Short Note: Estimates of Repeatability and Coefficients of Variation in Rubber (Hevea brasiliensis Muell. Arg.)

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Summary

Repeatability estimate for daily latex yield in *Hevea brasiliensis* was determined monthly for a period of one year. An average repeatability value (R = 0.71) was obtained, an indication that variability between daily yields was small. Yield variability between ramets of the same clone was however found to be high (CV = 30.6).

Key words: Repeatability,intra-class correlation, *Hevea*, Standard error.

Zusammenfassung

Schätzungen auf Wiederholbarkeit der täglichen Latexernte bei *Hevea brasiliensis* wurden über einen Zeitraum von einem Jahr monatlich durchgeführt. Ein durchschnittlicher Wert für die Wiederholbarkeit von R = 0,71 wurde ermittelt, was einen Hinweis darauf darstellt, daß die Variabilität zwischen den täglichen Erntemengen gering war. Unterschiede in der Erntemenge zwischen den Ramets desselben Klones wurden dagegen als hoch empfunden (CV = 30,6).

In 1968, a mono clonal block of clone RRIM — 623 (= Rubber Res. Inst. of Malaysia clone 623) was planted at the Rubber Research Institute of Nigeria near Benin City. Starting in October 1977, and continuing until September 1978, 70 ramets of the nine-year-old trees were selected from the mono clonal block and tapped every other day, each tapping consisting of a spiral cut halfway around the tree. The trees ranged from 61.9 to 80.1 cm diameter at the start of the experiment.

On each day, tapping started about 6.30 a. m. and latex was collected around noon. The latex from each tree was collected in a cup, coagulated by adding formic acid, milled, dried 48 hours at 65° C, and weighed. The results for each month were subjected to analysis of variance, with degrees of freedom and expected mean squares as shown below.

Source of Variation	D. F.	EMS
Between trees	69	$V_e + 15\,V_t$
Within trees	70(14) = 980	V_e

From the variance, repeatability or intra-class correlation estimates obtained according to the following formula:

$$\text{Repeatability} = \text{Intra-class correlation} = V_t / (V_t + V_e)$$

Also, coefficients of correlation were calculated according to the formula:

$$\text{Coefficient of variation} = \sqrt{V_e} / \text{Mean} \times 100$$

Over the 12-month test period the 70 ramets of clone RRIM-623 had a range of 13 to 63 and an overall average of 33 gm/tree/tapping.

The month-by-month estimates of repeatability and the coefficients of variation varied as shown below.

The average yield per tree became very low in January when the trees lost their leaves but was relatively constant through most of the rest of the test period. January was also the month with the lowest repeatability and the highest coefficient of variation.

The repeatability estimates given above are based upon 70 ramets of the same clone. They contain no genetic component and are therefore lower than they would be if based on an experiment including genetically diverse material. Waidyanatha and Fernando (1972) obtained a repeatability estimate (R = 0.685) for dry rubber yields from nursery seedlings.

The coefficients of variation are given on the third line in the above tabulation. Several authors in their investigations on clonal yield variability have given coefficients of variability closely similar to the obtained average value (CV = 30.6) as shown on the table. A report from Indonesia (Ferwada, 1969) gave coefficients of variation 16—22%, Malaysia (Hardon, 1969 and Narayanan *et al.*, 1972) 30—40% and 20—55% respectively and from Srilanka (Senanayake, 1975) 7.3—34.5% with an average value of 27.0%.

From the practical standpoint coefficients of variation are of greater interest than the repeatability estimates. The standard error of any particular estimate of a clone mean varied inversely as the square root of the number of observations. Thus, if the coefficient of variation (a figure applicable to single observations) is 30.6%, the standard error of a clone mean is 2.9/3% of the mean if based on 9 tappings, 3.4/4% of the mean if based on 16 tappings, 2.5/5% of the mean if based on 25 tappings, etc. In this manner the data given here can be used to determine the number of tappings necessary to determine clone means with any particular degree of accuracy.

