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Performance of Dothidella-resistant Hevea Clones in Malaya

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All the Dothidella-resistant clones imported into Malaya were bred in South America at the plantations of the Ford Motor Company and the Instituto Agronomico do Norte. This paper reports only on the performance of the primary and secondary clones which were tested in Malaya.

Clones Ford 351, FX 25 and FX 2784 were found to be promising parents which could be used in a breeding programme aimed at combining high yield with resistance to Dothidella.

One of the main limiting factors to the cultivation of *Hevea brasiliensis* in the western hemisphere is South American leaf blight. This disease is caused by the fungus *Dothidella ulei* P. Henn.* The entire Ford plantation at Fordlandia, Brazil, planted mostly with unselected seedling trees, was devastated by South American leaf blight between 1933 and 1940, with only a few isolated trees retaining their leaves. All the seedlings were of Tapajos origin except for the resistant ones which were found to be selections raised from seeds collected from other regions of the Amazon valley (LANGFORD AND TOWNSEND, 1954). These resistant trees were cloned and they formed the nucleus of the Dothidella-resistant material in the neotropics. They were used as experimental crown clones in 1936 and, from 1940, for crown budding the second plantation of the Ford Motor Company at Belterra, Brazil, which was also severely damaged by leaf blight. In 1937, Ford initiated a breeding programme to combine resistance and yield by crossing their resistant selections with high-yielding clones selected in Southeast Asia. C.H.T. Townsend Jr., plant breeder of Ford plantation, made an expedition to the Rio Negro area and obtained there some valuable *H. benthamiana* material.

In 1946, the Company's plantations of Fordlandia and Belterra were purchased by the Brazilian Government, which operated them as sub-stations of the Instituto Agronomico do Norte and carried on the work (RANDS AND POLHAMUS, 1955) initiated by Ford.

Early selections made by Ford scientists are known as Ford clones and the prefix F has been used to denote them; to avoid confusion, however, the word Ford is now used in full where F would otherwise stand alone. For example, FB 3300 is *H. brasiliensis* of Belem origin and Ford 4542 is *H. benthamiana* of upper Rio Negro origin. The progenies of Ford crosses made before 1945 are prefixed FX and clones bred by Instituto Agronomico do Norte have the prefix IAN. The numbers Ford 1 to Ford 1999 and Ford 2000 to Ford 3999 were reserved for primary *H. brasiliensis* selection made in Fordlandia and Belterra respectively, the latter including some oriental selections of *H. brasiliensis*. Ford 4000 to Ford 4999, Ford 5000 to Ford 5999 and Ford 6000 to Ford 6999 were reserved for primary selections of *H. benthamiana, H. guianensis* and *H. spruceana* respectively. Ford Acre and Ford Belem series, abbreviated to FA and FB, were the primary *H. brasiliensis* selections from Acre and Belem districts in Brazil. Other series not mentioned here are FI (for Ford Illegitimate), FM (for Ford *microphylla*) and FP (for Ford *pauciflora*).

The Rubber Research Institute of Malaya imported during 1951/52 a number of Dothidella-resistant clones and *Hevea* seeds of South American origin from Brazil (BROOKSON, 1956). The performance of the clones made from the

*The fungus is now known as *Microcyclus ulei* P. Henn.

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seedlings imported has been reported earlier (SUBRAMANIAM, 1969). The performance of the clones imported is reported here. Further importations, comprising mainly the Dothidella-resistant IAN seires clones, were made by the R.R.I.M. between 1956 and 1958 (WYCHERLEY, 1968); reports on their performance will be made in future publications.

DESIGN AND MATERIALS

The clones were compared in three trials, only one of which was replicated. These were planted at the R.R.I.M. Experiment Station in Fields 60B, 57B and 60F.

The replicated trial in Field 60B consisted of three randomised blocks of eighteen treatments. The plot size of each treatment was 0.25 acre. Although twenty-five clones were imported, budwood of only seventeen clones was available in sufficient quantity for the trial. Furthermore, budding success with Ford 4506 was poor and the plots were planted with Tjir 1 illegitimate seedling stumps. Another clone (Ford 1638) was planted in a single observation plot for the same reason. Two clones of oriental selection, RRIM 501 and Tjir 1, were used as controls.

