Agric. Res. J. Kerala, 1983, 21 (2) 83—86

# EFFICIENCY OF COVARIANCE ANALYSIS IN MANURIAL TRIALS ON CASHEW

A large part of experimental error in field trials with perennial crops arises from the variability of the genetic make up of the experimental trees and statistical designing of field experiments paying attention solely to control the soil heterogeneity often fails to afford precise estimates of treatment differences. The most effective method of controlling experimental error arising from the inherent variability of individual trees is by applying the technique of analysis of covariance to the experimental data. Efficiency of analysis of covariance largely depends upon the choice of suitable calibrating variables. Several calibrating variables have been suggested from time to time by various workers for different perennial crops and the gain in precision achieved through the adjustments evaluated. Narayanan (1936), Abeywardena (1970) and Menon and Tyagi (1971) estimated the efficiency of covariance analysis in rubber, coconut and mandarin orange respectively. All of them found that the analysis of covariance resulted in a considerable gain in precision for plots and blocks of different sizes. But no such studies are known to have been made on cashew—a prominent commercial crop of Kerala. Cashew, being a cross pollinated perennial crop is highly heterozygous and the ordinary direct methods of controlling variability often fail to produce satisfactory results. Thus the object of the present study is to assess the value of covariance analysis in improving the efficiency of field experimentation on cashew.

The data required for the present study were obtained from the available records of the Cashew Research Station, Madakkathara. The experimental material consisted of a compact block of 576 trees in a 24 x 24 arrangement. All the trees were seed propagated progenies of the same mother tree and of the same age group. Secondary data on yield for 5 years from 1976-1981 were gathered from each tree and were treated as the pre-experimental data. Manurial schedule was changed during the year 1980 in accordance with a $3^3$ confounded factorial design superimposed on them during the year 1980. The year which followed the application of treatment was considered as the experimental period. In addition to yield, observations on certain auxiliary characters related to yield such as height, spread of canopy and trunk girth were also gathered. Plots of different sizes and shapes were formed by combining adjacent trees in different geographical configurations; a tree representing the basic unit.

The zero order correlation matrix of experimental yield (Y), trunk girth ($X_2$), tree height ($x_2$), mean spread of canopy ($x_3$) and four year's pre-experimental yield ($x_4$) is given in Table 3. Maximum correlation coefficient of 0,4335 was observed between experimentai yield and pre-experimental yield total. The multiple regression equation of experimental yield on the above four calibrating variables was statistically significant. The standardised partial regression coefficients of experimental yield on girth, height, spread and pre-treatment yield (Table 2) were found to be 0.2276, -0.1067, 0.0762 and 0.3206. The partial regression coefficients were tested for significance and all of them except that for spread were found to be significant.

Height has a negative direct effect on yield whereas all the other variables had positive direct effects on yield. Pre-experimental yield is the most prominent character contributing to variations in the yield of experimental trees, followed by girth. It can be inferred that a unit increase in trunk girth would be followed by an increase of 0.2276 units in yield. Thus trunk girth can be used as an additional calibrating variable along with pre-experimental yield in improving the efficiency of field experimentation on cashew, A similar result has been reported by Menon and Tyagi (1971) on mandarin orange.

Identification of vigorous trees solely on the basis of pre-experimental yield, need not always give reliable results. A composite index incorporating several yield contributing and growth parameters is considered to be a better substitute of pre-experimental yield for the purpose of calibration. Thus the multiple linear regression equation of the experimental yield on pre-experimental yield and the three growth characters can be used as a linear discriminant function for identifying superior trees. The correlation coefficient between this selection index and experimental yield was found to be 0,50. The selection index derived from the data is given below.

$Y= - 0.6283 + 0.0586^{**} x_1 - 0.0039 x_2 + 0.0016 x_3 + 0.1862^{**} x_4$

$(R^2 = 0.24,\ F = 41.29^{**})$

where $x_1$ — trunk girth in cm

$x_2$ = height in cm

$x_3$ = mean spread in cm

$x_4$ = average annual pre-experimental yield in kg.

