

PATENT SPECIFICATION

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- (72) Inventor PHILIP BARRY DICKENSON



(54) COMPOSITION CONTAINING PLANT GROWTH REGULANT

(71) We, THE BOARD OF THE RUBBER RESEARCH INSTITUTE OF MALAYSIA, a Malaysian Body Corporate, of 260 Jalan Ampang, Kuala Lumpur, Malaysia, 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:—

It has long been known that ethylene occurs in traces in plant tissues and that it plays an important role in plant physiology and biochemistry, though the precise nature of this role is still not clear. The application of additional ethylene to plants, or to portions of them, is known to affect the physiology of growth and development, flowering, fruiting or seed germination, and in particular in many instances to speed maturation.

Because gaseous ethylene is, in itself, a difficult substance to apply, treatment may be achieved by the use of ethylene inducing chemicals such as the substituted phenoxyacetic acids which provoke the plant tissues to produce extra ethylene locally; or ethylene generating chemicals such as 2-chloroethylphosphonic acid and certain silane compounds which, when applied to the plant, decompose to produce ethylene locally; or by the use of compositions containing releasably stored ethylene or by the use of compositions which contain or produce compounds which mimic the activity of ethylene.

British Patent No. 1,315,131 describes and claims compositions for treating plants. These comprise a volatile or gaseous plant growth regulant, such as ethylene, and a solid non-volatile adsorbent material dispersed in a viscous fluid medium, with at least a part of the growth regulant releasably adsorbed on the surface of the adsorbent material.

Because the surface tissues of the tree or plant may be a barrier to effective penetration, use of such a composition or of ethylene-inducing or ethylene-generating chemicals is often accompanied by scraping the bark or boring a hole in the trunk to ensure assimilation of the growth regulant. For example where

growth regulating compositions or chemicals are used to increase the yield of rubber from *Hevea brasiliensis* this conventionally involves applying the composition or chemical to the exposed tapping cut, or to scraped bark below the tapping cut, or inserting the composition or chemical into a hole bored in the trunk. Each of these three alternative procedures has its disadvantages. Although application of the composition or chemical to the tapping cut is effective, it has to be repeated rather frequently and is thus expensive. The operations of scraping bark and boring holes in the trunk not only damage the trees, but are time-consuming and expensive when large numbers of trees have to be treated. Similar difficulties are met with other plants.

It is an object of this invention to provide means by which plant growth regulants can be effectively applied without physical damage to the tree or plant. This is achieved by the use of assimilation agents which assist penetrations of the bark of the tree or the cuticle of the plant.

The present invention accordingly provides a composition for the treatment of living plants comprising a volatile or gaseous plant growth regulant releasably adsorbed on the surface of a particulate solid adsorbent together with an aliphatic or aromatic carboxylic acid or anhydride and/or dimethylsulphoxide and/or glycerol as an agent to assist assimilation of the plant growth regulant by the plant.

The function of the aliphatic or aromatic carboxylic acid or anhydride and/or DMSO and/or glycerol is to act as an assimilation agent, i.e. to assist assimilation of the plant growth regulant by the plant. It is believed to do this by penetrating through the protective tissues, e.g. the corky bark or the waxy cuticle, of the plant. A chemical and physical modification of the protective tissues is probably involved. The preferred aliphatic carboxylic acid is acetic acid. Propionic acid, despite its disagreeable smell, and the higher homologues of acetic acid may also be effective in some circumstances. Succinic, pyruvic, malic, benzoic and coumaric acids may also be

useful. DMSO shows a positive effect as a bark penetrant, but one which is less marked than with acetic acid. Acetic anhydride may be useful in place of the free acid. These
5 assimilation agents do not themselves act as plant growth regulants. Acetic acid, like many other aliphatic carboxylic acids, is a naturally occurring material, so its use should not raise serious pollution or toxicity problems.

10 Any volatile or gaseous plant growth regulant that does not react with the substrate or the fluid medium (see below) may be used. Ethylene is the best known and most effective gaseous plant stimulant, but it is not the only one. Other volatile or gaseous plant growth
15 regulants include acetylene, propylene, carbon monoxide and the volatile halogenoparaffins.

In order to be capable of adsorbing a substantial amount of the plant growth regulant, the adsorbent material will normally be chosen
20 to have a large internal surface area, of, for example, at least 100 square metres per gram, and a suitably larger pore diameter in relation to the molecular size of the adsorbate. Preferred materials are alumino-silicates, known as
25 zeolites or molecular sieves, silica gel, and activated charcoal. Such materials are normally provided in a finely divided form, though they may be granulated or tableted for ease of handling. A controlled slow release of plant
30 growth regulant can be obtained from zeolites, which are therefore the preferred adsorbent materials.