The unreplicated observation trial in Field 57B was planted as twelve-tree plots of fifteen Dothidella-resistant clones with RRIM 501 as control. Three of these fifteen clones — namely, Ford 1638, 4537 and 4506 — were not included in the replicated trial. The number of trees in each plot was subsequently thinned to ten trees prior to opening for tapping.

An additional observation trial similar to the one above was planted along part of the boundary of Field 60F for which the control clones were PB 86, Tjir 1 and RRIM 501. Only eight Dothidella-resistant clones were compared, of which FX 516 and FX 2831 were the only clones not included in the other two trials.

In the two trials in Fields 60B and 57B, the following observations were recorded: girth at opening, annual yield, girth increment and thickness of virgin and renewed bark. Wind damage and incidence of leaf disease were also observed. For the second observation trial in Field 60F, only the mean yield of the clones over the tapping period has been considered.

The trials were tapped on S/2.d/2.100% and yield was recorded by cup coagulation at two tappings every month. The number of recording trees in the replicated trial was sixteen located in the centre of the plot. The yields of all the trees in the observation trials were recorded.

RESULTS

The mean yield and girth increment during the first five years of tapping and the yield of the sixth year, the latter being the first year on the second panel, are given for the replicated trial *[Table 1(a)]*.

RRIM 501 was superior to all other clones in mean yield for the first five years of tapping. The other oriental clone, Tjir 1 and the F_1 Dothidella-resistant clone FX 25 ranked next. In the sixth year, the yield of FX 25 surpassed that of RRIM 501 (which retained the second place), with Ford 1619 becoming the third. Very low-yielding clones were FB 3300, Ford 351 and Ford 409.

FX 2784 and Ford 1619 showed the best girthing during tapping, while RRIM 501 was the poorest. Girth increments in clones FB 3300, Ford 351 and Ford 409 were high but not significantly better than that of FX 25.

Data on the girth at opening, girth after five years of tapping and thickness of virgin and renewed bark five years after tapping are given in *Table 1(b)*.

FX 25 had the greatest immature vigour, while Tjir 1 seedlings (planted as stumps later than the rest) and FB 3300 were the poorest. FX 25 and FX 2784 ranked best in girth after five years of tapping, with Tjir 1 seedlings and RRIM 501 ranking as the lowest.

For thickness of virgin and renewed bark, FX 714 and FX 2784 are the best of the imported clones, the clonal differences being not significant for virgin bark thickness.

Table 2(a) gives the mean annual yields of the clones for the observation trial in Field 57B. RRIM 501, FX 4425 and FX 25 gave the highest mean yields over four years of tapping. The low yielders were Ford 351, Ford 409, Ford 4537 and Ford 4506.

Clone performances by growth in girth and bark thickness are presented in *Table 2(b)*. The

TABLE 1A. YIELD AND GIRTH INCREMENT OF CLONES IN FIELD 60B

Rank	Yield over five years		Yield in sixth year of tapping		Girth increment over five years' tapping	
	Clone	Mean (g/tree/tapping)	Clone	Mean (g/tree/tapping)	Clone	Mean (inches)
1	RRIM 501	41.8	FX 25	62.6	FX 2784	11.4
2	Tjir 1	28.7	RRIM 501	46.2	Ford 1619	11.3
3	FX 25	28.7	Ford 1619	33.7	Ford 409	10.7
4	FX 4037	26.3	Tjir 1	33.2	Ford 351	10.2
5	FX 2784	24.6	FX 2784	31.4	FB 3300	10.2
6	FX 714	22.3	FX 714	28.8	FX 25	10.0
7	FX 664	22.3	FX 232	25.8	FB 3363	9.5
8	FX 652	18.4	FX 664	24.7	FX 714	9.2
9	Ford 1619	18.1	FX 4037	24.1	FX 360	8.8
10	Tjir 1 seedlings	16.5	FB 3363	21.3	FX 652	8.8
11	FX 636	15.4	FX 652	21.1	FX 4037	8.7
12	FX 360	13.7	Tjir 1 seedlings	20.4	Tjir 1 seedlings	8.6
13	FX 232	13.3	FX 636	14.3	FX 664	8.5
14	FB 3363	13.3	FX 4421	13.4	FX 4421	8.3
15	FX 4421	11.2	Ford 351	12.8	Tjir 1	8.2
16	Ford 351	9.8	FX 360	12.7	FX 232	7.5
17	Ford 409	7.5	Ford 409	7.5	FX 636	6.7
18	FB 3300	2.0	FB 3300	2.1	RRIM 501	5.0
	S.E.	1.57	S.E.	2.94	S.E.	0.46
	Min. sig. diff. (P = 0.05)	4.5	Min. sig. diff. (P = 0.05)	8.5	Min. sig. diff. (P = 0.05)	1.3

