UNIFORMITY TRIALS ON COLOCASIA *(COLOCASIA ESCULENTA L.)*

BY

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THESIS

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DECLARATION

I hereby declare that this thesis entitled "UNIFORMITY TRIALS ON COLOCASIA (*Colocasia esculenta*.L)" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other university or society.

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CERTIFICATE

Certified that this thesis, entitled "UNIFORMITY TRIALS ON COLOCASIA (Colocasia esculenta.L)" is a record of research work done independently by Smt. LIZY.M.J. under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship, or associateship to her.

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Ariods are an important group of tropical tuber crops They are produced and consumed as staple foods by some 200 million people in the world. Ariods are adopted to a wide range of ecological conditions that exist in the tropics. Research and development in the edible ariods have been meagre compared to the other tropical tuber crops such as cassava, sweet potato and yams.

Among the various ariods the most important and most extensively cultivated ariod is Colocasia esculenta L. Colocasia (Colocasia esculenta L.) belongs to Araceae family. The leaves and young petioles of this crop are edible. This is a popular tuber crop in Kerala, Tamil Nadu and Karnataka. The best results are obtained by growing the crop on paddy fields and raised beds where soil moisture is always available.

There is considerable evidence that colocasia and other edible ariods were distributed from East India to Taiwan and the Solomon Islands. (Spencer 1966). In Hawai, colocasia has traditionally been used for the manufacture of 'poi', the staple food of Hawaiion's. It is prepared from boiled corms which is smashed into a paste and allowed to ferment a day or more(de la pena, 1970). In Asia and Pacific areas where colocasia is an important crop, the tops are cooked and used for human consumption as a very nutritious vegetable and the corms are used as staple food in place of rice or potato (de la pena 1970, Plucknett et al 1970). Commercial use of corms in the manufacture of colocasia chips has also been succesful in Hawai. Taro (colocasia) tops have been ensiled and fed to livestock. Nutritional and feeding qualities of taro silage have so far been all favourably shown by laboratory and feeding trials (Carpenter et al 1981).

The present status of world taro production is not clear. Production and consumption are primarily of the subsistance type with little reported commercial marketing activities (FAO,1975). Production is generaly in small plots and yield varies widely. Taro may be intercropped between other plants. World average production is 5t./ha./year, but its maximum yield potential is reported to be 75t./ha./year (Gnwueme, 1978).

Taro requires large amount of water. Since it is rare even in the humid tropics and subtropics, to have uniformly distributed rainfall through out the year, taro production is generally limited to places where irrigation water is available. Taro leaves contain a high propoition of proteins and taro corms are rich in calcium, phospnate, and vitamins A, B and C (Wrigley, 1969).

Like the tubers of other crops, corms are high in carbohydrate and low in fat and protein (Gopalan et al., 1979). For supplying nutrients, the corms may be considered as a good source of carbohydrate and potassium.

Five hundred g.of the corm will supply 2g. of potassium, .2g. of carbohydrate and 15g. of protein. Although taro corms are relatively poor in carotic acid and carotene (Peters,1958), the carotene content is equivalent to that of cabbage and twice that of potato.

The popular variety of taro grown in Kerala is known as 'Tamarakannan'. The seasons of this crop are mainly May-June to October-November, if it is rainfed and September-October to February-March if it is irrigated. The seed material is the side tubers each weighing 40-45g.

The crop is mainly planted in rows such that the row to row distance is 60cm and plant to plant distance, 45cm. As a basal dressing compost is applied at the rate of 12t./ha. at the time of planting. A fertilizer dose of 80:50:100 Kg. of N, P_2O_5, K_2O per ha. is applied as 2 split doses. Full dose of P and 1/2 dose of N and K is applied within a week after sprouting and the remaining 1/2 dose of N and K one month later along with weeding and earthing up. Soon after planting, the ridges are covered suitably by mulching materials for retension of moisture and control of weeds. Colocasia blight is the common disease of the crop which can be controlled by spraying ziram, zineb, dithane or blue copper at 2g/litre of water (1Kg./ha.). In Kerala average yield of this crop is estimated to be 20t./ha. As this crop plays an important role in the food habits of common man, field experiments are often taken up to standardise its cultivation

REVIEW OF LITERATURE

REVIEW OF LITERATURE

For improving the efficiency of experimental technique apart from other considerations like randomisation, local control and replication the size and shape of the plot adopted for the experiment are also of great importance. The size and shape of the plot depend on the variability present in the crop and the environment in which it is grown. Many attempts were made in evaluating the optimum size and shape of plots and blocks for many crops. On annual crops like paddy, wheat, jowar, maize and sugarcane, large number of studies were made in India and abroad. But regarding the suitable size and shape of the plot and block on tuber crops very little information is availabe in the country. No such attempts have been made with regard to colocasia.