The composition also preferably comprises
35 a fluid, particularly a viscous fluid medium, for example, animal, vegetable or mineral fats or oils, petroleum jelly BP, paraffin or other waxes, polyethylene oxide or polyethylene glycol materials, gelatin or agar, or appropriate mixtures of such materials, or natural
40 rubber coagulum derived after dispersion of the growth regulant-bearing material in fresh *Hevea* latex. If desired, this fluid medium may include a miscible organic liquid which is a
45 solvent for the stimulant and which may be helpful in promoting solution and diffusion of the growth regulant as it is desorbed from the adsorbent material.

50 Since in the preferred form of the invention, the rate of release of plant growth regulant from the adsorbent material is increased in the presence of water, it is generally preferable to use a substantially anhydrous fluid medium. A preferred fluid medium comprises from 60%
55 to 95% by weight of petroleum jelly with from 5% to 30% of a mineral oil. However, a small proportion of water may be present in the medium or may be deliberately added to provide a controlled release of the plant growth
60 regulant.

The composition of this preferred form of the invention may conveniently be made by rapidly dispersing the non-volatile adsorbent material, on whose surface the plant growth
65 regulant has been releasably adsorbed, in the

fluid medium. The assimilation agent may be added at any stage.

The weight of the volatile or gaseous plant growth regulant adsorbent material will
70 normally be at least 0.1%, preferably at least 1.0% of the weight of the adsorbent material. There is no upper limit of these ranges; in general, the more volatile or gaseous growth
75 regulant that can be adsorbed on a given volume of adsorbent material, the better. Adsorption of the growth regulant onto the adsorbent material can be easily effected by conventional methods. We find that zeolites will adsorb about 7% by weight of ethylene,
80 and activated charcoal about 4% by weight at ambient temperature and pressure.

The concentration of the plant growth regulant in the composition is not critical, and may be chosen, in accordance with well known principles, so that a convenient amount of the composition is applied to each plant. In the preferred form of the invention, the composition may suitably contain as little as 2.5 or 5% but more usually from 10% to 55% preferably from 20 or 30% to 50% by weight of the non-volatile adsorbent material and plant growth regulant combined. It appears that more plant growth regulant is required in the presence of assimilation agents such as acetic acid, than in their absence. This may be due to a tendency of acetic acid to reduce the efficiency of (basic) molecular sieve, or to drive some of the ethylene away altogether. The upper limit of the above ranges is set by the amount of adsorbent material that can be mixed with the fluid medium to provide a spreadable product.

The assimilation agent is generally present in an amount of from 0.5% to 15%, preferably from 2% to 10%, by weight on the weight
105 of the composition. While the upper limits are not critical, the disadvantages of going above them appear to outweigh the advantages.

Other conventional ingredients may be included in the composition. A surface-active agent will generally be included to aid dispersion of the assimilation agent in the viscous fluid medium and to improve adhesion of the composition to the tree. It is found that surface active agents are not themselves effective
115 assimilation agents, and are not able to promote adequate penetration of the growth regulant through the bark.

The compositions of this invention are principally intended for application to plants, particularly trees and shrubs, in order to affect their development, in particular to hasten the ripening of citrus fruits, pome fruits, pine-apples, tomatoes and grapes, or to stimulate the exudation of resins and latices. Such application accordingly forms one aspect of this invention. The amount applied will depend upon the size of the plant and on the nature of the plant growth regulant. Where ethylene is the growth regulant, the amount of composi-
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tion applied to each plant will generally be such as to contain from 0.005g. to 2.5g., preferably from 0.025g. to 1.0g., of ethylene.

The main use envisaged for the composition is application to *Hevea brasiliensis* to stimulate the yield of rubber latex.

Accordingly the invention also provides a method of treating *Hevea brasiliensis* to stimulate the yield of rubber latex therefrom, which method comprises applying to the tree an effective amount of the composition defined above. The amount applied will depend upon the size of the tree and the nature of the plant growth regulant. Where ethylene is the growth regulant, i.e. a latex flow stimulant, the amount of composition applied to each tree will generally be such as to contain from 0.005 g. to 2.5g. preferably from 0.025g. to 1.0g. of ethylene.

The composition is usually smeared on the scraped or, preferably unscraped bark of the tree or shrub. In treating *Hevea* it is also possible to apply the composition to the tapping cut. The position of application is not critical but in *Hevea* the generally preferred position is 1 to 3 inches below the tapping cut.

