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METHODOLOGY FOR CACAO GERMPLASM EVALUATION IN ARECA-CACAO INTERCROPPING EXPERIMENT WITH SUPER-IMPOSED TREATMENTS

by

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SUMMARY

A few Malaysian cacao accessions were introduced into India in 1969 with a view to study the possibility of cultivating them in arecanut gardens as an intercrop to enhance per unit area returns. Since cacao is gaining importance in the national economy in recent times, it necessitated identification of superior genotypes with high yield potential. Even though some of these introduced germplasm material showed high yield, as they are growing as an intercrop in an arecanut garden with manurial and spacing treatments, it couldn't be taken as their actual yield potential with certainty. Therefore a methodology has become very much essential to assess their genotypic potential to utilise them in future breeding programme.

An attempt is made here to evaluate the eleven germplasm material which are uniformly distributed in a spacing cum manurial trial of areca-cacao intercropping experiment. The experimental data arising out of the model

$$y_{ijk} = \mu + b_{i_1} + s_j + m_k + (sm)'_{jk} + e_{ijk}$$

under the usual assumptions were transformed to satisfy the model

$$y_{lm} = \mu + \tau_l + e_{lm}$$

by eliminating the various treatment effects (b_{i_1}, s_j, m_k, $(sm)'_{jk}$) and separating out the contribution of accessions (τ_l) which were masked in the residual term e_{ijk}.

Analysis of this transformed data enabled us to identify Amel × Na33, Landas 357 and Landas 364 as better performers with regard to both number and weight of pods.

METHODOLOGIE DE L'EVALUATION DU GERMOPLASME DU CACAOYER DANS DES EXPERIENCES DE CULTURES MIXTES AREQUIERS-CACAOYERS AVEC TRAITEMENTS SURIMPOSES

RESUME

Quelques nouvelles obtentions de cacaoyers malaisiens ont été introduites en Inde en 1969, en vue d'étudier la possibilité de les cultiver en association avec les aréquiers, pour rehausser le rapport par unité de surface. Le cacaoyer revêtant davantage d'importance dans l'économie nationale à l'heure actuelle, cela a exigé d'identifier des génotypes supérieurs, à fort rendement potentiel. Bien que certaines de ces obtentions de germoplasmes aient manifesté un fort rendement, comme il s'agissait d'une culture associée dans une plantation d'aréquiers, avec traitements par espacement et engrais naturels, il n'a pas été possible d'y voir leur potentiel réel de rendement de façon certaine. C'est pourquoi, une méthodologie est devenue très essentielle pour évaluer leur potentiel genotype pour les utiliser dans des programmes de sélection génétique de l'avenir.

Un effort est fait pour évaluer les onze matériels de germoplasme qui sont distribués de façon uniforme dans un dispositif d'essais d'espacement et de fumage, dans le cadre d'une expérience de culture associée aréquier-cacaoyer. Les données expérimentales qui découlent du modèle:

$$y_{ijk} = \mu + b_i + s_j + m_k + (sm)_{jk} + e_{ijk}$$

dans les hypothèses normales, ont été transformées pour répondre au modèle:

$$y_{lm} = \mu + \gamma l + e_{lm}$$

en éliminant les divers effets de traitements (b_i, s_j, m_k et $(sm)_{jk}$) et en séparant l'apport des obtentions (γl) qui était dissimulé dans le terme résiduel e_{ijk}.

L'analyse de ces données transformées nous a permis d'identifier Amel × Na 33, Landas 357 et Landas 364 comme ayant un meilleur comportement en ce qui concerne le nombre aussi bien que le poids des cabosses.

METODOLOGIA PARA AVALIAR GERMOPLASMA DE CACAU NUM ENSAIO DE ASSOCIAÇÃO DE PALMEIRA ARECA E CACAUEIRO COM TRATAMENTOS

RESUMO

Algumas variedades maláis de cacau foram introduzidas na India em 1969 afim de serem cultivadas em plantações de palmeiras areca, para aumentar a rentabilidade por unidade, Como o cacau está assumindo maior importância na economia nacional, é necessário identificar genótipos superiores com elevado potencial de rendimento. Apesar de que algumas das variedades introduzidas produziam muito bem não se tinha certeza de que essa produtividade correspondia ao seu potencial real, uma vez que eram cultivadas em associação com palmeiras areca, com espaçamento e adubação adequadas para esta última cultura. Assim, é preciso encontrar uma metodologia para averiguar o potencial genotípico dos cacaueiros para a sua utilização futura em programas de melhoramento.

Aqui procura-se avaliar onze germoplasmas uniformemente distribuidos num ensaio de espaçamento e adubação em associação com palmeiras areca. Os dados experimentais decorrentes do modelo

$$y_{ijk} = \mu + b_i + s_j + m_k + (sm)_{jk} + e_{ijk}$$

com as premissas habituais foram transformados para se adequar ao modelo

$$y_{lm} = \mu + \gamma l + e_{lm}$$

eliminando o efeito dos vários tratamentos (b_i, s_j, m_k e $(sm)_{jk}$) e excluindo a contribuição de variedades (γl) que foi velada no termo residual e_{ijk}.