2.1 Magnitude of soil fertility

An adequate characterisation of soil heterogeneity in an experimental site is a good guide and at times even a prerequisite for choosing a good experimental technique. Based on the premise that uniform soil when cropped simultaneously will produce the same, soil heterogeneity can be measured as the difference in performance of plants grown in a uniformly treated area. Soil heterogeneity constitutes a large source of error in field experiments and hence it is necessary to eliminate this upto maximum extend. Proper experimental techniques can considerably reduce the effect of soil heterogeneity on experimental results (Fisher, 1951; Panse and Sukhatme, 1954; Cochran and Cox, 1957; and Federer, 1963).

Harris (1920) proposed the intra class correlation coefficient of yields from adjacent areas as an index of soil heterogeneity. He concluded that the correlation between the yields of adjacent plot was either due to initial, physical and chemical similarities of the soil or to the influence of previous crops upon the nature and composition of the soil.

Bose (1935) found that an experimental site which was uniform for one crop in one season was not necessarily be uniform for another crop in another season. He concluded that the Analysis of Variance was more useful than Harris's index of soil heterogeneity because it provided not only the nature of soil fertility but also permitted the identification of fertility gradients.

Smith (1938) proposed an index of soil heterogeneity which gives a single value as a quantitative measure of soil heterogeneity in an area. This index is proposed on the emperical relation between plot variance and plot size:

$$V_X = V_1 X^{-b}$$

where, V_X is the variance of mean yield per plot based on plots of X units in size; V_1 is the variance among plots of size unity and 'b' is the index of soil heterogeneity. The value of the index 'b' indicates the degree of correlation between adjacent experimental plots. Normally the value of 'b' varies between zero and unity. The larger the value of the index, the lower is the correlation between adjacent plots, indicating that fertile spots are distributed randomly or in patches.

From a uniformity trial on tobacco Crews et al.(1963) showed that the soil heterogeneity index was higher for yield, than for other charecters. However 'b' for different characters varied within individual trials and 'b' for yield was not always higher. Federer (1963) found that the value of b were in most cases lie in the range 0.3 to 0.7. Gupta and Raghavaiao (1971) on onion bulbs found that Smith's relation,

$$Y=aX^{-b}$$

was satisfactory. The significance of b was tested and it was significant at 5% level of significance. Similar results were obtained by Bharghava et al.(1973)on apple, Sreenath (1973) on sorghum, Bist et al. (1975) on potato, Rambabu et al. (1980) on grass and Nair(1984)on turmeric. Nair (1981) obtained the value of b as high as 0.97 where as on oats Handa et al. (1982) obtained the values within the range 0.084 and 0.187. Mangat (1984) on cotton also obtained the significance of b value. Nair (1984) found that the value of b was more nearer to zero than unity and hence the appearance of strong correlation between neighbouring plots were established.

Using Fairfield Smith's law George *et al.* (1979) established the relationship:

$$Y=ax^{-g}$$

in turmeric to find out the relationship between plot size(x) and coefficient of variation (Y) where 'g' is the heterogeniety coefficient.

Generalisation of this law in the form:

$$Y=ar^{-g_1}c^{-g_2}$$

was also tried by them to compare the heterogeneity of rows (r) and columns(c), where g's denote the corresponding heterogeneity coefficients. The coefficient of variation of a plot with 'r' rows and 'c' columns was represented by the relationship:

$$Y=ar^{-g_1}c^{-g_2}$$

The rowwise heterogeneity was significantly higher than columnwise heterogeneity, thereby emphasising that formation of plots with more number of rows will give more homogeneous blocks for experiments.

