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(54) IMPROVEMENTS IN THE EXTRACTION OF RUBBER LATEX FROM *HEVEA BRASILIENSIS*

(71) We, THE BOARD OF THE RUBBER RESEARCH INSTITUTE OF MALAYA, a Body Corporate organised under the laws of Malaysia, of 3rd Mile Ampang Road, Kuala Lumpur, Malaysia, and AM-CHEM PRODUCTS INC., a Corporation organised under the laws of the Commonwealth of Pennsylvania, United States of America, of Brookside Avenue, Ambler, Pennsylvania, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a method of extracting rubber latex from the rubber-bearing *Hevea brasiliensis* in which low intensity tapping systems are used in conjunction with chemical treatments to enhance latex flow.

The object of the invention is to decrease the cost of exploiting rubber-bearing *Hevea brasiliensis* by increasing the yield relative to the cost of exploitation, either by increasing the yield per acre in absolute terms without a proportionate increase in costs, or by maintaining a reasonable yield with reduced costs.

As is well known, latex is obtained from *Hevea brasiliensis* by making a cut in the bark of the trunk and re-opening this cut periodically. A version of this procedure which is in wide use employs a sloping cut extending over one half of the circumference of the tree and opened every alternate day. This procedure of exploitation is known as the half alternate daily system of tapping, abbreviated to S/2.d/2. This system is conventionally said to represent a "tapping intensity" of 100%. It is possible to use longer cuts or more frequent re-opening of cuts: either alteration is said to raise the tapping intensity relative to S/2.d/2 or to above 100%. Similarly, the use of shorter cuts or the re-opening of half spiral cuts less frequently than every alternate day are said to lower the tapping

intensity, i.e. the tapping intensity is less than 100%. Low intensity tapping systems, i.e. tapping systems having an intensity substantially less than 100%, require less labour and consume less bark than the conventional half spiral, alternate daily system but hitherto have given reduced and unacceptably reduced yields of latex. Thus, latex flow from tapping cuts of less than half spiral length normally ceases rapidly and consequently yields are low. Yields are also low when half spiral cuts are tapped less frequently than alternate daily (d/2).

It is also known that certain chemical treatments may be applied to rubber-bearing *Hevea brasiliensis* which have the effect of enhancing latex flow when used in conjunction with conventional tapping systems, for example S/2.d/2; some of these treatments are economically advantageous although others are of limited usefulness in practice as a result of the relatively high cost of the treatment in relation to the increase of yield obtained.

Surprisingly, we have now found that where low intensity tapping systems are used in conjunction with chemical treatments that enhance latex flow, the reduction in yield normally associated with such tapping systems as compared with a 100% tapping intensity is reduced, in many cases very markedly so. Not only can acceptable or in many cases enhanced yields be obtained with low tapping intensities, with the resultant obvious economies, but in the case of certain treatments the yield is so well maintained with decreasing tapping intensity that treatments which would not be commercially viable with conventional tapping techniques become economically attractive. The low intensity tapping systems comprise, for example, the use of one third, one quarter and one eighth spirals (S/3, S/4 and S/8) and/or less frequent tapping e.g. fourth daily and sixth daily (d/4 and d/6). The chemical substances used to enhance latex flow comprise growth substances which cause ethylene or acetylene to be released in or

in close proximity to the latex-bearing tissues of the tree: for example, ethylene, acetylene, and substances which release ethylene by hydrolysis, for example, 2-chloroethyl phosphonic acid and the *n*-butyl ester of 2,4,5-trichlorophenoxyacetic acid are effective.

The present invention accordingly provides a method of extracting rubber latex from rubber-bearing *Hevea brasiliensis* which method comprises subjecting the tree to a chemical treatment by applying to the tree a substance which causes ethylene or acetylene to be released in or in close proximity to the latex-bearing tissues of the tree, and tapping the tree on a low intensity system as hereinbefore defined.

The invention is further described and illustrated by the following examples and Figures 1—11 of the accompanying drawings which are graphs indicating the yields obtained from rubber trees subjected to various methods of tapping, mostly in accordance with the invention, as compared to conventionally tapped controls not subjected to chemical treatment.