Note: For simplicity in presentation, the multiple range test lines have not been shown in *Tables 1(a)* and *1(b)*.

most vigorous clones before tapping were FX 2784 and FX 25. Ford 4537 was the poorest. The most vigorous clones during the immature period were also the ones with the best girth after four years of tapping. The clones Ford 351, Ford 409 and Ford 1619 had the highest girth increment, and RRIM 501 the lowest. In thickness of virgin and renewed bark after four years of tapping, clone FX 2784 was the leader.

The mean yield over the first four years of tapping for all the clones in the replicated and the two observation trials are presented in *Table 3*. The agreement in the ranking of the clones by yield in the three trials is good. FX 4037, FX 25 and FX 2784 were the leading occidental clones in each instance.

TABLE 1B. GIRTH AND BARK CHARACTERS OF CLONES IN FIELD 60B

Rank	Girth at opening		Girth after five years' tapping		Bark thickness after five years' tapping			
	Clone	Mean (inches)	Clone	Mean (inches)	Clone	Virgin (mm)	Clone	Renewed (mm)
1	FX 25	24.8	FX 25	34.8	FX 714	8.9	Tjir 1 seedlings	8.2
2	FX 232	23.3	FX 2784	33.9	Tjir 1	8.9	FX 714	7.7
3	FX 664	23.1	Ford 351	32.2	FX 2784	8.8	Tjir 1	7.4
4	FX 652	22.4	FB 3363	31.8	FX 652	8.2	FX 2784	7.3
5	FX 2784	22.4	FX 664	31.6	RRIM 501	8.1	Ford 1619	7.1
6	FB 3363	22.2	Ford 409	31.4	FX 25	7.9	FX 652	6.8
7	FX 636	22.0	FX 652	31.2	Ford 351	7.8	FX 360	6.6
8	Ford 351	21.9	Ford 1619	31.1	Ford 1619	7.7	FB 3300	6.5
9	FX 360	21.9	FX 232	30.8	Tjir 1 seedlings	7.6	FX 4037	6.3
10	RRIM 501	21.7	FX 360	30.8	FX 664	7.5	Ford 409	6.3
11	FX 4037	21.0	FX 4037	29.8	FX 360	7.4	FX 25	6.2
12	FX 4421	21.0	FX 4421	29.3	Ford 409	7.4	Ford 351	6.2
13	Ford 409	20.6	FX 714	29.3	FB 3300	7.4	FX 664	6.1
14	Tjir 1	20.3	FX 636	28.8	FX 4037	7.3	RRIM 501	6.0
15	FX 714	20.1	Tjir 1	28.5	FX 636	7.1	FX 4421	5.9
16	Ford 1619	19.8	FB 3300	28.3	FB 3363	7.1	FX 636	5.7
17	Tjir 1 seedlings	18.9	Tjir 1 seedlings	27.8	FX 4421	6.6	FB 3363	5.7
18	FB 3300	18.1	RRIM 501	26.8	FX 232	6.5	FX 232	4.7
	S.E.	0.54	S.E.	0.69	S.E.	0.83	S.E.	0.30
	Min. sig. diff. (P = 0.05)	1.5	Min. sig. diff. (P = 0.05)	2.0	Min. sig. diff. (P = 0.05)	2.4	Min. sig. diff. (P = 0.05)	0.9

DISCUSSION AND CONCLUSION

The superior mean yield of RRIM 501 on the first panel virgin bark is the result of its high yield during the first four years. FX 25, which lagged behind during the first four years, outyielded RRIM 501 *in the sixth year by* 35% (*Figure 1*). Often the yield per acre of RRIM 501 drops after the fourth year of tapping due to wind damage, but since yield is expressed here in grams per tree per tapping, wind damage has not influenced the drop in yield. The low incidence of wind damage of RRIM 501 *was due to the delayed opening of the trial* (*Figure 2*). The wind damage losses in FX 25