A análise destes dados transformados permitiu a identificação de Amel × Na 33, Landas 357 e Landas 364 como as variedades de melhor rendimento, em função do número e peso dos frutos.

METODOLOGIA PARA LA EVALUACION DE GERMOPLASMA DE CACAO EN UN EXPERIMENTO DE INTERCULTIVO DE ARECA/CACAO CON TRATAMIENTOS SUPERIMPUESTOS

RESUMEN

En 1969 se introdujeron en la India unas cuantas planta de cacao de Malasia con el fin de estudiar la posibilidad de su cultivo en plantaciones de areca como intercultivo que aumentaría el rendimiento por unidad de área. Como el cacao está ganando importancia en la economía nacional en los últimos tiempos se necesitaba la identificación de genotipos superiores con potencial de alto rendimiento. Aunque parte del germoplasma introducido mostraba un alto rendimiento, como crecía como intercultivo en una plantación de areca, con tratamientos de estiércol y de espaciamiento, no se lo podía considerar como su potencial de rendimiento con certidumbre. Por ello se hizo necesaria una metodología para evaluar su potencial genotípico para utilizarlo en futuros programas de multiplicación.

Se hace aquí una tentativa por evaluar los once germoplasmas que están distribuidos uniformemente en un experimento de espaciamiento con estercolado en un intercultivo de areca/cacao. Los datos del experimento obtenidos del modelo:

$$y_{ijk} = \mu + b_i + s_j + m_k + (sm)_{jk} + e_{ijk}$$

en las hipótesis usuales se transformaron para satisfacer el modelo

$$y_{lm} = \mu + \gamma l + e_{lm}$$

eliminando los varios efectos de tratamiento (b_i, s_j, m_k y $(sm)_{jk}$) y separando la contribución de accesiones (γl) que estaban ocultadas en el término residual e_{ijk}.

El análisis de esos datos transformados nos permitió identificar Amel × Na 33, Landas 357 y Landas 364 como de mejor actuación en lo que respecta tanto al número como al peso de las mazorcas.

INTRODUCTION

CACAO was introduced in India mainly to study its adaptability as an intercrop of arecanut or coconut palms to enhance the returns per unit area (Shama Bhat and Bavappa, 1972). Initially eleven promising cacao accessions of Malaysia were introduced and laid out in a spacing cum manurial trial with arecanut. Presently, since cacao is gaining considerable importance in the national economy, it necessitated identification of superior genotypes with high yield potential. Even though some of these introduced germplasm material showed high yield, as they are growing as an intercrop in an arecanut garden with spacing cum manurial treatments, it couldn't be taken as their actual yield potential with certainty. Therefore a methodology which attempts to remove all the effects due to super-imposed treatments and partition the effect due to accessions has become very much essential to assess the actual genotypic potential of each accession. The accessions thus identified for better yield can be exploited in varietal improvement programmes.

A methodology such as this, will serve as a very important tool for eliciting more and more information from an on-going experiment. This is more helpful especially for researchers in perennial crops, because the perennial crop experiments take a long time to arrive at the conclusions. In most of the cases, experiments planned with a specific purpose may contain some more useful information hidden in it. In the past, Ray *et al.* (1973) have estimated optimum size and shape of plot from fertilizer trial data on tomato. Bhagavan and Nair (1986) have obtained vigour index in arecanut from a varietal trial.

MATERIALS AND METHODS

At this Regional Station, an experiment involving 6 spacings and 2 manurial doses laid out in 1970 in a 6 × 2 asymmetrical confounded factorial design with 4 replications is in progress. Cacao seedlings from 11 accessions were uniformly distributed within and between plots. These 11 accessions are Amel × Na32, Amel × Na33, Amel × PA7, PA7 × Na32, Red Axil, Landas 356, Landas 357, Landas 358, Landas 361, Landas 364 and Landas 365. The basis of the analysis of this experiment follows from the model

$$y_{ijk} = \mu + b_{i_1} + s_j + m_k + (sm)'_{jk} + e_{ijk}$$
$$i = 1, 2 \ldots 4 \qquad i_1 = 1, 2 \ldots 8 \qquad \text{(A)}$$
$$j = 1, 2 \ldots 6 \quad \text{and} \quad k = 1, 2$$

where μ is the mean contribution common to all plots, s_j is the mean contribution of j^{th} spacing, m_k is the mean contribution of plots receiving k^{th} manurial dose, b_{i_1} is the unadjusted contribution of i_1^{th} block, $(sm)'_{jk}$ is the unadjusted contribution of plots receiving k^{th} manurial dose in j^{th} sapcing which is mixed up with block effects and e_{ijk} are random errors normally distributed about a mean zero and constant variance σ^2.

