trial Experiment

Clone		Yield in lb. per tree per annum 1936	1937	1938
Pilmoor B. 84	...	5.8	8.5	9.2
„ A. 44	...	8.1	9.0	9.5
P. B. 186	...	4.9	8.1	9.5
Avros 50	...	4.5	7.0	8.8
Tjirandji 1	...	7.4	10.2	12.2

This indirect method of comparison is open to several objections not the least of which is the small number of trees in the cross B. 84. D. 65 in the fourth series, but owing to the absence of budded controls in the first four series no other method of comparison is available. None the less, when it is considered that the buddings of A. 44 in series 5 were subjected to competition from the surrounding seedling trees it seems very doubtful whether the best yielding of the families of seedling crosses would be capable of higher yields than buddings of A. 44 if grown under comparable conditions.

The general conclusion to be drawn from a study of these families of legitimate seedlings is that the best families are not better than the best proved clones. This is a reversal of the opinion first formed from a study of the oldest crosses of the first three series. A study of the later tapping records of the older series and of the yields of the younger series has made it necessary to modify the view originally formed and to say that although the best families of seedlings may be as good as the best clones, the evidence on the whole does not support the view that they are better.

II. The Illegitimate Seedling Families

Illegitimate seedlings or "clonal" seedlings as they are sometimes called are seedlings of which only the mother-tree is known.

In the first three series the crosses were planted in groups spaced at intervals throughout the fields and illegitimate seedlings of some of the clones used as parents were planted between the groups of crosses.

The planting and treatment of the illegitimate seedlings was uniform with that of the legitimate seedlings.

The illegitimate seedlings were collected from the Pilmoor experimental plot which consists of a strip of land 7.6 × 15.2 chains in extent bounded by mature seedling rubber trees on two adjacent sides and by younger budded trees on the other two sides. Although it is probable that most of the seeds resulted from pollination between the clones in the experimental area, it

is to be expected that a certain amount of pollen reached the budded trees from the surrounding old trees. In addition to the clones used as parents of the legitimate seedling families, about one-fifth of the experimental area was occupied by poor-yielding clones which were not used for making crosses.

The girths and yields of the illegitimate seedling families are set out in Tables XI to XIII.

TABLE XI

Clonal Seedlings, First Series. Planted December 1928 to May 1929
Girth in inches at 40 inches from the ground and yield in lb. per tree per annum estimated on 160 tappings

Family	Girth measurements: Girth in inches at 40 inches from ground level				Yield: Pounds dry rubber per tree				Storm Damage	Brown Bast
	1935	1936	1937	1938	1935	1936	1937	1938	1938	1938
A8	21.3	23.3	25.1	26.9	3.4	5.6	7.3	9.3	—	1
	44	*44*	*44*	*44*	*37*	*38–42*	*43–44*	*44*		
A44	21.7	23.8	26.0	27.2	5.8	8.0	9.8	11.8	—	13
	169	*168*	*168*	*168*	*125*	*139–151*	*156–157*	*156*		
B58	21.9	24.2	25.9	27.9	4.6	6.4	8.3	10.5	1	1
	81	*81*	*81*	*81*	*64*	*71–73*	*74–75*	*76*		
B84	22.5	25.0	27.3	29.3	5.6	8.2	11.6	15.8	1	—
	21	*21*	*21*	*21*	*14*	*20–21*	*21*	*21*		
D61	21.5	23.9	26.1	27.8	4.1	6.4	7.8	9.1	—	2
	29	*28*	*28*	*28*	*22*	*28*	*28*	*28*		
B16	18.1	20.8	23.3	25.1	2.7	5.3	6.3	7.4	—	1
	8	*8*	*8*	*8*	*3*	*5–6*	*7–8*	*8*		
B95	21.9	24.7	25.8	28.5	2.9	4.8	5.2	6.5	—	—
	27	*27*	*26*	*26*	*21*	*25–27*	*27*	*26*		
B11	18.5	21.1	23.5	25.9	1.7	2.9	4.1	5.5	—	—
	14	*14*	*14*	*14*	*7*	*12–13*	*14*	*14*		
Unselected Seedlings	18.1	20.7	22.9	25.0	1.8	2.8	3.4	4.1	1	1
	69	*69*	*69*	*66*	*29*	*49–63*	*65–68*	*68*		
A44	23.4	25.0	26.7	—	7.1	8.8	10.0	—	—	—
	107	*106*	*103*	—	*89*	*94–99*	*100*	—		
D61	24.0	26.5	28.6	—	5.8	7.6	9.8	—	—	—
	80	*79*	*78*	—	*69*	*75–76*	*77*	—		
B11	23.9	26.7	29.8	—	2.3	4.3	5.5	—	—	—
	26	*27*	*27*	—	*24*	*27*	*27*	—		
Unselected Seedlings	23.4	26.3	28.7	—	3.1	4.6	5.9	—	—	—
	79	*79*	*79*	—	*70*	*78*	*79*	—		