2.2. Size and shape of plots

The ultimate experimental unit on which the random assignment of treatment is made is called the experimental plot. The size of the plot therefore refers the whole unit recieving the treatment. The shape of the plot refers to ratio of its length to its width.

The first theoretical consideration of plot shape was made by Christids (1931). By making use of the assumption of linear fertility gradient Harris and Scofield (1920) derived a formula for the effect of plot shape on variation and he established the result that long and narrow plots was more efficient than square ones. A battery of research workers agreed with his findings. They include Kripasankar (1972) on soybean, Saxena et al. (1972) on fodderr oat, Sreenath (1973) on sorghum, Hariharan (1981) on brinjal and Nair (1984) on turmeric.

Size of a plot may be determined by the facilities available for handling the plots. Kempthorne (1974) declared that use of small plots is limited to a certain extent by the unfavourable ratio of border to the test area occuring with them. When plot size reduces, the area left for the border area increases; i.e., the ratio of border to test area increases.

Smith (1938) proposed the first theoretical formula for assessing the effect of plot size on variation. He developed a linear relationship between variance and plot size with the regression coefficient describing the degree of correlation between adjacent areas of land. Almost all workers had fitted this equation.

Koch and Rigney (1951) developed a new method called "variance component heterogeneity index method" for estimating plot size by using data from actual field experiments and not from uniformity trial data. This method consisted in estimating the components of variance due to plots of different sizes by constructing the analysis of variance of the specified designs and using estimated variances for fitting Smith's equations. They illustrated the use of experimental data from split-plot and lattice design in determining the optimum plot size.

Cochran(1940) also considered the problem of the shape of plot for various types of fields. He attributed the cause of variation with small and large values of fertility gradients in the experimental field. When the value of the fertility gradient is small, the selected plot shape did not exert considerable effect on soil heterogeneity. For large values of fertility gradient long and narrow plots should be selected.

Sardana et al. (1967) found that the optimum plot size for field experiments with potato was about $8.4m^2$. Agarwal et al. (1968) conducted a uniformity trial on arecanut to study the effect of size and shape of the plot on coefficient of variation. They found that the magnitude of coefficient of variation decreases with the time interval. The coefficient of variation decreases with the increase in plot size. With regards to the optimum plot size for a given area the objective should be to decrease the plot size as far as possible, subject to the practical considerations and to the number of replications.

Abraham and Vachani (1964) conducted a uniformity trial on rice to find out the size and shape of plots and blocks. He found that coefficient of variation for five or ten plot blocks decreased with an increase in plot size irrespective of the shape of the plots. The shape of the plots did not show any consistent effect on plot variability. Plots elongated in the east-west direction showed less variability than plots elongated in the north-south direction.

In field experiments with mandarian orange, Menon and Tyagi (1971) observed that relative information per tree was maximum in case of single tree plots. With confounding systems and balanced incomplete block designs the effective relative efficiency of the balanced incomplete block designs varied from field to field.

Pahuja and Mehra (1981) in chickpea suggested that with four replications maximum precision could be obtained from a plot size of 1.8m x 5m. However within the value of the coefficient of variation, a difference of less than 17% of the mean was detected. Therefore larger plots are recommended so that differences of 10-15% are detectable. The values of the coefficient of variation decreased continuosly as the row length or the number of rows harvested per unit area increased. However coefficient of variation did not show a regular trend.

Saxena et al. (1972) conducted a uniformity trial on fodder oat to determine the optimum size and shape of the plots. They found that the coefficient of variation decreased with an increase in plot size. Marcer and Hall (1911) while working with mangoes found no superiority of long and narrow plots over square ones. Similar conclusions were reached by Smith (1958) in beans and by Stephens and Vinall (1928) in sorghum.

Bist et al. (1975) on potato found that the shape of the plot had no consistent effect on coefficient of variation. Similar results were obtained by Rambabu et al. (1980) on fodder grass and Biswas et al. (1982) on cabbage.

Singh et al. (1975) examined the data of bhindi by leaving single and double guard rows for different plot sizes and blocks of six and eight plots. It will be observed with the single or double guard rows a plot of 192 sq.ft for six and eight plot blocks required the minimum area. Effect of size of plots on block efficiency was also examined. It was seen that for any given plot size, the coefficient of variation does not appear to be affected appreciably by the change in block shape. It will be again observed that block efficiency increases with the increase in plot size upto a plot of six units for blocks of both the size and upto a plot of 24 units.