Example 1

Acetylene, originating from calcium carbide, was applied to trees of *Hevea brasiliensis*. (For this purpose we used the apparatus (applicator) described in our British Patent Specification No. 1192528: Method and Apparatus for Applying a Gas to a Tree.). 2-Chloroethyl phosphonic acid, which releases ethylene by

hydrolysis was applied to another group of trees of *Hevea brasiliensis*. (In this case the applicators were modified to allow direct contact between the bark and a solution of the 2-chloroethyl phosphonic acid). The well-known yield stimulant, *n*-butyl ester of 2,4,5-trichloro-phenoxy acetic acid (2,4,5—T) was also applied to a third group of trees, on scraped bark.

The trees treated were of mixed clothes budded in 1951 and currently tapped on the first panel of bark of first renewal. In the case of acetylene, 60 g. of calcium carbide were used with each tree. In the case of 2-chloroethyl-phosphonic acid, 3 ml. dissolved in 21 ml. of propylene glycol were applied to each tree. In the case of the *n*-butyl ester of 2,4,5—T, 17 mgm. of a formulation containing 1% by weight acid-equivalent of 2,4,5—T in palm oil were applied to each tree. With each treatment the tapping systems shown in Table 1 were employed. Each combination of tapping system and treatment was applied to 10 trees. A like number of control trees were tapped on the conventional half-spiral, alternate daily system (S/2.d/2) without chemical treatment.

Table 1 shows the comparative yields, expressed as pounds of rubber per acre for the first two months after application of the stimulants, with the relationship to control, as a percentage, in parentheses.

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TABLE 1

Adjusted yield in lbs/acre/two months

(Figures in parenthesis relative to S/2.d/2.100% untreated as a percentage)

Tapping system	Intensity	<i>n</i> -butyl ester of 2,4,5-T	2-chloroethyl phosphonic acid	Acetylene derived from calcium carbide
S/2.d/2	100%	618 (126)	693 (141)	591 (120)
S/4.d/2	50%	264 (54)	536 (109)	550 (112)
S/8.d/2	25%	176 (36)	475 (97)	357 (73)
*5 mm d/2	1%	41 (9)	193 (39)	178 (36)
S/2.d/4	50%	300 (61)	673 (137)	476 (97)
S/4.d/4	25%	169 (34)	457 (93)	296 (60)
S/8.d/4	12.5%	84 (17)	320 (65)	278 (57)
*5 mm d/4	0.5%	61 (12)	186 (38)	60 (12)
S/2.d/2.(2×2d/4)	100%	640 (130)	901 (183)	730 (148)
S/4.d/2.(2×2d/4)	50%	360 (73)	596 (121)	591 (120)
×4×5 mm d/2.(2×2d/4)	4%	259 (53)	556 (113)	389 (79)

*A 5 millimetre cut to the wood is opened at every tapping.

×Eight 5 mm cuts are made on the tree; four are tapped on one tapping day and four on the other; tapping is done only on alternate days; each of the two groups of four cuts is tapped only every fourth day.

5 Figures 1—11 illustrate the comparative yield trends relative to control for the tapping systems in Table 1 over the same two month period.

10 It can be seen that the yields obtained from several of the systems using shorter tapping cuts (e.g. S/4) and/or less frequent tapping of cuts of conventional length (e.g. S/2.d/4), in conjunction with acetylene or 2-chloroethyl phosphonic acid are comparable even with the yields obtained from the conventional S/2.d/2 system without concomitant chemical treatment. When the low intensity systems are used in conjunction with the well known stimulant *n*-butyl ester of

2,4,5—T the yields are lower but still substantial and greater than would be expected by the use of the low intensity systems without concomitant chemical treatment.

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Example 2

2-chloroethyl phosphonic acid was mixed in palm oil to give a final concentration of 6.7% by weight of the active ingredient. This formulation was applied to bark of *Hevea brasiliensis* trees of assorted clones. The trees were in three groups and the application was made at a different position on the trunks in each group as indicated in Table 2.

