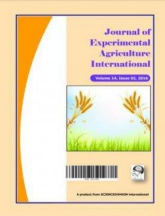

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Stimulants and Plugging Index in *Hevea brasiliensis*: A Preliminary Investigation of Plausible Effect of Some Stimulants on Plugging Index

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Authors' contributions

This work was carried out in collaboration between all authors. Author OAE designed the study, wrote the protocol and wrote the first draft of the manuscript. Authors EOU and FUO performed the statistical analysis. Authors AMDU, ANC and UUE managed the analyses of the study. Authors JAO and DE managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The probable impact of some stimulants on plugging index during tapping in *Hevea* trees was investigated using the NIG 805 clone in the clonal garden of Rubber Research Institute of Nigeria, Iyanomo, Benin City. The experiment comprised of five (5) different treatments in three replicates. Each replicate comprised of 3 trees making a total of forty-five (45) trees. The study spanned a three month period (October to December) for two consecutive years. Stimulation was done once monthly and tapping done using the ½S, d/3 tapping mode. Data collected include length of tapping cut, initial volume (volume of latex flow within the first five minutes after tapping) and the final volume (volume of latex flow two hours after tapping. Results were analysed using ANOVA. The result for both years showed that there was no significant difference in the plugging index of the trees stimulated with Mortex 50, Vitex and control while there was a significant difference for those trees stimulated with Ethephone and Mortex 25.

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Keywords: Hevea; stimulation; tapping; mortex; plugging index.

1. INTRODUCTION

Natural rubber is obtained from the latex of the *Hevea brasiliensis* Muell.-Arg (Para rubber) tree. This tree which is native to rain forests of the tropical region of the Great Amazonian basin of South America [1] is presently the only economically viable source of natural rubber. The excellent physical properties and good yield gives its rubber a wide variety of industrial uses [2,3,4]. The *Hevea* tree has a distinctive physiology, where the production of latex – a secondary metabolite - is confined to the latex vessels called laticifers. These laticifers are found exclusively in the phloem tissue of the vascular bundle [5]. The biosynthesis of the latex, like other secondary metabolites, is affected by plant hormones.

For efficient latex production in the *Hevea* tree, an efficient tapping system is required. Tapping is the controlled incision of the bark of the *Hevea* tree which results in latex out-flow. The quantity of latex obtained with each successive tapping depends on how easily the latex flows [6], the duration of flow [7] and latex regeneration within the tree [8,9]. The ease of the latex flow is also dependent on the speed or time within the latex coagulates, thereby clogging up the incised laticifers.

[10,11] had observed that the decrease in the rate of latex flow was due to an obstruction to the flow commencing soon after tapping. This obstruction, located at or near the cut ends of vessels is as a result of the vessels being plugged internally with coagulated rubber. This internal plug formation starts soon after tapping, and with time as more vessels become plugged, a gradual decrease in the flow rate results. The flow ultimately ceases when all the vessels are plugged. Based on these observations of [11] research advanced in two main lines: one, seeking physico-chemical explanations on the mechanism controlling vessel plugging [12,13,14,15,16,17], while the other looked into clonal differences in plugging behaviour and latex flow pattern [18,19,20,21].

Plug formation is an important physiological clonal characteristic which is probably genetically determined. The rapidity of plug formation determines the time of latex flow as its flow declines sharply and stops within a short period in clones where plugging is swift [22]. The reverse is the case in clones where plug formation is slower.

Studies on flow curves and plugging behaviour of clones prompted [19] and [18] to evolve an important parameter, "the plugging index", which is a good measure of the rapidity of plugging in clones. The plugging index is defined as one hundred times the initial flow rate (in ml/min) for the first five or ten minutes after tapping upon the total volume (yield) of latex.

Plugging index has been found be positively correlated with girth increment, Dry rubber content (DRC) of latex and response to yield stimulation, but negatively correlated with yield and incidence of dryness (Brown Bast) in *Hevea* [22].

