

ABSTRACT
STUDIES ON THE GENETICS OF RESISTANCE IN
***THEOBROMA CACAO* L. TO WITCHES' BROOM DISEASE**
CAUSED BY *CRINIPELLIS PERNICIOSA*

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Host (age, leaf number, clone/seedling), pathogen (inoculum concentration) and environmental (incubation time) factors were manipulated in shade house experiments to develop an inoculation methodology aimed at achieving 100% infection to witches' broom disease, on a repeatable basis, with a susceptible *Theobroma cacao* genotype. Three different methods of inoculation (agar-droplet, water-droplet and spray) were tested to determine their repeatability. The optimized method based on an inoculum concentration of 350,000 basidiospores/mL and an incubation time of 60 h, using the agar-droplet technique, was able to produce 100% infection on both clonal and seedling plants of a susceptible genotype, on a repeatable basis. The results showed that the resistance level of seedlings can be determined in 12-month-old plants. Leaf number did not significantly affect percentage symptomatic plants or broom characteristics.

Twenty four micrografted clonal genotypes and 13 open-pollinated derived progenies were tested in a randomized complete block design with three replications in a greenhouse using the optimized screening methodology developed. Ten measures of resistance were investigated to determine the measure that was able to provide a valid, precise/repeatable, accurate and heritable estimate of resistance. The measures were also evaluated for their ability to differentiate between intermediate levels of resistance and for their ability to be used as single plant estimates. Pearson's correlation analysis was carried out on the 10 measures of resistance to assess the interrelationships between the various measures of resistance.

The results indicated that incubation period (days to symptom appearance) was the most effective measure of resistance, out of all the criteria. Further, this measure correlated well with field resistance and with broom number and size, which are epidemiologically important measures of resistance. The results also showed that one can predict the levels of parental resistance based on evaluation of 25-30 top cross progeny genotypes. The study identified 9 new sources of resistance that can be used in cacao breeding for witches' broom resistance. The study also furthered the understanding of the mechanisms of resistance to *Crinipellis perniciosa* in cacao.

The genetics of resistance to witches' broom disease was investigated using two mating designs (a) M x N mating design using 12 parents and (b) a 4 x 4 diallel without selfs. Genetic analysis was performed using the North Carolina Model-II analysis, diallel analysis and parent-offspring analysis. The results showed that inheritance was quantitative and under the control of predominantly additive genetic effects. Non-additive effects were less important and varied depending on the cross. The heritability in the broad-sense and narrow-sense were 93.5% and 79.3% for broom-base diameter and 94.7 % and 78.6% for incubation period based on North Carolina Model-II analysis. The narrow-sense heritability for incubation period and broom-base diameter based on parent-offspring regression analysis were 85% and 88%, respectively. The high general combining ability for the resistance parameters indicated that parents can be selected for breeding based on their *per se* performance determined by the optimized screening approach. A pre-breeding method to incorporate witches' broom resistance based on the findings is suggested. The results show that considerable genetic gain could be achieved using the optimized screening method.

Keywords: Inheritance of resistance, inoculation method, resistance screening