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TABLE 2

Adjusted yield in grams/tree/tapping

(Figures in parenthesis relative to S/2.d/2.100% untreated as a percentage)

Tapping system	Intensity	Applied to scraped bark below cut	Applied to renewing bark above tapping cut	Applied to scraped bark above stock/scion union
S/2.d/2	100%	100.9 (176)	74.5 (130)	79.2 (138)
S/4.d/2	50%	59.8 (104)	48.8 (85)	96.6 (168)

In each case the width of the band of bark to which application was made was $1\frac{1}{2}$ " ; its length was the same as the length of the cut. Two tapping systems (S/2.d/2 and S/4.d/2) were used with each group of trees and the yields obtained were compared with a control group of trees tapped on S/2.d/2 but receiving no chemical treatment.

Table 2 gives results for two months and shows that direct application of 2-chloroethyl phosphonic acid in palm oil is effective. This provides an alternative procedure to the use of the modified applicator employed in Example 1. Direct application is actually simpler and therefore more attractive in practice.

In further experiments different concentrations (6.7%, 10% and 13.3% by weight) of 2-chloroethyl phosphonic acid in palm oil were tested. It was found that a concentration of 10% was convenient and effective generally. The precise optimum concentration varies somewhat with different clones and seedlings of *Hevea brasiliensis* in different situations and could be determined experimentally in a given case if desired.

As a carrier for 2-chloroethyl phosphonic acid palm oil may be substituted by other fluids or vegetable, animal or mineral oils or greases whose suitability may be determined experimentally in individual cases.

Example 3

Trees of clone PR 107 currently tapped on the second panel of virgin bark, were treated with the *n*-butyl ester of 2,4,5-T (see Example 1) and with 10% by weight of 2-chloroethyl phosphonic acid mixed in palm oil.

There were six groups each of 20 trees: one group was tapped on S/2.d/2 and another on S/4.d/2(2×2d/4) without chemical treatment. These served as controls. The low intensity tapping system S/4.d/2(2×2d/4) is further explained as follows: the existing half spiral cuts on the trees were divided into two halves of quarter spiral length (S/4); the upper and lower halves were tapped in alternation, each quarter spiral being tapped once in four days (2×2d/4); each tree was thus tapped alternate daily on a quarter spiral (S/4.d/2).

One group of trees on S/2.d/2 and one on S/4.d/2(2×2d/4) was treated with the *n*-butyl ester of 2,4,5-T applied to scraped bark immediately below the half spiral length of the cut. The band of scraped bark below the cut was $1\frac{1}{2}$ " wide.

One group of trees on S/2.d/2 and one on S/4.d/2(2×2d/4) was treated similarly with 10% 2-chloroethyl phosphonic acid mixed in palm oil. The chemical treatments were repeated every two months.

Table 3 shows the results over five months.

TABLE 3

Adjusted yield in grams/tree/tapping.

(Figures in parenthesis relative to S/2.d/2.100% untreated as a percentage)

Tapping System	Intensity	Untreated	<i>n</i> -butyl ester of 2,4,5-T	2-chloroethyl phosphonic acid
S/2.d/2	100%	(100)	28.7 (146)	35.3 (180)
S/4.d/2. (2×2d/4)	50%	(85)	23.5 (120)	34.7 (177)

The yield from S/2.d/2 tapping is increased by the well-known stimulant *n*-butyl ester of 2,4,5—T and increased still more by 2-chloroethyl phosphonic acid mixed in palm oil (consistently with our co-pending application No. 50185/68 (Serial No. 1,281,524): "A method of stimulation of rubber yield in *Hevea brasiliensis*"). The low intensity tapping system S/4.d/2(2×2d/4) gives only 85% of the yield from S/2.d/2 but this is increased to 120% by treatment with the *n*-butyl ester of 2,4,5—T and to 177% by 2-chloroethyl phosphonic acid.

Thus the use of this low intensity tapping system in conjunction with chemical treatment allows of an *improved* yield compared with conventional tapping: the yield is greatly improved when the chemical treatment in-

volves 2-chloroethyl phosphonic acid which causes ethylene to be released.