Note: The last four families were planted in December 1928, the other families from March to May 1929.

TABLE XII

Clonal Seedlings, Second Series. Planted October—November 1929

Girth in inches at 40 inches from the ground and yield in lb. per tree per annum estimated on 160 tappings

Family	Girth measurements: Girth in inches at 40 inches from ground level				Yield: Pounds dry rubber per tree				Storm Damage	Brown Bast
	1935	1936	1937	1938	1935	1936	1937	1938	1938	1938
A44	19.8	22.3	24.3	26.2	3.8	5.9	8.8	9.2	—	1
	67	*67*	*67*	*66*	*52–55*	*55–58*	*60*	*60*		
B50	17.1	20.4	22.6	25.2	3.2	4.6	7.3	6.6	1	1
	32	*31*	*31*	*31*	*18–23*	*23–28*	*30*	*30–31*		
B58	18.5	21.2	23.4	25.5	2.9	5.0	7.5	7.5	—	1
	70	*70*	*70*	*70*	*55–61*	*61–65*	*67*	*67*		
B84	19.4	22.2	24.7	27.3	4.0	7.0	10.5	11.0	—	4
	157	*154*	*157*	*157*	*125–133*	*133–139*	*143*	*145–148*		
D61	16.7	19.7	22.1	24.4	3.2	5.5	8.4	8.2	1	—
	60	*60*	*60*	*60*	*38–44*	*44–46*	*47*	*51–52*		
Unselected Seedlings	13.8	17.4	20.3	23.0	1.4	2.3	3.8	3.6	2	2
	244	*234*	*239*	*240*	*70–110*	*110–170*	*200*	*213–222*		

Note: In 1935 tapped April—December only, but yields estimated on 160 tappings.

Discussion

Study of Tables II to VIII shows that both parents affect the yield of a cross, though they may not appear to have an equal effect. In the third series A. 44 was crossed with six other clones and the yields varied in 1938 from 14.1 lb. when crossed with Lunderston N to 6.4 lb. when crossed with D. 65. A family of clonal seedlings will consist of several crosses, the actual number depending on the number of pollen parents within range during the flowering season, and the yield of such a family will be equal to the average yield of the different crosses of which it is composed in the proportions in which those crosses occur. In the Pilmoor experimental area some of the illegitimate seedlings of the best parent clones will be produced as a result of pollinations by inferior clones or by the surrounding unselected seedling rubber. In consequence of this every family will contain a proportion of comparatively low-yielding trees and it is to be expected that the average yield of a family of illegitimate seedlings of a clone will be lower than the best crosses in which that clone has been used.

TABLE XIII

Clonal Seedlings, Third Series. Planted February—April 1930

Girth in inches at 40 inches from the ground and yield in lb. per tree per annum estimated on 160 tappings.