Tapping has been shown to affect latex regeneration and increase the possibility of the development of Tapping Panel Dryness (TPD), therefore, lower tapping frequencies have been adopted while using stimulants to enhance the yield, compensating for the reduced tapping frequencies [23]. Studies have also shown that tapping frequency is not only reduced with stimulants but also increases land and labour productivity [24,25].

Stimulants are chemical hormones which when applied on the tree bark (over, under or on the tapping panel) tends to delay plugging thereby prolonging the duration of the latex flow [26]. Ethelene in various forms has over the years been the most common stimulant used. The ethylene acts by increasing the pressure and elasticity of the laticifers, thereby decreasing the coagulation of the latex and extending the latex flow time [27]. To ensure high and sustained yields, suitable tapping and stimulation regimes must be adopted, which have little or no deleterious effects on tree growth, bark renewal, and appearance of the phenomenon of bark dryness [23].

The essence of this study is to investigate the impact of a new stimulant Mortex on the plugging index in *Hevea* tress, in comparison with other existing stimulants, using the NIG 805 trees in the clonal garden of the Rubber Research Institute of Nigeria, Iyanomo, Benin City.

2. MATERIALS AND METHODS

The NIG 805 clone developed by the Rubber Research Institute of Nigeria, Iyanomo was used as the test clone in an experiment which was set out in a randomised complete block design in the clonal garden of Rubber Research Institute of Nigeria, Iyanomo. The experiment had five (5) different treatments in three replicates comprising three trees each, making a total of forty-five (45) trees. The treatments used were mortex 25, mortex 50, vitex, ethephon and the control which had no stimulant. The ½S, d/3 tapping mode was used in tapping the trees and the stimulation was done once a month (thirty days). The latex flow time for each tree was two hours. Tapping and data collection was carried out over a three consecutive month period - September, October and November. Data collected include initial volume (volume [ml] of latex flow within the first five minutes after tapping), final volume (volume [ml] of latex flow two hours after tapping). The experiment was repeated the following year over the same period (September, October and November) using the same set of trees. The results were analysed using Analysis of Variance (ANOVA).

3. RESULTS AND DISCUSSION

The results of the analyses of variance showed a significant difference in the mean plugging index of the experimental trees due to the treatment (Table 1), indicating that the stimulants had some effect on the plugging index. This is in accord with [10] claim that stimulants increase yield by delaying the plugging index which in turn prolongs the flow of latex. A mean separation (Fig. 1) showed no significant difference in the plugging index of the trees stimulated with Vitex, Mortex 50 and the control which had no stimulation. The plugging indices of the trees stimulated with mortex 25 and ethephone, were not significantly different from each other, though that of ethephone was signigicantly different from Vitex, Mortex 50 and the control.

The plugging index is also related to many other clonal characters in the *Hevea* tree. Although it is negatively correlated with yield and incidence of dryness, it is positively correlated with the dry rubber content (DRC) of the latex, girth, and the extent of response to yield stimulation [22]. An analysis of variance (Table 2) and subsequently a test of the level of significance of the mean DRC (Fig. 2) showed that there was a significant difference in the DRC of the latex produced by the test trees. The trees of the control had the highest DRC. Amongst the stimulated trees, those of the Mortex 25 had the highest DRC of 43% closely followed by those of Vitex with 39.92% (Table 3). Though the test results may not have conformed totally to the findings of [22], it however showed that the trees stimulated with Ethephone which had the lowest plugging index also had the lowest DRC. Therefore, going by these findings and those of [22], a *Hevea* tree with high plugging index will most likely have a high DRC.