The smear may optionally be covered with a protective layer which may conveniently be adhered to the tree trunk around the smear. We generally prefer to use protective layers which are impervious to the plant growth regulant but layers which are not impervious can be satisfactorily used. We prefer to use aluminium foil, poly-vinyl chloride, or polyvinylidene chloride (PVDC) tape for the protective layer, particularly the latter as it is substantially impervious to ethylene.

The bark penetrants will also be useful with other types of plant growth regulant which are added directly to the bark of trees or shrubs, and may also be useful in promoting the assimilation of plant growth regulants normally applied by spraying.

In contact with the trunk of trees it is believed that the acetic acid (or other assimila-

tion aid) reacts with the bark, swelling it and changing its physical and/or chemical nature, so as to permit the rest of the composition, or at least the plant growth regulant, to penetrate to the interior of the trunk. The plant growth regulant is slowly desorbed from the adsorbent material, passes into solution in the fluid medium, and from there passes into the tissues of the tree. The viscous fluid, in addition to constituting a convenient medium for application of the plant growth regulant to the tree and protecting the adsorbent from rapid loss to the atmosphere of the adsorbate (stimulant), is believed also to moderate the desorption of the plant growth regulant from the adsorbent material, thus providing a controlled slow release of plant growth regulant to the tree. Many of the suitable viscous fluid media are themselves slowly absorbed into the tissues of the tree, probably carrying the plant growth regulant with them.

Where the tree being treated is rubber bearing *Hevea brasiliensis* the composition is preferably applied to unscraped bark near the tapping cut. A suitable area of application is roughly one to twelve square inches of bark on a fully grown tree and this may be laterally extended to suit viscous compositions. An advantage of these compositions is that, having once stimulated the tree, one may either recover an increased yield of rubber from the tree, or reduce the tapping frequency without loss of yield, or reduce the length of the tapping cut without loss of yield. Tapping costs are a major factor in the price of natural rubber, and the benefit of reducing the tapping frequency, say from 2 to 4 days, may therefore be great. Alternatively, a reduction in the length of the tapping cut e.g. from half spiral to one eighth spiral, may prolong the useful life of the tree.

The following Examples illustrate the invention.

(13)

EXAMPLE 1

The yield stimulant compositions used were as follows:—

Ingredient	Weight (g) in Formulation				
	A	B	C	D	E
Powdered Molecular Sieve** Grade 4a	250	250	250	250	250
White Petroleum Jelly BPC	251	708	251	708	708
Liquid Paraffin BPC	23	63	39	106	148
Acetic Acid (Glacial)	—	—	15	43	—
Span* 85 (Surfactant)	—	4	—	4	4
Tween* 80 (Surfactant)	2	—	2	—	—
Dimethylsulphoxide	30	86	—	—	—

* Registered Trade Marks

** previously impregnated with ethylene

Composition E contains no assimilation agent and is for comparison.

5 Four grams of each formulation were applied to each of 20 mature trees of *Hevea brasiliensis* (PB 86 clone) just below the tapping cut. In some cases, the application was to scraped bark, and in some cases to unscraped bark. In some cases, a polyvinylidene chloride tape was applied over the smear of composition. Application was made at the beginning

of the experiment, and was repeated once every 10 two months. All the trees were tapped on a system S/2.d/2. 100% [i.e. on the $\frac{1}{2}$ spiral cut alternate day system; equivalent to a tapping intensity of 100%] on Panel C. Mean results, in grams per tree per tapping for the 15 control and in % of the control for other formulations are set out in the table below.

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Formulation	Tape Covering	Bark Scraped (S) or Unscraped (U)	Formulation with Bark Penetrants					Total Yield at 18 Months
			First 2 Months	Second 2 Months	Third 2 Months	Mean of 6 Months	% 100	
Control	-	-	45.7g	34.7g	37.4g	39.3g		Kg/Ha 2338
A	yes	S	175%	128%	163%	157%	154%	3606
A	yes	U	153	118	152	142	158	3694
B	yes	S	187	130	172	165	155	3616
B	yes	U	158	127	166	151	146	3457
C	no	S	158	117	149	143	150	3500
C	no	U	154	137	145	146	164	3842
C	yes	S	184	127	174	164	183	4267
C	yes	U	191	144	162	168	180	4203
D	no	S	158	130	164	151	160	3747
D	no	U	143	126	144	138	157	3660
E	no	S	171	137	174	162	184	4311
E	no	U	135	121	139	132	152	3547
E	yes	S	192	133	189	174	187	4368
E	yes	U	143	116	155	139	147	3443

The effect of applying formulation C to unscraped bark is particularly noteworthy.