Family	Girth measurements				Yield				Storm Damage	Brown Bast
	Girth in inches at 40 inches from ground level				Pounds dry rubber per tree					
	1935	1936	1937	1938	1935	1936	1937	1938	1938	1938
A44	15.6	18.5	21 3	23.4	3.6	5.6	8.8	8.7	—	—
	31	*29*	*31*	*31*	*18–20*	*21–23*	*24*	*26*		
B58	12.0	15.8	17.8	19.3	3.0	5.0	8.7	7.7	—	—
	22	*20*	*21*	*22*	*6–9*	*9–12*	*14*	*15–16*		
B84	18.5	21.8	24.7	27.0	2.5	5.2	9.0	7.2	—	—
	11	*11*	*11*	*11*	*7–10*	*10–11*	*11*	*11*		
B90	16.3	20.6	24.0	27.6	1.5	3.2	6.0	6.1	—	—
	13	*13*	*13*	*13*	*7–9*	*9–12*	*12*	*13*		
D61	7.3	9.6	12.6	14.9	2.0	4.2	4.7	4.1	—	—
	7	*7*	*7*	*7*	*0–1*	*1*	*2*	*3*		
D65	11.4	14.0	17.2	20.3	2.3	3.6	6.7	7.7	1	—
	57	*56*	*56*	*56*	*9–18*	*18–29*	*30*	*36–41*		
B16	13.1	15.6	18.5	21.0	2.5	4.8	8.1	7.4	1	1
	46	*43*	*45*	*45*	*14–19*	*19–25*	*30*	*33–35*		
Unselected Seedlings	13.4	17.1	20.0	22.8	1.2	2.4	4.2	3.8	2	—
	143	*138*	*141*	*142*	*41–62*	*62–97*	*104*	*113–121*		

Note: In 1935 tapped April—December only, but yields estimated on 160 tappings.

Comparison of the yields of the illegitimate seedling families given in Tables XI, XII and XIII with the yields of the legitimate families in Tables II, III and IV respectively shows that although greatly superior to the unselected seedlings the yields of the illegitimate seedling families are inferior to those of the best legitimate seedling families.

There is however a considerable difference between the yields of the different families. A. 44 and B. 84 which produced high-yielding legitimate seedling families when crossed in many combinations with other clones have shown themselves to be the best parents of illegitimate seedling families, but in no case are the yields of either family equal to the cross A. 44. B. 84.

On the other hand B. 16 which gave such excellent results when crossed with A. 44 and B. 84 has not proved so valuable a parent as might be expected.

Clone D. 65 which showed itself to be a poor parent in various crosses appears to be an equally poor producer of illegitimate seedlings.

That clonal seedlings consist of a mixture of crosses is of importance in selecting clones for use in a seed garden designed to produce seed on a commercial scale.

It is desirable that all the clones used in a seed garden should have been crossed in all possible combinations and that the yields of all possible crosses should be known. If this is impracticable, at any rate only clones which have shown themselves to be producers of high-yielding families when used in several combinations should be used. For instance, of the Pilmoor Clones, B. 84 and A. 44 and possibly B. 16 would be suitable for use in seed gardens if the secondary character of the seedlings could be ignored and if the production of high-yielding seedlings were the sole consideration. On the other hand B. 58 and D. 61 although they have produced high-yielding families when crossed with A. 44 and B. 84 would be unsuitable for inclusion since, when crossed with each other, they produce a large proportion of very weak trees with a comparatively poor yield. If B. 58 and D. 61 were included in a seed garden it would be quite possible that owing to the vagaries of the time of flowering and the wide differences in the amount of seed set by the different clones, a large proportion of the seed set might be from the cross B.58.D.61 If this should happen the value of a sample of seed from such a garden would be disappointingly poor.