Table 1

Source of variation	df	SS	MS	F
Week	14	17.43	1.24	1.87
Treatment	4	2.14	0.53	2.54*
Error	56	31.33	0.56	
Total	74	50.90		

*p≤0.05: * means significant difference in plugging index of latex produced*

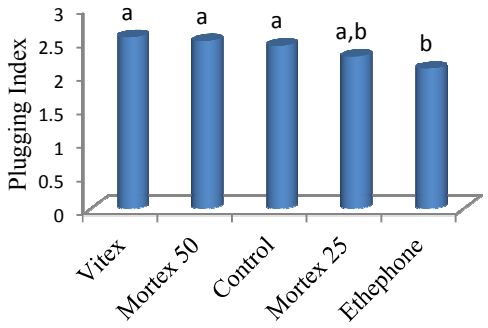

Fig. 1. Mean plugging index for the different stimulants
LSD = 0.31

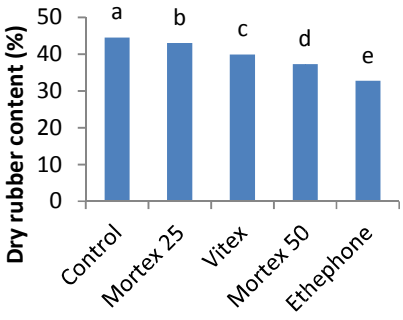

Fig. 2. Mean separation of the Rubber Content (DRC %) of latex produced
LSD = 1.49: a,b,c,d,e; means are significantly different

Table 2. Analysis of variance of mean rubber content (DRC %) of latex

Source of variation	df	SS	MS	F
Week	11	717.38	65.22	7.78
Treatment	4	1056.57	264.14	31.49*
Error	44	369.03	8.39	
Total	59	2142.98		

*p≤0.05: * means significant difference in dry rubber content of latex produced*

Table 3. Comparison of the means of the plugging index and dry rubber content (DRC %) of latex

Stimulant	Plugging index	Dry rubber content
Vitex	2.56[a]	39.92[c]
Mortex 50	2.5[a]	37.25[d]
Control	2.43[a]	44.5[a]
Mortex 25	2.27[ab]	43[b]
Ethephone	2.09[b]	32.75[e]
LSD	0.31	1.49

4. CONCLUSION

From the foregoing, it is shown that stimulation may actually have no serious effect on plugging index as there was no significant difference in the plugging index of the control trees and the Mortex 50 and the Vitex stimulated trees. However, one cannot say conclusively that there is actually a positive correlation between the plugging index and the DRC. More studies will definitely need to be carried out to confirm the correlation.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Strahler AN. Physical geography, 3rd ed. Wiley, New York; 1969.
2. Archer BL, Audeley BG. The biosynthesis of rubber. Biochemistry Journal. 1963;89: 565–574. [PMC free article] [PubMed]
3. Backhaus RA. Rubber formation in plants: A mini-review. Israel Journal of Botany. 1985;34:283–293.
4. Asawatreratanakul K, Zhang YW, Wititsuwannakul D, Wititsuwannakul R, Takahashi S, Rattanapittayaporn A. Molecular cloning, expression and characterization of cDNA encoding cis-prenyltransferases from *Hevea brasiliensis*. European Journal of Biochemestry. 2003;270:4671–4680. [PubMed]
5. Funkhouser JM. Immunohistochemical analysis of transgenic tissues. In: Murphy D, Carter DA, editors. Methods in Molecular Biology. Transgenesis Techniques Principles and Protocols. Humana Press. 1993;395–406.
6. Low FC. Distribution and concentration of major soluble carbohydrates in *Hevea latex*, the effect of ethephon stimulation and the possible role of these carbohydrates in latex flow. Journal of the Rubber Research Institute of Malaysia. 1978;26(21).
7. Southorn WA. Physiology of *Hevea* (latex flow). Journal of the Rubber Research Institute of Malaysia. 1969;21(4):494–512.
8. Jacob JL, Prevot JC, Roussel D, et al. Yield-limiting factors, latex physiological parameters, latex diagnosis and clonal typology. In Physiology of Rubber Tree Latex, J. L. Jacob, J. d'Auzac, and H. Chrétin, Eds., CRC Press, Boca Raton, Fla, USA. 1989;345–382.
9. Eschbach JM, Lacrotte R. Factors influencing response to hormonal yield stimulation: Limits of this stimulation. In Physiology of Rubber Tree Latex, J. L. Jacob, J. d'Auzac, and H. Chrétin, Eds CRC Press, Boca Raton, Fla, USA. 1986;321.
10. Boatman SG. Perliminary physiological studies on the promotion of latex flow by plant growth regulators. Rubb. Res. Inst. Malaya. 1966;19(5):243.
11. Buttery BR, Boatman SG. Effects of tapping, wounding and growth regulators on turgor pressure in *Hevea brasiliensis* Muell. Arg. J. exp. Bot. 1967;18(57):644.
12. Southorn WA. Physiology of *Hevea* (latex flow). Planters' Bullettin. Rubber Research Institute of Malaya. 1968a;99:181-199.
13. Southorn WA. Latex flow studies. I. Electron microscopy of *Hevea brasiliensis* in the region of the tapping cut. Journal of Rubber Research Institute of Malaya. 1968b;20:176-186.
14. Southorn, Edwin. Latex flow studies. II. Influence of lutoids on the stability and flow of *Hevea* latex. Journal of the Rubber Research Institute of Malaya. 1968;20:187-200.