Each of the 48 plot yields (p_q, $q = 1, 2 \ldots 48$) were transformed to adjusted plot yields (p'_q) by eliminating the various treatment effects (unadjusted block effect, spacing effect, manures effect and unadjusted interaction effect) as described by Ray *et al.* (1973). This resulted in transformation of model (A) to

$$y_{ijk} = \mu + e_{ijk} \qquad \text{.. (B)}$$

Further, each plot consists of several trees belonging to different accessions. Let n_q denote the number of trees in q^{th} plot and t_{rq} denote the tree yield of r^{th} tree in q^{th} plot, where $r = 1, 2 \ldots. n_q$ and $q = 1, 2 \ldots. 48$. With the assumption that the effect of imposed treatment on a plot will be uniformly distributed to all the trees within the plot, each tree yield was adjusted against all imposed treatment effects using

$$t'_{rq} = t_{rq} - (p_q - p'_q) \qquad \text{.. (C)}$$

and the model (B) was transformed by partitioning the accession effects from the residual term resulting in

$$y_{lm} = \mu + \tau_l + e_{lm}$$
$$l = 1, 2, \ldots, 11 \quad \text{and} \quad m = 1, 2, \ldots, n_l \qquad \text{.. (D)}$$

where τ_l is the mean contribution in respect of l^{th} accession. This model (D) facilitates the analysis to be carried out as in the case of completely randomized design to assess the performance of accessions.

RESULTS AND DISCUSSION

Distribution of accessions receiving various treatments is given in Table 1. The trees belonging to various accessions are randomly distributed over all the treatments. In fact even the trees within each plot belong to different accessions, thereby satisfying the basic assumption of random allocation of accessions in the experiment for a completely randomized design (CRD) analysis.

After eliminating the various treatment effect and after adjusting tree yields using equation (C), analysis of CRD was carried out separately for number of pods and weight of pods. The analysis of variance table (Table 2) reveals that the accessions differ significantly for both the yield attributes. Mean yield, standard error and the differing pattern of eleven accessions are given in Tables 3 and 4 for number of pods and weight of pods respectively. It is observed that Landas 364, Landas 357 and Amel × Na33 performed better with respect to both the yield attributes.

TABLE 2
Analysis of variance.

		Mean sum of squares	
Source	*df*	*No. of pods*	*Wt. of pods*
Between accessions	10	1,462.36*	127.26*
Within accessions	372	661.68	64.96

*Significant at $P \leqslant 0.05$.

TABLE 1
Frequency distribution of trees under each treatment.

	Treatments											
Accessions	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
Red Axil	3	4	2	1	1	2	2	1	3	3	2	2
Amel × Na33	6	6	3	3	2	2	4	4	6	5	4	4
Amel × Na32	6	6	3	3	2	2	3	4	6	6	4	4
PA7 × Na32	6	6	3	3	2	2	3	4	4	5	3	4
Amel × PA7	6	6	4	4	2	4	4	5	3	5	3	4
Landas 356	3	3	2	2	1	1	2	2	3	3	2	2
Landas 357	3	2	2	2	1	1	2	2	2	2	2	2
Landas 358	6	6	4	3	4	2	4	4	5	6	2	4
Landas 361	2	2	2	2	1	1	2	2	2	2	2	2
Landas 364	2	2	1	1	1	1	2	2	2	2	1	1
Landas 365	4	3	2	2	1	1	1	2	3	3	2	2

TABLE 3
Mean number of pods, standard error and differing pattern of accessions.

Accessions	*Mean number of pods*	*Standard error*	*Differing pattern*
Red Axil	51.30	5.04	│
Amel × Na32	52.09	3.22	│ │
Landas 361	55.47	3.46	│ │
Landas 365	57.83	4.19	│ │
Landas 356	61.41	5.06	│ │ │
PA7 × Na32	61.76	4.52	│ │ │
Landas 358	62.24	3.38	│ │
Amel × PA7	63.10	3.56	│ │
Landas 364	67.35	5.81	│ │
Amel × Na33	70.33	4.93	│
Landas 357	70.64	3.18	│

TABLE 4
Mean weight of pods standard error and differing pattern of accessions.

Accessions	*Mean weight of pods (kg)*	*Standard error*	*Differing pattern*
Amel × Na32	17.24	1.07	│
Red Axil	17.95	1.70	│ │
Landas 361	18.08	1.13	│ │ │
Landas 365	18.25	1.34	│ │ │
Landas 356	18.35	1.74	│ │ │
Landas 358	19.59	1.00	│ │ │
Amel × PA7	19.76	1.06	│ │ │
PA7 × Na32	20.39	1.44	│ │ │ │
Amel × Na33	21.34	1.32	│ │ │
Landas 357	22.77	1.10	│ │
Landas 364	24.48	2.64	│

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