One further point in connexion with seed gardens may be mentioned here. The time of flowering is a clonal characteristic, some clones flowering early in the season and others late in the season. It sometimes happens that with mature budded trees crosses between certain clones could seldom occur naturally. As an instance of this in 1937 on the Experiment Station clone Avros 157 had completely finished flowering before any of the flowers of P. B. 186 had reached maturity. With younger budded trees up to their fifth or sixth year there is more variation in the time of flowering of the individual trees of a clone, and crosses between two clones which would be impossible at maturity may occur plentifully. Unless the times of flowering of two clones used in a seed garden are known to coincide, the assumption that crosses between these clones will occur naturally is not justified.

In addition to being a clonal characteristic the time of flowering is affected by weather conditions. In a wet flowering season the period of flowering is extended and crosses may in consequence occur which would not occur in a dry season. A sample of seed from a seed garden may therefore be expected to vary in genetic

constitution not only at different times during the same season but from year to year also.

The illegitimate seedlings of D. 61 may be used as an example of this variation from year to year. In the first three series their yields as a percentage of A. 44 were in 1938, 77, 89 and 47 respectively. In the third series there were only a few trees, and they were poorly grown and bad yielders. During the same period illegitimate seedlings of B. 58 showed very little variation yielding respectively 89, 81 and 88 per cent of the illegitimate seedlings of A. 44.

III. Clones from Legitimate Seedlings

When the legitimate seedlings were from one to two years old, from three to six bud-patches were cut from the stem and were used for budding in the field. In this way 989 new clones were made from the seedling crosses of the first five series.

Tapping of the buddings made from the first series of crosses commenced in July 1935 and of the later series as they reached tappable size from January 1936.

In general there is a tendency for the clones to reproduce the characteristics of the mother-trees, but the relationship so far as yield is concerned is not as close as might be expected. This is shown by the correlations between the yields of the mother-trees and those of the clones, (Table XIV) which range from +0.23 to +0.63.

TABLE XIV

Correlations. Yield of Mother Trees 1935 with yield of Clones 1936

2nd Series			3rd Series		
Cross	No. of pairs of comparisons	Coefficient of Correlation	Cross	No. of pairs of comparisons	Coefficient of Correlation
D61 × B84	23	+ 0.55			
D61 × A44	19	+ 0.58	D61 × A44	20	+ 0.46
B84 × A44	27	+ 0.39	B84 × A44	19	+ 0.35
A44 × B58	22	+ 0.63			
A44 × D61	15	+ 0.59	A44 × D61	40	+ 0.43
			A44 × B16	52	+ 0.43
			B84 × B16	16	+ 0.40
			A44 × Lun. N.	15	+ 0.23

Moreover the secondary characters of the clones, such as smoothness or roughness of the bark, tendency to spiral fluting of the stem and an erect or leaning habit tend to show a condition intermediate between those of the parents. There is however a considerable range in the incidence of these characters in the various clones. For instance, the bumpy bark and uneven renewed bark characteristic of buddings of A. 44 appear in a great many of the new clones made from crosses of which A. 44 is a parent, but it is none the less possible to select from these individual clones which show very little trace of these undesirable characteristics. At the same time the presence of these unfavourable parental characters in a large number of the clones limits very considerably the choice of clones for further test.

It has however been possible to select a number of clones with satisfactory secondary characters which have yields in excess of those of the best proved clones, and 23 such clones have already been selected for further testing on a large scale under a variety of conditions. The yields of these clones are set out in Table XVII.

As would be expected the majority of these clones are from crosses between the clones which produced the highest-yielding families of seedlings, namely, A. 44, B. 16, B. 84 and Lunderston N. It is remarkable, however, that out of over 700 clones, which have been in tapping for two years or more, four of the 23 selected clones should come from the family of 15 clones made from crosses of A. 44 x Lun. N. Since this family is of especial interest the yields of the mother-trees and the clones made from them are set out in Table XV.

The mother-trees are growing in a compact group in Field 16 South on poor but apparently uniform soil. In Table XV the clone mother-trees are arranged in order of their total yields for the four years of tapping, and it is clear from the irregular order of the yields of the clones, that the yield of the mother-tree is likely to be an unreliable guide to the yield of the clone made from it.