TABLE 2A. YIELD OF CLONES IN FIELD 57B

Rank	Clone \ Year tapped	Yield in g/tree/tapping				Mean
		1	2	3	4	
1	FX 4425	40.9	40.9	35.7	31.5	37.3
2	FX 25	15.3	24.8	39.1	64.3	35.8
3	FX 2784	20.6	24.1	26.1	30.5	25.3
4	FX 4037	21.2	24.4	18.7	21.7	21.5
5	FX 652	13.2	15.1	17.8	20.2	16.6
6	FX 664	15.3	15.3	15.8	19.2	16.4
7	Ford 1619	6.2	10.1	15.8	22.5	13.7
8	FX 360	13.9	15.0	12.7	12.7	13.6
9	FX 232	7.2	9.9	14.8	22.4	13.5
10	Ford 1638	7.2	9.4	13.4	22.7	13.2
11	FB 3363	6.2	8.3	11.3	16.6	10.6
12	Ford 351	3.0	5.2	10.5	17.2	9.0
13	Ford 409	3.2	6.8	10.0	13.8	8.4
14	Ford 4537	4.0	7.3	6.6	6.4	6.1
15	Ford 4506	3.0	6.4	4.3	4.4	4.5
	Mean	12.0	14.9	16.8	21.7	16.3
	RRIM 501	41.6	42.2	50.2	56.2	47.5
	S.E.	2.31				
	Min. 5 sig. diff. (P = 0.05)	6.9				

were mainly uprooting. Though Ford 351 is a poor yielder in both trials, it is a parent of FX 25 and thus it may be useful as a parent in a programme of breeding of Dothidella-resistant material. In support of this contention, HOLLIDAY (1967) reported Ford 351 and FX 25 resistant to Dothidella in Trinidad, while BOS AND MCINDOE (1965) who used FX 25 and FX 232 (both progeny of Ford 351) as parents in the Firestone breeding programme have reported that on an average about 1.2% of the progeny were resistant to Dothidella when tested against the disease in Guatemala. SUBRAMANIAM (1969) found that the illegitimate progeny of FX 25 was the highest yielding material in one trial and one selection made from this population had reached the final stage of testing at the R.R.I.M.

As Ford 351 and FX 25 are of less than average susceptibility to Oidium and Gloesporium

TABLE 2B. GIRTH AND BARK CHARACTERS OF CLONES IN FIELD 57B

Rank	Girth at opening		Girth after four years' tapping		Girth increment over four years' tapping		Bark thickness after four years' tapping			
	Clone	Mean (inches)	Clone	Mean (inches)	Clone	Mean (inches)	Clone	Virgin (mm)	Clone	Renewed (mm)
1	FX 2784	27.0	FX 2784	31.5	Ford 351	6.1	FX 2784	8.9	FX 2784	7.2
2	FX 25	26.8	FX 25	31.2	Ford 409	5.8	RRIM 501	8.7	FX 360	6.7
3	FX 664	25.6	Ford 409	31.0	Ford 1619	5.6	FX 25	8.3	FX 4037	6.5
4	Ford 409	25.2	FX 664	29.7	FX 232	5.1	Ford 351	8.2	Ford 4506	6.5
5	RRIM 501	24.8	FX 232	29.7	Ford 1638	4.9	FX 4037	8.1	FX 664	6.5
6	FX 4425	24.7	Ford 351	28.7	FB 3363	4.7	FX 360	7.9	FX 25	6.5
7	FX 232	24.6	Ford 1619	27.6	FX 2784	4.5	FX 652	7.9	RRIM 501	6.2
8	FX 652	23.4	FX 652	27.2	FX 25	4.4	Ford 1638	7.8	FX 652	6.1
9	Ford 351	22.6	FX 4425	26.5	FX 664	4.1	FX 664	7.8	FX 4425	6.0
10	Ford 1619	22.0	FB 3363	26.4	Ford 4506	3.9	Ford 4506	7.5	Ford 351	5.9
11	FB 3363	21.7	Ford 1638	26.3	FX 652	3.8	Ford 409	7.5	Ford 409	5.4
12	Ford 1638	21.4	RRIM 501	25.8	FX 4037	3.8	FX 4425	7.3	Ford 1619	5.4
13	FX 4037	19.2	FX 4037	23.0	FX 360	3.4	Ford 4537	6.8	Ford 4537	5.3
14	FX 360	18.4	FX 360	21.8	FX 4425	1.8	FX 232	6.5	Ford 1638	4.9
15	Ford 4506	16.8	Ford 4506	20.7	Ford 4537	1.8	Ford 1619	6.3	FB 3363	4.7
16	Ford 4537	14.2	Ford 4537	16.0	RRIM 501	1.0	FB 3363	6.2	FX 232	4.5