Example 4

Trees of close RRIM 501, currently tapped on the first panel of bark of first renewal, were treated with the *n*-butyl ester of 2,4,5—T and with 10% by weight 2-chloroethyl phosphonic acid mixed in palm oil.

There were nine groups each of 50 trees. There were three tapping systems: S/2.d/2, S/4.d/2 and S/8.d/2. For the S/4 system only the lower half of the original half spiral cuts on each tree was tapped; for the S/8 system only the lowest quarter of the original half spiral was tapped.

Table 4 shows the results over one month, which confirm and extend those of Example 3.

TABLE 4

Adjusted yield in grams/tree/tapping

(Figures in parenthesis relative to S/2.d/2.100% untreated as a percentage)

Tapping System	Intensity	Untreated	<i>n</i> -butyl ester of 2,4,5-T	2-chloroethyl phosphonic acid
S/2.d/2	100%	87.9 (100)	131.1 (149)	162.4 (185)
S/4.d/2	50%	45.7 (52)	78.4 (89)	115.5 (131)
S/8.d/2	25%	26.5 (30)	50.6 (58)	75.4 (85)

Progressive reduction of tapping intensity reduces yield as expected; such systems give much higher yields in conjunction with the *n*-butyl ester of 2,4,5—T and very much higher yields in conjunction with 2-chloroethyl phosphonic acid. Thus, even with S/8.d/2. (25% intensity) the yield under treatment with 2-chloroethyl phosphonic acid reaches 85% of that from untreated trees tapped on the conventional S/2.d/2 (100%) system.

Example 5

Besides the use of applicators and palm oil and other formulations of chemical substances designed to enhance latex flow with low intensity tapping systems, other methods of applying the appropriate chemical substances

are of interest and we have found several to be feasible.

For example we have sprayed 2-chloroethyl phosphonic acid on bark and also injected it into holes drilled into the wood (xylem tissues) of the tree. In the case of spraying, the substance was dissolved in water with or without emulsified dibutyl phthalate; in the case of injection it was applied as a 48% by weight solution in propylene glycol.

Injection was the more effective of these two procedures, giving excellent yield increases compared with untreated controls and producing highly satisfactory results with low intensity tapping systems.

Table 5 gives results from the use of 2-chloroethyl phosphonic acid by injection over one year.

TABLE 5

Adjusted yield in grams/tree/tapping

(Figures in parenthesis relative to S/2.d/2. 100% untreated as percentage)

Tapping System	Intensity	Treatment with 2-chloroethyl phosphonic acid by injection	Yield
S/2.d/2	100%	None	67.5 (100)
S/2.d/2	100%	0.48g/tree/2 mths	113.0 (167)
S/2.d/2	100%	0.96g/tree/2 mths	124.2 (184)
S/4.d/2	50%	0.48g/tree/2 mths	85.6 (127)
S/4.d/2	50%	0.96g/tree/2 mths	106.3 (157)

The trees were of assorted clones; each treatment was carried out on 8 trees, with 8 untreated trees tapped S/2.d/2 serving as control. There were two tapping systems S/2.d/2 and S/4.d/2 and two levels of dose of 2-chloroethyl phosphonic acid: 0.48 grams (1 ml of solution) per tree once every two months and 0.96 grams (2 ml of solution) per tree once every two months.

As Table 5 plainly shows, injected 2-chloroethyl phosphonic acid increases yield from trees tapped on S/2.d/2 and also produces from trees tapped on the low intensity system, S/4.d/2, yields well *above* that of untreated trees tapped on S/2.d/2.

Example 6

In this example several of the procedures already described were applied to large blocks (48 trees per treatment) of trees of three different clones. For each clone there was a control group of 48 untreated trees tapped S/2.d/2. Table 6 shows the results over 6 months.