Month	1977 10	11	12	1978 1	2	3	4	5	6	7	8	9	Mean
Repeatability	.61	.79	.67	.50	.81	.83	.65	.75	.84	.72	.67	.70	.71
Coefficient of variation (%)	27.9	25.2	35.7	49.1	28.7	28.5	34.1	31.7	22.1	28.7	31.2	24.2	30.6

Literature Cited

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Report

Third International Workshop on the Genetics of Host-Parasite Interactions in Forestry, 14—21.9.1980, Wageningen, Netherlands. This workshop, attended by 72 scientists from 21 countries, was organized by a committee formed by IUFRO Subject Group S2.05 (Resistance to insects and diseases) and was supported financially by the Heidemij Company, the North Atlantic Treaty Organization, and the Dutch Ministry of Agriculture and Fisheries. The workshop was a sequel of the meetings in 1964 in Pennsylvania and 1969 in Idaho with the same general topic: resistance breeding in trees.

The theme of the workshop "Breeding for Balance" proved to be a most stimulating and elusive abstraction, which provoked, intrigued, and inspired all participants.

The 41 invited speakers presented papers during 9 plenary sessions which centered on the following topics: Host-Parasite Interactions and the Environment, Host-Parasite Interactions and Genetics on the Individual Plant Level, Resistance Mechanisms and their Genetic Control, Biochemical Aspects in Resistance Breeding, Genetic Variation in Fungal Pathogenicity, Population Genetics and Breeding for Balance, and Presentation and Analysis of Current Breeding Programs. In addition 20 voluntary papers were presented in 3 concurrent sessions called Insect Resistance, Root and Butt Rot of Conifers, and Resistance in Pines (to fungi). The workshop did not consist only of sessions in which papers were presented. The participants were also assigned to 6 discussion groups, each with a given topic. These groups delivered their reports to a special plenary session.

Although the participants represented many fields of research involved in both theoretical and practical aspects of resistance breeding, it was generally felt that the representation from tropical and sub-tropical areas was regrettably small, to say the least. Therefore, one of the adopted recommendations strongly points out the need to strengthen the fields of pathology, entomology, and resistance breeding in those areas. For the same reason, the IUFRO Subject Group S2.05 was urged to organize a next workshop in a tropical country in 1985. Another weakness also became apparent: there seem to be rather few forestry scientists in the world who study genetics of host-arthropod interactions.

A recommendations committee working throughout the workshop analyzed and combined suggestions from the participants into 14 recommendations. It was recommended that:

1. scientific and technical terms be used with precision and consistency;
2. international and national agencies for research and development be encouraged to acquire and train scientific and technical personnel to combat pests (includes all biotic agents that damage trees) attacking or threatening forest plantations in tropical and sub-tropical countries;
3. systems for integrated forest pest management be designed such that they are based on genetic resistance and provide for maintenance of ecosystem stability;
4. genetical, physiological, and epidemiological aspects of host-parasite interactions all be investigated so that mechanisms underlying resistance can be understood;
5. legislative and regulatory agencies be alerted to the danger that well-intentioned actions to ensure excellence of clonal material may have the undesired side effect of restricting the number and variety of clones legally available for use, and that said agencies be encouraged to modify such actions wherever warranted, so as to foster use of adequate numbers of clones in mixed or mosaic plantations;
6. actions to conserve genetic resources contained in forest ecosystem be taken soon, that conservation be undertaken at one or more levels (alleles, co-adapted gene complexes, populations, or ecosystems), and that ecosystems of special interest be secured intact so that interacting populations can continue to co-evolve and remain available for study;
7. procedures for international exchange and testing of agronomic host-plant germplasm be examined for applicability to forestry situations, and be modified, as necessary to increase effectiveness in monitoring and breeding for pest resistance in forest trees;
8. those formulating theories, models, and strategies for forest populations be encouraged to draw on genetic concepts from the broader fields of population and community biology, as well as from the narrower but richer experience had in closely bred agronomic system;
9. population genetics of major tree species and their pests be investigated so as to characterize qualitative and quantitative components of environmental and genetic variation;
10. efforts to develop trees resistant to decay agents be increased, in view of recent, promising advances in decay research;
11. parallel non-protected experiments be conducted to determine if resistance is lost where materials in breeding programs are given artificial protection against damaging agents;
12. model host-parasite systems, analogous to *Drosophila* and *Escherichia coli*, be identified and developed for detailed investigations of tree-pest interactions;