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EXAMPLE 2

The yield stimulant compositions used were as follows:—

Ingredient	Weight (g) in Formulation		
	C	E	F
Powdered Molecular Sieve* Grade 4a	250	250	250
White Petroleum Jelly B.P.C.	251	708	708
Liquid Paraffin B.P.C.	39	148	106
Acetic Acid (Glacial)	15	—	—
Span 85 (Surfactant)	—	4	4
Tween 80 (Surfactant)	2	—	—
Glycerol	—	—	43

* Previously impregnated with ethylene.

The "trees" were 16 small illegitimate seedlings of *Hevea brasiliensis* about two years old, 1½—2 metres high and 4—5 cms in circumference at the tapping point, grown in a tropical greenhouse in 22 cm diameter pots containing a fertilised peat/sand mixture. All seedlings possessed well defined suberised corky brown tissue on the stem at, and for 15 cms at least above the tapping point, this exterior tissue being identical to the corky bark of a mature tree, though less developed.

Daily tapping was performed for 9 days by a single prick with a fine needle just below the intended point of application of the stimulant mixture. The seedlings were then divided into four groups each of four seedlings, the member of each group possessing similar variations in yield.

The average yield over the nine day period of pre-treatment tapping prior to stimulation was:—

- First Group—
4.4 mg dry rubber per plant per day
- Second Group—
4.8 mg dry rubber per plant per day
- Third Group—
4.25 mg dry rubber per plant per day
- Fourth Group—
4.1 mg dry rubber per plant per day

Stimulant materials were then applied to each seedling as follows:—

To each plant of the first group was applied to an area 1 cm² of lightly scraped "bark" just above the tapping area 0.05gms of Formula E without assimilation aid, the paste being covered with PVDC film.

To each plant of the second group was applied direct to the unscraped "bark" just above the tapping area, 0.05g of Formula E without assimilation aid, the paste being covered with PVDC film.

To each plant of the third group was applied direct to the unscraped "bark" just above the tapping area, 0.05g of Formula F containing glycerol as an assimilation aid, the paste being covered with PVDC film.

To each plant of the fourth group was applied direct to the unscraped bark 0.05g of Formula C containing glacial acetic acid as an assimilation aid, the paste being covered with PVDC film.

The average yield over the nine days following stimulation were:—

- First Group—
18.4 mg dry rubber per plant per day
- Second Group—
11.5 mg dry rubber per plant per day
- Third Group—
20.2 mg dry rubber per plant per day
- Fourth Group—
15.4 mg dry rubber per plant per day.

The value of glycerol and acetic acid as assimilation aids on unscraped bark is thus demonstrated.

The health of all trees and plants subjected to Experiments 1 and 2 was not adversely affected.

WHAT WE CLAIM IS:—

1. A composition for the treatment of living plants comprising a volatile or gaseous plant growth regulant releasably adsorbed on the surface of a particulate solid adsorbent together with an aliphatic or aromatic carboxylic acid or anhydride and/or dimethylsulphoxide and/or glycerol as an agent to assist assimilation of the plant growth regulant by the plant.

2. A composition as claimed in claim 1, wherein the amount of plant growth regulant adsorbed is at least 1% by weight.

3. A composition as claimed in either claim 1 or claim 2 wherein the plant growth regulant



EXAMPLE 2

The yield stimulant compositions used were as follows:—

Ingredient	Weight (g) in Formulation		
	C	E	F
Powdered Molecular Sieve* Grade 4a	250	250	250
White Petroleum Jelly B.P.C.	251	708	708
Liquid Paraffin B.P.C.	39	148	106
Acetic Acid (Glacial)	15	—	—
Span 85 (Surfactant)	—	4	4
Tween 80 (Surfactant)	2	—	—
Glycerol	—	—	43

* Previously impregnated with ethylene.

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Daily tapping was performed for 9 days by a single prick with a fine needle just below the intended point of application of the stimulant mixture. The seedlings were then divided into four groups each of four seedlings, the member of each group possessing similar variations in yield.

The average yield over the nine day period of pre-treatment tapping prior to stimulation was:—

First Group—

4.4 mg dry rubber per plant per day

25 Second Group—

4.8 mg dry rubber per plant per day

Third Group—

4.25 mg dry rubber per plant per day

Fourth Group—

30 4.1 mg dry rubber per plant per day

Stimulant materials were then applied to each seedling as follows:—

To each plant of the first group was applied to an area 1 cm² of lightly scraped "bark" just above the tapping area 0.05gms of Formula E without assimilation aid, the paste being covered with PVDC film.