In this small family there is no correlation between the total yield of the mother-trees and the total yield of the clones.

One of the highest-yielding clones, from tree 13/11, has very bumpy renewed bark and has been rejected. The highest-yielding clone, from tree 16/12, has a general habit very like that of Lunderston N with satisfactory bark characters, and has been given the number R.R.I. 501 and selected for further trial. (The yield per tree in 1938 is the highest recorded of any of the new clones under trial at the R.R.I. Experiment Station).

The data from the family B. 84, A. 44 in the third series has been similarly treated (Table XVI). In this family group there

TABLE XV

A. 44 x Lun. N. Yields of Mother-Trees and Clones made from them

No. Tree	Mother trees					Buddings			
	Yield in lb. per tree per annum					Yield in lb. per tree per annum			
	1935	1936	1937	1938	Total	1936	1937	1938	Total
16/10	12.4	13.3	15.5	37.4	**78.6**	3.4 *1*	4.9 *3*	5.3 *5*	**13.6**
*14/9	9.8	10.6	18.1	29.9	**68.4**	8.5 *4–5*	14.0 *5*	12.4 *5*	**34.9**
16/11	8.8	15.2	20.6	18.2	**62.8**	4.7 *1*	7.8 *1–2*	9.7 *2*	**22.2**
13/12	5.6	9.4	18.2	23.9	**57.1**	6.0 *1–3*	6.6 *4*	8.5 *5*	**21.1**
*16/12	4.6	9.7	16.4	17.5	**48.2**	9.3 *2*	18.2 *2*	26.3 *2*	**53.8**
*15/10	8.4	11.1	12.9	13.2	**45.6**	9.4 *3–4*	12.8 *4–5*	11.4 *5*	**33.6**
12/11	2.1	5.0	13.2	21.3	**41.6**	4.9 *2*	6.3 *4*	9.5 *4*	**20.7**
15/12	3.2	5.0	9.7	13.0	**30.9**	2.2 *2–3*	3.1 *5*	3.9 *6*	**9.2**
12/9	2.2	4.3	8.9	6.8	**22.2**	3.0 *2*	5.1 *2*	7.5 *2*	**15.6**
12/10	1.6	2.6	5.5	10.5	**20.2**	5.0 *2*	9.2 *2*	10.6 *2*	**24.8**
13/11	3.3	3.6	5.1	6.4	**18.4**	10.2 *2*	18.2 *2*	20.0 *2*	**48.4**
13/10	1.7	2.2	3.7	9.8	**17.4**	3.0 *0–1*	4.6 *2*	6.4 *3*	**14.0**
*13/9	2.7	4.4	B.B.	8.8	**15.9**	8.1 *2–3*	10.4 *3*	13.4 *3*	**31.9**
14/10	—	0.9	2.7	3.6	**7.2**	4.7 *0–1*	9.2 *1*	9.6 *1*	**23.5**
12/12	—	—	—	4.1	**4.1**	3.9 *0–1*	7.7 *1*	11.5 *1*	**23.1**

* Trees 16/12, 14/9, 13/9 and 15/10 are the mother trees of Clones 501, 504, 505 and 509 respectively.

is a closer relationship between the yields of the mother-trees and their clones, the correlation (for the total yield per tree) being +0.42.