In this example the trees of clones Tjir 1 and PB 86 were tapped on the first panel of bark of first renewal and those of clone RRIM 600 on the first panel of virgin bark. The tapping system S/4.d/2 (2×2d/4) was as described in Example 3. For the tapping system S/3.d/2 (2×2d/4) the existing half spiral cuts on the trees were lengthened to two-third spirals; these were divided into two halves of third spiral length; the upper and lower halves were then tapped in alternation, each third spiral being tapped once in four days (2×2d/4) and each tree being tapped alternate

daily on a third spiral S/3.d/2). For the system S/3.d/4 (2×4d/8) the same configuration of cut was used, but each one third spiral was tapped once in eight days (2×4d/8) and each tree once in four days on a third spiral S/3.d/4). The system S/R.d/6 employed a single three-quarter spiral cut, tapped once in six days.

Treatments with 2-chloroethyl phosphonic acid were made by applying the substance mixed in palm oil at 10% by weight concentration to scraped bark immediately below the full length of the cut. For application below half spiral cuts, whether or not divided into two quarter spirals, the band of scraped bark was 1½" wide. For application below two-third spiral cuts, as in the system S/3.d/2 (2×2d/4) the band of scraped bark was 1¼" wide. For application below three-quarter spiral cuts (S/R), the band of scraped bark was 1" wide. These variations ensured that, regardless of the length of cut, the area of bark treated was the same on all trees. This was desirable for our experimental purposes but in practical use such rigid control of band width is unnecessary.

Application of acetylene from carbide (30 g per tree) was made with an applicator similar to that used in Example 1 but with the modification that the frame was of foam rubber instead of expanded polystyrene.

The results in Table 6 show that with all the low intensity tapping systems, used in conjunction with the chemical treatments, the yields are raised above what would be expected from these systems without chemical treatment.

TABLE 6

Tapping System	Intensity	Treatment (% are by weight)	Yield from clones, as percentage of S/2.d/2. untreated control (100)		
			Tjir 1	PB 86	RRIM 600
S/2.d/2	100%	10% CEPA*	193	225	132
S/2.d/2	100%	acetylene	194	157	124
S/2.d/4	50%	10% CEPA	167	175	132
S/2.d/4	50%	acetylene	86	108	100
S/2.d/6	33%	10% CEPA	146	156	114
S/2.d/6	33%	acetylene	54	78	68
S/4.d/2.(2×2d/4)	50%	10% CEPA	198	194	128
S/4.d/2.(2×2d/4)	50%	acetylene	130	128	112
S/3.d/2.(2×2d/4)	67%	10% CEPA	223	215	141
S/3.d/2.(2×2d/4)	67%	acetylene	162	157	126
S/3.d/4.(2×4d/8)	33%	10% CEPA	188	174	125
S/3.d/4.(2×4d/8)	33%	acetylene	64	94	88
S/R+.d/6	50%	10% CEPA	171	169	116
S/R.d/6	50%	acetylene	78	117	102

*CEPA = 2-chloroethyl phosphonic acid

+ S/R = three-quarter spiral

Especially noteworthy are the very high yields obtained with the shorter tapping cuts e.g. in the systems S/4.d/2 (2×2d/4) and S/3.d/2 (2×2d/4) used in conjunction with 2-chloroethyl phosphonic acid. The yields with this (and other) systems used in conjunction with acetylene are lower, but would still be acceptable.

Also noteworthy are the yields from the systems of low frequency, S/2.d/6 and S/R.d/6, which would permit a large reduction in cost of tapping.

WHAT WE CLAIM IS:—

1. A method of extracting rubber latex from rubber-bearing *Hevea brasiliensis* which method comprises subjecting the tree to a chemical treatment by applying to the tree a substance which causes ethylene or acetylene to be released in or in close proximity to the latex-bearing tissues of the tree, and tapping

the tree on a low-intensity system as hereinbefore defined.

2. A method as claimed in claim 1 in which the chemical treatment is the application of ethylene or of a substance which releases ethylene by hydrolysis.

3. A method as claimed in claim 1 in which the chemical treatment is the application of the *n*-butyl ester 2,4,5-trichlorophenoxy acetic acid.

4. A method as claimed in claim 1 in which the chemical treatment is the application of acetylene gas.

5. A method as claimed in claim 4 in which the acetylene gas is generated from calcium carbide.

6. A method as claimed in claims 1 and 2 in which the chemical treatment is the application of 2-chloroethyl phosphonic acid.

