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(54) A METHOD OF STIMULATION OF RUBBER YIELD IN
HEVEA BRASILIENSIS

(71) We, THE RUBBER RESEARCH INSTITUTE OF MALAYA, a Body Corporate of Malaysia, of 3rd Mile Ampang Road, Kuala Lumpur, Malaya, and AMCHEM PRODUCTS, INC., a Corporation organized under the laws of the State of Pennsylvania, United States of America, of Brookside Avenue, Ambler, State of 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 the treatment of rubber-bearing *Hevea brasiliensis*.

The invention provides a method of treating rubber-bearing *Hevea brasiliensis* for the purpose of stimulation of yield of rubber latex therefrom, which method comprises applying thereto a substance, other than a substance in the following list, which causes ethylene to be provided in or in close proximity to the latex-bearing tissues of the tree.

The following substances are known to stimulate the yield of latex from *Hevea brasiliensis* by substantial amounts:—

1. 2,4 - dichloro - 5 - fluorophenoxyacetic acid.
2. 2,4,5 - trichlorophenoxyacetic acid.
3. 2,4 - dichlorophenoxyacetic acid.
4. Copper sulphate.
5. 2,5 - dichlorobenzoic acid.
6. 3 - indolylacetic acid.
7. α - naphthaleneacetic acid.
8. β - naphthaleneacetic acid.
9. phenylmercuryacetate.
10. phenylmercury chloride.
11. 2-methoxy - 4 - diethylamino - 6 - isopropylamino - 1,3,5 - triazine.
12. N,N - diallyl - α - chloroacetamide.
13. Neomycin sulphate.
14. Dichloro - m - xylenol.
15. 1,1' - dimethyl - 4,4' - bipyridylum dichloride.

Further compounds are known to produce some degree of stimulation, whereas various other substances, e.g. maleic hydrazide, and 2,3,5 - triiodobenzoic acid (TIBA) were found to be ineffective as yield stimulants in *Hevea* (Abraham, P. D. Boatman, S. G. Blackman, G. E. and Powell, R. G., Ann. Appl. Biol. 62 159 1968).

Among the compounds listed which induce a longer flow of latex and greater yields of rubber there is a very wide range of chemical composition. The present invention arose from a search for a common factor between all these materials. It is now known that many of them stimulate the formation of ethylene by plant tissues from endogenous substrates. Also, maleic hydrazide and TIBA do not stimulate ethylene formation in plants and, as noted, are ineffective as yield stimulants.

These facts suggested that the yields of *Hevea brasiliensis* trees would be enhanced by treatment with ethylene itself or with substances that are converted directly into ethylene, instead of merely stimulating ethylene formation from other substances by the trees.

This prediction was borne out by our experiments in which trees were treated with:—

a) 2 - chloroethylphosphonic acid (a substance known to be directly convertible into ethylene by hydrolysis), e.g. in admixture with a suitable oil or grease, the mixture typically containing from 2.5% to 25% by weight of the 2 - chloroethylphosphonic acid.

b) gaseous ethylene.

The efficiency of ethylene-releasing compositions as yield stimulants for rubber trees has been well demonstrated in our experiments as shown in the following examples.

EXAMPLE 1

A mixture was prepared of 2 - chloroethylphosphonic acid in palm oil containing 2.7% active ingredient. Approximately 1.7 grams of the mixture, containing about 46 mg of the active ingredient were applied on a two and a

- half inch strip of scraped bark below the tapping cut to each of 45 trees of mixed clones budded in 1951 and currently (1968) tapped on the first panel of bark at first renewal. A like number of similar trees were each treated with 1.7 grams of a formulation containing 1% acid equivalent of the n-butyl ester of 2,4,5 - trichlorophenoxyacetic acid (2,4,5,—T), that is, 17 mg acid equivalent per tree. These and a like number of similar control trees were tapped on a half spiral alternate system and the yields were recorded for eleven months. The first treatment was made in May 1968 and repeated after six months, i.e., in November 1968. The comparative yields in grams of dry rubber per tree per tapping (after adjustment for differences in yield before treatment) are presented in Table 1. The yields expressed as percentage of control are also given in Table 1, in parenthesis.

TABLE 1

Comparative yields under different treatments applied in May 1968 and re-applied after six months in November 1968
Grams of dry rubber per tree per tapping and expressed as percentage of control in parenthesis

Month	Controls 100%	1% 2,4,5—T	2.7% 2-chloroethyl- phosphonic acid
1st month	55.7	93.0 (167)	88.8 (159)
2nd month	64.2	83.6 (130)	77.4 (121)
3rd month	56.2	65.2 (116)	60.4 (107)
4th month	52.5	57.5 (110)	55.9 (106)
5th month	58.0	62.8 (108)	62.7 (108)
6th month	55.2	60.1 (109)	60.1 (109)
Mean over first six months	57.0	70.4 (124)	67.6 (119)
7th month	60.8	83.3 (137)	104.7 (172)
8th month	56.9	58.5 (103)	71.7 (126)
9th month	63.9	67.9 (106)	76.0 (119)
10th month	52.7	59.6 (113)	58.5 (111)
11th month	42.9	44.0 (103)	45.8 (107)
12th month	55.0	64.7 (118)	66.9 (122)
Mean over second six months	55.4	63.0 (113)	70.6 (127)
Mean over twelve months	56.2	66.7 (118)	69.1 (122)

- The predicted increase in yield by application of 2 - chloro - ethyl - phosphonic acid, known to produce ethylene in plant tissues, was obtained. Next, the direct effect of ethylene gas was tested. (In this experiment trees were also treated with gaseous acetylene derived from calcium carbide for comparison.