Table 1

Correlation matrix of different plant characters in cashew

| | Y | $x_1$ | $x_2$ | $x_3$ | $x_4$ |
|---|---|---|---|---|---|
| Y | 1.0000 | 0.3497** | 0.1871** | 0.3689** | 0.4335" |
| $x_1$ | | 1.0000 | 0.6786** | 0.7286** | 0.4249** |
| $x_2$ | | | 1.0000 | 0.5965** | 0.2935** |
| $x_3$ | | | | 1.0000 | 0.5971** |
| $x_4$ | | | | | 1.0000 |

Table 2

Partial regression coefficient, their standard errors and 't' values

| Name of the character | Partial regression coefficient (bi) | Standardised partial regression co-efficients | Standard error of bi | 't' value |
|---|---|---|---|---|
| Girth | 0.0586 | 0.2276 | 0.0156 | 3.75** |
| Height | -0.0039 | -0.1067 | 0.0019 | 2.053* |
| Spread | 0.0016 | 0.0762 | 0.0013 | 1.215 |
| Pre-expl. yield | 0.1862 | 0.3206 | 0 0270 | 6.91** |

** Significant at 0.01 **level**

* Significant at 0.05 level

Table 3

Efficiency of covariance analysis with different covariates in blocks of different sizes

| No. of plots/ block | unadjusted M. S. E. | Adjusted M. S. E. | | | Percentage reduction in M.S.E. | | | Relative efficiency | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | A | B | C | A | B | C |
| 4 | 9.0476 | 6.3001 | 7.8621 | 5.8621 | 30.37 | 13.10 | 35.20 | 143.61 | 115.08 | 154.33 |
| 8 | 9.5974 | 7.0694 | 8.6453 | 8.6453 | 26,34 | 9.92 | 32.84 | 135.76 | 111.01 | 148.88 |
| 12 | 9.6355 | 7.1306 | 8.7461 | 8.7461 | 25.96 | 9.23 | 27.92 | 135.12 | 110.17 | 138.74 |

A = pre-experimental yield  B = trunk girth  C — selection index

Selection indices based on other combinations of explanatory variables gave smaller values of coefficient of determination and hence were not retained for further analysis.

Analysis of covariance was performed with pre-experimental yield (A), girth (B) and selection index (C) as concomitant variables and the relative efficiency of covariance analysis over ordinary analysis of variance was estimated. The results are given in Table 3.

It can be seen that covariance analysis resulted in a considerable gain in precision with single tree plots in blocks of varying sizes. Single tree plots were chosen for estimating the relative efficiency due to the sole fact that they provided with maximum precision on a per tree basis in cashew. With larger plots the efficiency of covariance analysis would be still larger (Menon and Tyagi, 1971). Among the three calibrating variables the selection index served as a better covariate than four years pre-experimental yield and trunk girth. In existing orchards where data on previous yield of trees are not available, girth can also profitably be used as auxiliary variate for making adjustments through analysis of covariance. But the reduction of error through analysis of covariance using girth as the covariate was not appreciable. Narayanan (1966) has recommended trunk girth as a calibrating variable in rubber. Menon and Tyagi (1971) noted a 90 per cent gain in efficiency due to analysis of covariance with spread of canopy as the auxiliary variate in experiments on mandarin orange. But with cashew only five to ten per cent gain in precision could be achieved through analysis of covariance using spread as the auxiliary variate.

## സംഗ്രഹം

കശുമാവിൽ സഹവ്യതിയാന വിശ്ലേഷണത്തിന്നുപയോഗിക്കാവുന്ന സഹഗാമിചരങ്ങളെ നിർണ്ണയിക്കുന്നതിനും തൻമൂലമുണ്ടാകുന്ന സൂക്ഷ്മതാലാഭം ആകലിക്കുന്നതിനുമായി ഒരു വളപരീക്ഷണത്തിൻെറ ഫലങ്ങളെ സാംഖ്യകീയമായിran> പഗ്രഥിക്കുകയുണ്ടായി സഹവ്യതിയാന വിശ്ലേഷണത്തിന് പൂർവ്വ സംപ്രയോഗ വിളവിനേക്കാൾ ffnu^jEoos/leOsiണതു് പ്രത്യുത ചരവും ഏതാനും വ്യുദ്ധിചരണങ്ങളും ഉൾക്കൊള്ളുന്ന ഒരു രേഖികഫലനമാണ്. മുൻകാല വിളവിനെക്കുറിച്ചുള്ള വിവരങ്ങ30 ലഭ്യമല്ലാത്ത അവസ്ഥയിൽ പരീക്ഷണം തുടങ്ങുന്നതിനു തൊട്ടുമുമ്പുള്ള വർഷത്തിൽ ശേഖരിച്ച വൃക്ഷങ്ങളുടെ കടവണ്ണത്തെക്കുറിച്ചുള്ള ദത്തങ്ങൾ പിശകു ന്യൂനീകരണത്തിനു സഹായിക്കുന്നതായിക്കണ്ടു. ഏതു് പരിതഃസ്ഥിതിയിലും സഹവ്യതിയാന വിശ്ലേഷണം സംപ്രയോഗ പ്രഭാവങ്ങളുടെ സൂക്ഷ്മമായ ആകലനത്തിന് വഴി തെളിക്കുമെന്ന് ദത്തങ്ങൾ സൂചിപ്പിക്കുകയുണ്ടായി.

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