7. A method as claimed in claim 6 in which the 2-chloroethyl phosphonic acid is applied

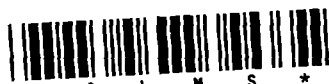


TABLE 6

Tapping System	Intensity	Treatment (% are by weight)	Yield from clones, as percentage of S/2.d/2. untreated control (100)		
			Tjir 1	PB 86	RRIM 600
S/2.d/2	100%	10% CEPA*	193	225	132
S/2.d/2	100%	acetylene	194	157	124
S/2.d/4	50%	10% CEPA	167	175	132
S/2.d/4	50%	acetylene	86	108	100
S/2.d/6	33%	10% CEPA	146	156	114
S/2.d/6	33%	acetylene	54	78	68
S/2.d/2.(2×2d/4)	50%	10% CEPA	198	194	128
S/2.d/2.(2×2d/4)	50%	acetylene	130	128	112
S/2.d/2.(2×2d/4)	67%	10% CEPA	223	215	141
S/3.d/2.(2×2d/4)	67%	acetylene	162	157	126
S/3.d/4.(2×4d/8)	33%	10% CEPA	188	174	125
S/3.d/4.(2×4d/8)	33%	acetylene	64	94	88
S/R+.d/6	50%	10% CEPA	171	169	116
S/R.d/6	50%	acetylene	78	117	102

*CEPA = 2-chloroethyl phosphonic acid

+ S/R = three-quarter spiral

Especially noteworthy are the very high yields obtained with the shorter tapping cuts e.g. in the systems S/4.d/2 (2×2d/4) and S/3.d/2 (2×2d/4) used in conjunction with 2-chloroethyl phosphonic acid. The yields with this (and other) systems used in conjunction with acetylene are lower, but would still be acceptable.

Also noteworthy are the yields from the systems of low frequency, S/2.d/6 and S/R.d/6, which would permit a large reduction in cost of tapping.

WHAT WE CLAIM IS:—

1. A method of extracting rubber latex from rubber-bearing *Hevea brasiliensis* which method comprises subjecting the tree to a chemical treatment by applying to the tree a substance which causes ethylene or acetylene to be released in or in close proximity to the latex-bearing tissues of the tree, and tapping

the tree on a low-intensity system as hereinbefore defined.

2. A method as claimed in claim 1 in which the chemical treatment is the application of ethylene or of a substance which releases ethylene by hydrolysis.

3. A method as claimed in claim 1 in which the chemical treatment is the application of the *n*-butyl ester 2,4,5-trichlorophenoxy acetic acid.

4. A method as claimed in claim 1 in which the chemical treatment is the application of acetylene gas.

5. A method as claimed in claim 4 in which the acetylene gas is generated from calcium carbide.

6. A method as claimed in claims 1 and 2 in which the chemical treatment is the application of 2-chloroethyl phosphonic acid.

7. A method as claimed in claim 6 in which the 2-chloroethyl phosphonic acid is applied

- in admixture with a fluid, oil or grease as carrier.
- 5 8. A method as claimed in claim 7 in which the 2-chloroethyl phosphonic acid is admixed with palm oil.
9. A method as claimed in claim 6 in which 2-chloroethyl phosphonic acid is sprayed on the bark of the trees in solution in water.
- 10 10. A method as claimed in claim 9 in which the solution contains dibutyl phthalate.
11. A method as claimed in claim 6 in which 2-chloroethyl phosphonic acid is injected into a hole drilled into the wood of the tree.
- 15 12. A method as claimed in any of the preceding claims in which the low-intensity tapping system comprises the use of a tapping cut shorter than the half spiral.
13. A method as claimed in any of the preceding claims in which the low-intensity tapping system comprises the use of a tapping frequency less than alternate daily.
14. A method as claimed in claim 1, and substantially as hereinbefore described in any of Examples 1 to 6.
15. Rubber-bearing *Hevea brasiliensis* when treated by the methods claimed in any one of claims 1 to 14.
16. Latex obtained by the method of any of claims 1 to 14.
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