The clones from trees 19/19 and 19/20 were selected in 1937 for large-scale testing and have been given the numbers R.R.I. 522 and 516 respectively. The second highest-yielding clone in

TABLE XVI

A. 44.B.84. Third Series. Yields of Mother-Trees and Yields of Clones made from them

Tree No.	Mother trees					Buddings			
	Yield in lb. per tree per annum					Yield in lb. per tree per annum			
	1935	1936	1937	1938	Total	1936	1937	1938	Total
20/19	8.3	13.6	19.2	23.6	**64.7**	5.2 *1*	8.5 *1*	10.3 *1*	**24.0**
21/19	8.5	11.9	14.5	27.5	**62.4**	4.3 *2*	7.0 *2*	7.5 *2*	**18.8**
21/21	7.3	11.6	18.1	23.6	**60.6**	2.9 *3*	6.6 *3*	8.9 *3*	**18.4**
19/2	5.1	11.0	17.8	18.6	**52.5**	6.4 *0–2*	11.0 *2*	10.4 *2*	**27.8**
18/23	7.5	12.4	16.3	14.9	**51.1**	3.8 *4–5*	6.7 *5*	7.8 *5*	**18.3**
30/24	3.5	8.8	20.1	18.2	**50.6**	5.2 *6*	9.4 *6*	10.6 *6*	**25.2**
17/20	6.8	8.5	12.3	22.1	**49.7**	5.2 *2–3*	7.2 *4*	8.6 *4–5*	**21.0**
18/22	7.4	10.2	17.4	13.2	**48.2**	2.7 *3–4*	5.0 *4*	5.0 *4*	**12.7**
17/25	6.8	5.8	12.6	22.2	**47.4**	4.8 *2*	7.7 *2–3*	4.8 *4*	**17.3**
21/20	5.7	8.9	13.4	15.2	**43.2**	3.7 *1–4*	3.7 *4*	4.1 *4*	**11.5**
19/22	6.3	9.8	13.2	11.5	**40.8**	4.9 *2–5*	8.2 *6*	8.8 *6*	**21.9**
18/24	7.1	8.6	11.4	12.0	**39.1**	6.1 *1–3*	7.7 *4*	8.5 *4*	**22.3**
29/22	3.9	7.3	13.0	12.8	**37.0**	3.1 *1*	6.1 *1*	8.2 *1*	**17.4**
20/22	4.2	7.4	9.8	15.1	**36.5**	3.6 *3–5*	6.3 *5*	8.8 *5*	**18.7**
16/2	—	5.7	9.7	14.4	**29.8**	3.0 *2–4*	5.3 *5*	7.5 *5–6*	**15.8**
18/21	2.3	3.5	7.0	16.5	**29.3**	1.2 *1*	4.5 *1*	4.2 *1*	**9.9**
29/23	3.5	5.5	9.5	10.6	**29.1**	2.0 *2–3*	3.0 *5*	3.1 *5*	**8.1**
19/25	4.5	5.9	9.7	8.6	**28.7**	3.0 *2*	4.3 *2*	4.0 *2*	**11.3**
18/20	5.9	5.1	10.4	6.1	**27.5**	— —	2.1 *1*	3.1 *2*	**5.2**
19/21	4.8	5.7	6.5	10.2	**27.2**	5.7 *1–2*	9.0 *2*	11.5 *2*	**26.2**

TABLE XVI (*Continued*)