leaf diseases (*Figure 2*), they could become promising parents in a breeding programme against these diseases. YOON (1967) noted increased yield of certain panel clones when FX 25 was used as a crown.

FX 25 has been planted on a commercial scale in Brazil, but little information about its resistance to Dothidella has been published. However, Dr P. de T. Alvim (see SUBRAMANIAM, 1969) has reported that the clone had been severely attacked by Dothidella in the Bahia State of Brazil; perhaps a new strain of the fungus was involved in this case.

Clone FX 4425 is high-yielding in the only trial in which it is represented but has had a falling yield trend after the second year. FX 2784, though not in the highest yielding bracket, is another clone of promise. It has the best girth increment during tapping and the best bark characters. It has also been noted as resistant to Dothidella in Guatemala (ROSS, 1967). This clone suffered less than 1 % wind damage in the R.R.I.M. trials, and had below average susceptibility to Oidium and average susceptibility to Gloeosporium. In a laboratory test, CHEE (1968) found FX 2784 to be less susceptible to

TABLE 3. YIELD OF CLONES OVER FOUR YEARS FOR THE THREE TRIALS AND CORRELATIONS BETWEEN THEM

Trial / Clone	Yield in g/tree/tapping		
	Field 60B	Field 57B	Field 60F
RRIM 501	39.5		42.2
Tjir 1	27.1		23.5
FX 4037	25.4	21.5	26.5
FX 25	23.3	35.8	20.9
FX 2784	22.9	25.3	19.6
FX 714	21.2		
FX 664	20.3	16.4	
FX 652	16.4	16.6	13.0
Tjir 1 seedlings	15.3		
Ford 1619	14.5	13.7	
FX 636	13.6		
FX 360	12.8	13.6	
FB 3363	11.3	10.6	9.4
FX 232	10.9	13.5	9.5
FX 4421	10.2		
Ford 351	7.7	9.0	
Ford 409	6.1	8.4	
FB 3300	1.3		
FX 4425		37.3	
Ford 1638		13.2	
Ford 4537		6.1	
Ford 4506		4.5	
PB 86			23.9
FX 516			15.4
FX 2831			15.2
Correlation coefficient and degrees of freedom in brackets	0.84**[9] (Field 60B–Field 57B)	0.71 N.S.[4] (Field 57B–Field 60F)	
	0.98***[6] (Field 60B–Field 60F)		