To each plant of the second group was applied direct to the unscraped "bark" just above the tapping area, 0.05g of Formula E without assimilation aid, the paste being covered with PVDC film.

To each plant of the third group was applied direct to the unscraped "bark" just above the tapping area, 0.05g of Formula F containing glycerol as an assimilation aid, the paste being covered with PVDC film.

To each plant of the fourth group was applied direct to the unscraped bark 0.05g of Formula C containing glacial acetic acid as an assimilation aid, the paste being covered with PVDC film.

The average yield over the nine days following stimulation were:—

First Group—

18.4 mg dry rubber per plant per day

Second Group—

11.5 mg dry rubber per plant per day

Third Group—

20.2 mg dry rubber per plant per day

Fourth Group—

15.4 mg dry rubber per plant per day.

The value of glycerol and acetic acid as assimilation aids on unscraped bark is thus demonstrated.

The health of all trees and plants subjected to Experiments 1 and 2 was not adversely affected.

WHAT WE CLAIM IS:—

1. A composition for the treatment of living plants comprising a volatile or gaseous plant growth regulant releasably adsorbed on the surface of a particulate solid adsorbent together with an aliphatic or aromatic carboxylic acid or anhydride and/or dimethylsulphoxide and/or glycerol as an agent to assist assimilation of the plant growth regulant by the plant.

2. A composition as claimed in claim 1, wherein the amount of plant growth regulant adsorbed is at least 1% by weight.

3. A composition as claimed in either claim 1 or claim 2 wherein the plant growth regulant



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is ethylene, acetylene, propylene, carbon monoxide or a volatile halogeno paraffin.

4. A composition as claimed in any one of claims 1 to 3 wherein the particulate adsorbent is a zeolite, silica gel or activated charcoal.

5. A composition as claimed in any one of claims 1 to 4 wherein the particulate adsorbent has a specific surface area of at least 100 square metres per gram.

6. A composition as claimed in any one of claims 1 to 5 wherein the particulate adsorbent and plant growth regulant combined comprise from 2.5 to 55% by weight of the composition.

7. A composition as claimed in claim 6 wherein the adsorbent and regulant comprise from 20 to 50% by weight of the composition.

8. A composition as claimed in any one of claims 1 to 7 wherein the composition includes a fluid medium.

9. A composition as claimed in claim 8 wherein the fluid medium comprises an animal vegetable or mineral fat or oil, petroleum jelly, paraffin or other wax, polyethylene oxide, polyethylene glycol, gelatin, agar or mixtures of these, or natural rubber coagulum derived after dispersion of the growth regulant bearing material in fresh *Hevea* latex.

10. A composition as claimed in either claim 8 or claim 9 wherein the fluid comprises from 60 to 95% by weight of petroleum jelly and from 5 to 30% of a mineral oil.

11. A composition as claimed in any one of claims 1 to 10 wherein the assimilation agent is one or more acetic, propionic, succinic, pyruvic, malic, benzoic and coumaric acids and acid anhydrides.

12. A composition as claimed in any one of claims 1 to 11 wherein the assimilation agent is present in an amount of from 0.5 to 15% by weight on the weight of the composition.

13. A composition as claimed in claim 12

wherein the amount of assimilation agent is from 2 to 10% by weight.

14. A composition as claimed in anyone of claims 1 to 13 additionally containing a surfactant.

15. A composition as claimed in any one of claims 1 to 14 and substantially as herein-before described in any one of the Examples.

16. A method of regulating the growth of the plants which comprises applying thereto an effective amount of the composition claimed in any one of claims 1 to 15.

17. A method as claimed in claim 16 wherein the plant is a tree or shrub.

18. A method as claimed in claim 18 wherein the plant is one bearing citrus fruit, pome fruit or pine-apples, tomatoes or grapes.

19. A method of stimulating the yield of rubber latex from a tree of the species *Hevea brasiliensis*, which comprises applying thereto an effective amount of the composition claimed in any one of claims 1 to 15.

20. A method as claimed in any one of claims 16 to 19 wherein the composition is applied to the unscraped bark of the plant.

21. A method as claimed in any one of claims 16 to 19 wherein the composition is applied to the scraped bark of the plant.

22. A method as claimed in either claim 16 or 21 wherein the composition is covered by a protective layer.

23. A method as claimed in any one of claims 16 to 22 and substantially as herein-before described in anyone of the Examples.

STEVENS, HEWLETT & PERKINS,
Chartered Patent Agents,
5 Quality Court,
Chancery Lane,
London, W.C.2.