Tree No.	Mother trees					Buddings			
	Yield in lb. per tree per annum					Yield in lb. per tree per annum			
	1935	1936	1937	1938	Total	1936	1937	1938	Total
21/23	3.9	7.3	8.0	7.0	**26.2**	2.4 *1–2*	3.7 *2*	3.0 *3*	**9.1**
19/19	2.4	3.3	7.5	11.8	**25.0**	6.3 *2*	12.4 *2*	11.8 *2*	**30.5**
20/23	3.7	5.4	7.7	6.5	**23.3**	2.4 *1–3*	2.7 *5*	3.2 *6*	**8.3**
27/24	2.9	4.4	7.4	8.2	**22.9**	4.9 *1–2*	9.9 *2*	8.9 *4*	**23.7**
19/24	4.8	4.8	6.6	6.3	**22.5**	4.7 *3*	4.9 *4*	4.1 *5*	**13.7**
29/24	3.3	5.0	5.5	5.2	**19.0**	4.5 *0–1*	5.4 *3*	6.8 *4*	**16.7**
19/23	3.2	5.9	7.0	B.B.	**16.1**	2.6 *3–4*	4.9 *4*	5.5 *4*	**13.0**
27/23	2.2	3.5	3.9	4.0	**13.6**	1.9 *0–3*	2.2 *4*	2.2 *5*	**6.3**
19/20	—	3.0	4.4	4.5	**11.9**	5.1 *2*	10.4 *2*	8.2 *3*	**23.7**
31/24	—	2.9	3.5	4.0	**10.4**	— —	5.8 *2–3*	5.0 *3*	**10.8**
17/22	1.6	1.6	3.2	2.3	**8.7**	2.6 *1–2*	5.1 *2*	5.8 *2*	**13.5**
17/24	—	2.3	2.7	2.5	**7.5**	2.6 *3*	4.2 *3*	4.8 *3*	**11.6**
21/24	—	1.9	2.5	2.9	**7.3**	— —	2.4 *2*	2.3 *2*	**4.7**
30/23	—	—	—	—	—	2.9 *4–5*	5.4 *6*	7.8 *6*	**16.1**

1937, derived from tree 19/2, has been rejected owing to its liability to suffer from storm damage, the trunks of three out of six buddings made having been broken at a few feet above the ground.

The clones were selected before the yields for 1937 and 1938 were available, and at that time there was no indication to what extent the precocity of A. 44 has been transmitted to the clones made from its seedlings. From the 1937 and 1938 yields it is clear that this precocious tendency had been inherited by several of the selected clones particularly by clones 504, 508, 509, 510, 513, 516, 517, 521 and 522.

A number of buddings of Avros 50 have been planted throughout Fields 14 A and B in which 19 of the selected clones are growing. This clone yielded during the first three tapping years 2.8 lb., 4.0 lb. and 5.0 lb. compared with 4.5, 7.0 and 8.8 lb. in Field 5. If the yields of Avros 50 can be regarded as a rough guide to the difference of soil fertility between the two fields it is very clear that the yields of the selected clones are greatly in excess of those of the highest yielding of the proved clones in the first three years of tapping.

TABLE XVII

Yield in lb. per Tree per annum of the first selection of Clones made from Legitimate Seedlings

Clone No.	Origin of Mother Tree	Yield in lb. per tree per annum				Clone No.	Origin of Mother Tree	Yield in lb. per tree per annum		
		1935	1936	1937	1938			1936	1937	1938
500	B84 × A44	5.6	13.1	15.9	17.9	512	B84 × A44	6.0	10.3	12.3
		3	*3*	*3*	*3–4*			*1–3*	*3*	*3*
501	A44 × Lun N	—	9.3	18.2	26.3	513	B16 × A44	8.0	19.2	16.5
			2	*2*	*2*			*1*	*1*	*1*
502	B16 × A44	3.8	9.1	8.7	13.5	514	A44 × B58	7.1	14.6	15.1
		4	*4*	*4*	*4*			*4*	*4–5*	*5*
503	A44 × B16	—	8.1	8.9	11.8	515	A44 × D61	6.4	13.9	11.4
			1–2	*2–3*	*3*			*3*	*3*	*5*
504	A44 × Lun N	—	8.6	13.8	12.4	516	B84 × A44	5.1	10.4	8.2
			4	*4*	*4*			*2*	*2*	*3*
505	,,	—	7.1	10.4	13.6	517	B84 × A44	4.8	8.5	4.9
			2–3	*3*	*3*			*2*	*2–3*	*4*
506	B84 × A44	—	7.6	13.8	16.1	518	D61 × A44	5.2	11.4	13.5
			3	*3*	*3*			*4*	*4*	*4–5*
507	,,	—	6.5	9.0	11.4	519	A44 × B16	6.3	10.5	12.5
			5	*5*	*5*			*2–3*	*4*	*4–5*
508	B16 × A44	2.6	6.5	8.2	8.0	520	,,	5.0	10.1	13.6
		4	*4*	*4*	*5*			*3*	*3*	*3*
509	A44 × Lun N	—	9.2	12.6	11.4	521	A44 × B58	5.2	9.4	7.5
			2–3	*4–5*	*5*			*5*	*5*	*5*
510	B58 × A44	—	7.9	10.2	9.7	522	B84 × A44	6.3	12.4	11.8
			1–2	*2*	*2*			*2*	*2*	*2*
511	A44 × B16	—	8.1	13.3	14.2					
			3	*3–4*	*5*					