** : P < 0.01 *** : P < 0.001 N.S. : Not significant

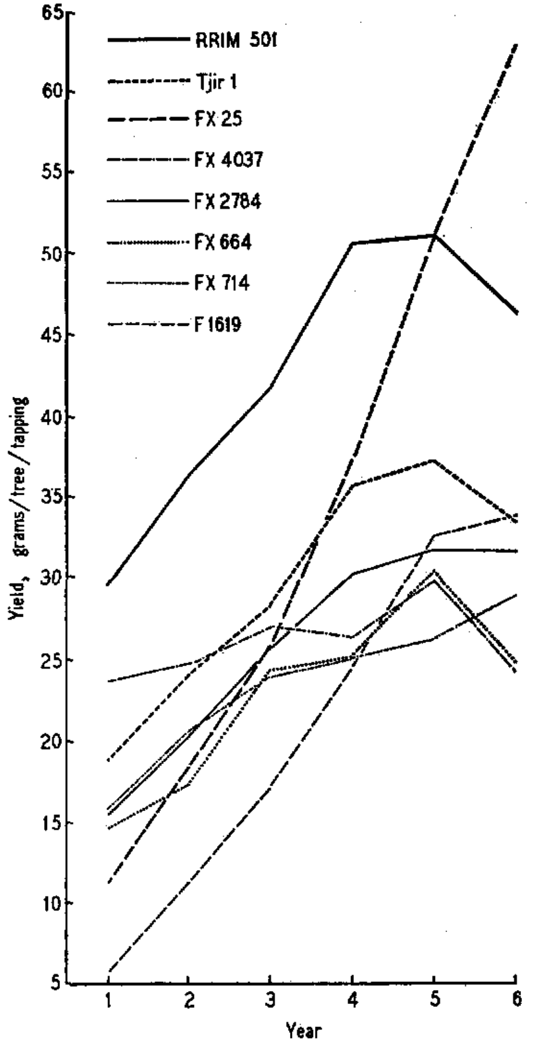

Figure 1. Yield trend of clones in Field 60B.

Phytophthora but its field response is still not known.

Ford 1619, a primary clone, was low-yielding during the initial years of tapping but rose up to be among the best in the later years. The low initial yield of this clone may be due to its poor immature vigour, and the excellent girth increment during tapping has been responsible for its high yield in the later years of tapping.

The clones FX 25 and Ford 1619 display a rising yield trend.

The results presented here indicate that clones FX 25, FX 2784 and Ford 351 could be exploited as parents in a breeding programme for combining Dothidella-resistance from the various sources with high yield.

The susceptibility of FX 25 and its parent, Ford 351 in Brazil — although they are still resistant in Guatemala and Trinidad — precludes their use as the sole source of resistance. Similar

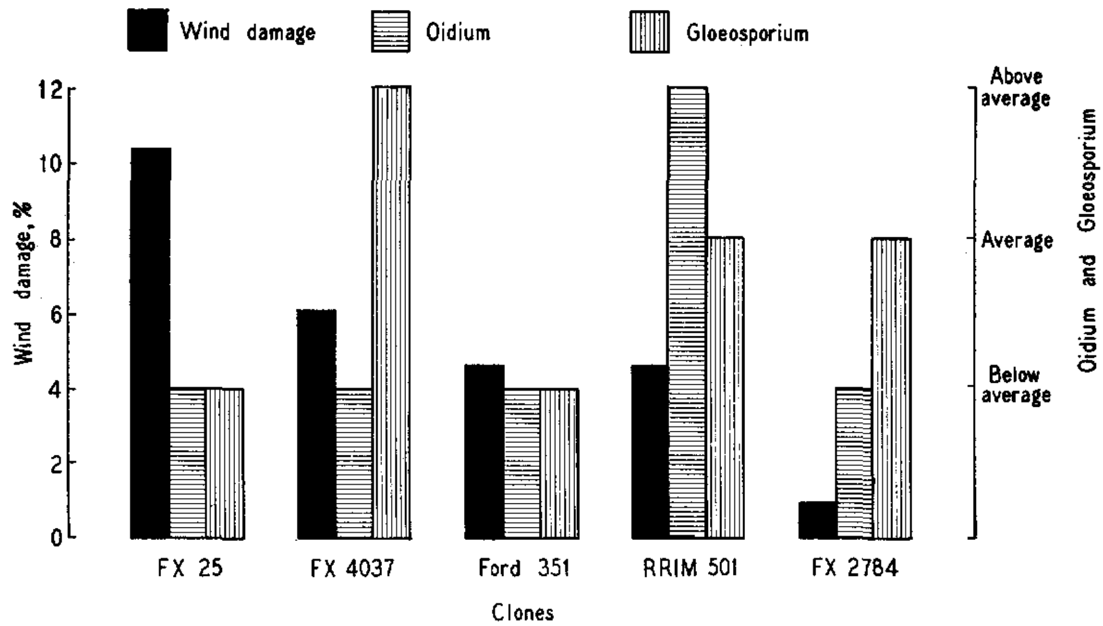

Figure 2. Incidence of wind damage and leaf diseases.

arguments apply to other sources of Dothidella-resistance such as Ford 409, the Madre de Dios Firestone clones or the widely used Ford 4542 and its progeny such as FX 2784 (MILLER, 1966). Future programmes must therefore combine resistance from several sources, instead of relying upon recurrent back-crossing from only one resistant parent.

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