15. Southorn, Esah Yip. Latex flow studies. III. Electrostatic considerations in the colloidal stability of fresh *Hevea* latex. Journal of the Rubber Research Institute of Malaya. 1968a;20:201—215.
16. Southorn, Esah Yip. Latex flow studies. V. Rheology of fresh *Hevea* latex flow in capillaries. Journal of the Rubber Research Institute of Malaya. 1968b;20: 236-247.
17. Esah Y, Southorn WA. Latex flow studies. VI. Effects of high pressure gradients on flow of fresh *Hevea* latex in narrow bore capillaries. Rubber Research Intsitute of Malaya. 1968;20:248-256.
18. Milford GFJ, Paardekooper EC, Ho CY. Latex vessel plugging, its importance to yield and clonal behavior. Journal of Rubber Research Institute of Malaya. 1969;21(3):274-282.
19. Paardecooper EC, Sanit S, et al. Clonal variation in flow pattern. Rubber Research Institute of Malaya. 1968;21:264-273.
20. Sethuraj MR. Studies on the physiological aspects of rubber production. I. Theoretical considerations and preliminary observations. Rubber Board. Bullettin. 1968a;9:47-62.
21. Sethuraj MR. A physiological approach to the problems of exploitation. Rubber Planters' Conference India. 1968b;31-35.
22. Waidyanatha UP, Pathiratne LSS. Studies on latex flow patterns and plugging indices of clones. Journal of Rubber Research Institute of Sri Lanka. 1971;48:47-55.
23. Eschbach JM, Banchi Y. Advantages of Ethrel stimulation in association with reduced tapping intensity in the Ivory Coast. Planter. 1985;61:555–567.
24. Lacote R, Gabla O, Obouayeba S, Eschbach JM, Rivano F, Dian K, Gohet E. Longterm effect of ethylene stimulation on the yield of rubber trees is linked to latex cell biochemistry. Field Crops Research. 2010;115:94-98.
25. Traore MS, Diarrassouba M, Okoma KM, Dick KE, Soumahin EF, Coulibaly LF, Obouayeba S. Long-term effect of different annual frequencies of ethylene stimulation on rubber productivity of clone GT1 of *Hevea brasiliensis* (Muell. Arg.) in south east of Cote d'Ivoire. Agriculture and Biology Journal of North America. 2011;2: 1251-1260.
26. Wenxian X, Xiaodi W, Yanqing P. A review of studies on exploitation with ethephon: Stimulation and proposals for new panel planning in China. In Proceedings of the IRRDB Rubber Physiology and Exploitation Meeting, Hainan, China. 1986;21–32.
27. d' Auzac J. Historical account of the hormonal stimulation of latex yield. In 'Physiology of Rubber Tree Latex' (eds. J. d' Auzac, J.L. Jacop and H. Chrestin) Florida: CRC Press Inc.; 1989.

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