Note. 1. Clones 500, 502 and 508 were tapped from July to December only in 1935, but the yields are estimated on 160 tappings.

Note. 2. Clones 500, 502 and 508 were budded in the field in November 1930. Clone 512 was budded in the field in June 1932.
The remaining clones were budded in the field in October—November 1931.

It must be understood that these results are from small-scale trials on a few trees only and none of these clones is yet regarded as sufficiently tested for use on a commercial scale.

(5) Note on the Production of New Clones

In concluding this paper a note on the establishment and selection of new clones from hand-pollinated seedlings may not be out of place.

Reference has already been made to the method of establishing new clones from legitimate seedlings by "disbudding"; that is to say by removing some of the dormant buds from the upper part of one-year-old seedling trees and budding them in the field on stocks previously prepared for the purpose. By these means clones of from three to six trees were made.

The next step is to select from these clones the most promising ones for testing on a comparatively large scale. Testing should where possible be carried out in several different places under different environmental conditions. After about five years of tapping the best of these clones should be sufficiently well tested for use on a small scale in commercial planting.

The more usual alternative method is to make a comparatively small number of clones from the best of the hand-pollinated seedlings selected after a short period of test-tapping. These are established in field trials and the best are selected for commercial use on a small scale after five years tapping.

The essential difference between the two methods is that by the first method selection is between clones and by the second method between clone mother-trees.

It is claimed that there are two advantages to be got from the first method; they are firstly that the correlation between the yields of clones and their mother-trees may be so low that some of the best clones would be missed and secondly that a much wider field for selection is obtained owing to the small number of trees of each clone that are necessary if the selection of the best clones takes place in two stages instead of in one stage.

The chief disadvantage is that the process of selection is slightly retarded; the difference however is not great and should not amount to more than six months to one year, which is not a very long time when it is considered that under the conditions on our Experiment Station it must take about 18 years from the time that the crosses are made until the clones made from them are sufficiently tested for commercial planting on a small scale. This is perhaps best illustrated by an example.

The first series of crosses were made in August—September 1928 and the seedlings resulting from these crosses were planted

in the field in February—May 1929. New clones were made by disbudding these seedlings in November 1930 and these were first brought into tapping in July 1935. Selections were made from these clones in 1937 and these were budded in the field for large-scale testing in October 1937, the budwood being cut from the original budded trees and used without previous multiplication. (Budwood multiplication nurseries were also established at the same time for testing these clones on other experimental areas in 1938 and 1939). The best of these clones should be ready for use on estates after about five years' tapping, that is to say by October 1947.

The mother-trees of these clones were first tapped in January 1935. If the same period of tapping is allowed before selection takes place, new clones would be established for budding in the field and testing on a large scale in April 1937. Allowing the same period of ten years for growing and testing these new clones they should be ready for use in commercial planting on a small scale by April 1947 or six months earlier than those selected by the disbudding method. This is a very small advantage when it is considered that a total period of about 18 years must elapse between the actual hand pollination and the completion of the testing of a new clone made from hand-pollinated seedlings and it would be more than compensated for by the advantages which have been claimed for this method.

A further disadvantage of the method by which clones are selected in two steps is that a larger area of land is required; if the land is available, this is not a great disadvantage for it should be capable of giving a sufficiently high yield to be commercially profitable.

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