EXAMPLE 2

- Similar trees to those used in the previous experiment were treated as follows with 10 trees per treatment. In addition to the control group of trees, other groups of trees were treated with 2,4,5 - trichlorophenoxyacetic acid at 1% acid equivalent and 2 - chloroethyl-

phosphonic acid at 2.7%, 8.1% and 24.3% acid equivalents respectively, applied in palm oil to a two and a half inch strip of scraped bark below the tapping cut. The upper parts of the tapping panels of 20 trees were enclosed in polyethylene jackets in which were introduced 30 g. calcium carbide to generate acetylene by reaction with water vapour naturally present (10 trees), or 15 ml. of an alcoholic solution of ethylene to release the gas by volatilization (10 trees). It was not possible to determine accurately the amounts of the gases (ethylene and acetylene) applied to each tree. However,

it was known that acetylene formation from calcium carbide and hence its action on the tree continued for several weeks, whereas the application of ethylene gas, by the method used, was much more transitory. The treatments were first applied in September 1968 and yields were recorded.

The comparative yields in grams of dry rubber per tree per tapping (after adjustment for differences in yield before treatment) are shown in Table 2, and with the yields expressed as percentage of the control in parenthesis.

TABLE 2

Comparative yields under different treatments applied September 1968.
Grams of dry rubber per tree per tapping and expressed as percentage of control in parenthesis

Tapping No. Treatment	1	2	3	4	5	6*	7	8	9	10	11	12	13	Mean
Control	45.4 (100)	47.4 (100)	48.4 (100)	49.8 (100)	50.1 (100)	45.1 (100)	45.6 (100)	50.0 (100)	52.1 (100)	38.1 (100)	49.4 (100)	47.3 (100)	44.2 (100)	47.6 (100)
1% 2,4,5-T	75.7 (167)	81.0 (171)	88.7 (183)	86.1 (173)	79.9 (159)	56.3 (125)	80.5 (177)	79.7 (159)	78.3 (150)	62.4 (164)	61.5 (124)	52.1 (110)	48.5 (110)	73.4 (154)
2.7% 2-chloroethyl- phosphonic acid	116.9 (257)	99.5 (210)	82.1 (170)	86.7 (174)	71.3 (142)	52.9 (117)	77.3 (170)	67.7 (135)	81.5 (156)	55.2 (145)	56.1 (114)	47.5 (100)	44.5 (101)	74.5 (157)
8.1%	112.8 (248)	89.6 (189)	84.7 (175)	83.8 (168)	78.7 (157)	59.2 (131)	84.5 (185)	81.6 (163)	94.4 (181)	65.2 (171)	63.3 (128)	55.2 (117)	57.5 (130)	79.8 (168)
24.3%	111.7 (246)	80.8 (170)	84.4 (174)	80.3 (161)	70.6 (141)	52.1 (116)	53.5 (183)	64.0 (128)	75.5 (145)	65.2 (171)	61.5 (124)	51.3 (108)	51.1 (116)	73.7 (155)
Ethylene gas	86.8 (191)	63.8 (135)	50.7 (105)	57.2 (115)	59.2 (118)	50.5 (112)	41.4 (91)	54.8 (110)	51.5 (99)	32.8 (86)	46.3 (94)	47.8 (101)	43.4 (98)	53.2 (112)
Acetylene gas	169.6 (374)	120.8 (255)	100.3 (207)	100.3 (201)	98.8 (197)	59.7 (132)	84.6 (186)	79.6 (159)	80.0 (154)	57.7 (151)	59.5 (120)	48.5 (103)	45.9 (104)	88.1 (185)

*Rain interfered with collection.

The greater initial response to 2 - chloroethylphosphonic acid than to 2,4,5-T is entirely consistent with the fact that this compound is converted directly to ethylene instead of merely stimulating its formation by the tissues of the tree. The initial response to ethylene is also marked as expected. It is rather transitory but this is obviously due to a low initial concentration and subsequent losses by diffusion. The stimulant action of acetylene is probably due to its structural analogy to ethylene.

The lower initial response to the highest concentration (24.3%) of 2 - chloroethylphosphonic acid reported here may indicate that the 8.1% concentration is nearer to the optimum.

We make no claim to the use of any of the following substances to stimulate the yield of rubber latex from *Hevea brasiliensis*:—

1. 2,4 - dichloro - 5 - fluorophenoxyacetic acid.
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Subject to this disclaimer, we declare that

WHAT WE CLAIM IS:—

1. A method of treating rubber-bearing *Hevea brasiliensis* for the purpose of stimulation of yield of rubber latex therefrom which method comprises applying thereto a substance which causes ethylene to be provided in or in close proximity to the latex-bearing tissues of the tree.

2. A method as claimed in claim 1, wherein the substance is or contains free ethylene.

3. A method as claimed in claim 1, wherein the substance decomposes to form ethylene within, or in contact with, the tree.

4. A method as claimed in claim 3, wherein the substance is or contains 2 - chloroethylphosphonic acid.

5. A method as claimed in claim 4, wherein the 2 - chloro - ethylphosphonic acid is applied to the tree in admixture with a suitable oil or grease.

6. A method as claimed in claim 5, wherein the mixture contains from 2.5% to 25% by weight of the 2 - chloroethylphosphonic acid.

7. A method as claimed in claim 5 or claim 6, wherein the oil is palm oil.

8. A method as claimed in any one of claims 1 to 7, and substantially as hereinbefore described in Example 1 or Example 2.

9. Rubber-bearing *Hevea brasiliensis* when treated by the method claimed in any one of claims 1 to 8.

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