Using uniformity trial data on tomato they observed that coefficient of variation decreased gradually as the plot size increased for all sizes of the blocks. The average coefficient of variation with four plants per plot ranged from 33.63% to 35.02%. With the increase in plot size upto 24 plants the coefficient of variation reduced to 16.16% . Any further increase in the plot size did not result in the decrease in coefficient of variation. It was observed that minimum area required per treatment increased as the plot size increased, hence the smallest plot size in this case would be optimum. On cabbage and knol-khol they observed that the coefficient of variation decreased with an increase in plot size. They described the optimum plot size as the plot size which required the experimental material for a given standard error of the mean.

2.3. Soil productivity contour map

A simple but informative presentation of soil heterogeneity is the soil productivity contour map. The map describes graphically the productivity level of the experimental site based on moving averages of contingous units. This approach of describing variation in fertility has been adopted by large number of research workers. They include Hutchinson and Panse (1935) on cotton, Agarwal et al. (1968) on arecanut, Jayaraman(1979) on sunflower, Hariharan(1981) on brinjal and Nair(1984) on turmeric.

2.4. Direction of fertility gradient

Gomez and Gomez (1976) gave a method to find out the direction of fertility gradient by computing row and column mean sum of squares. The relative size of the two mean-squares indicates the possible direction of the fertility gradient and the suitable orientation for both plots and blocks.

Jayaraman(1979) conducted a study on sunflower which revealed that mean sum of squares due to rows were much higher than mean sum of squares due to columns.

2.5. Methods of estimation of plot size

Several methods are available to evaluate the pattern of soil heterogeneity based on uniformity tests. A brief account of the various methods of estimation of optimum plot size are given below.

2.5.1. Maximum curvature method

For determining the optimum plot size Gupta and Raghavarao(1971) conducted a uniformity trial on onion. They found out the optimum plot size by using the maximum curvature method i.e., the optimum plot size is the abscissa of the point just after the point of maximum curvature. He observed the point of maximum curvature for X=8 approximately so that the optimum plot size was nine.

Jayaraman(1979) on sunflower also used this method and showed that the region of maximum curvature was between four and eight units. Then he adopted the calculus method and found out the optimum plot size as 4.413 basic units.

Hariharan(1981) adopted this method for obtaining the optimum size of the plot for experiments in brinjal. He noticed that the coefficient of variation was decreased as the size of the plot was increased upto $8m^2$, thereafter the decrease was rather slow. Thus he established the best plot size for field experiments on brinjal was about $8.64m^2$.

Raghavarao(1983) suggested that the optimum plot size could be determined from Smith's law in the modified form mathematically using calculus method by maximising curvature of the variability function. He estimated the optimum plot size of radish using this technique as 4 to $8m^2$

Nair(1984) also estimated the optimum plot size by the method of maximum curvature. He has obtained the optimum plot size for turmeric as six units.

Lucyamma(1986) observed the maximum curvature at 6.80, 6.14, 6.23 and 6.03 respectively for each year pair for cashew.

2.5.2. Heterogeneity index method

Smith(1938) gave a method of determining optimum plot size which will be referred as 'heterogeneity index method'. The empirical law given by him is ,

$$V_X=V_1X^{-b}$$

Smith considered the cost function also in determining the optimum plot size. Assuming the cost per unit is a linear function, he minimised the cost for the plot size X and considered that the value of X as the optimum size of the plot. The cost function assumed by him is of the form

$$C=C_1+C_2X$$

where, C_1 is the cost assosciated with number of plots, C_2 is the cost associated with a unit area within the plot and X is the number of basic units per plot.The estimate of optimum plot size as suggested by Smith(1938) was,

$$X_{opt} = bc_1/(1-b)c_2$$

Smith's equation in the modified form is,

$$Y=aX^{-b}$$

where, Y is the coefficient of variation per plot based on plots of X units in size, 'a' is the coefficient of variation per plot based on plots of size unity and 'b' is the index of soil heterogeneity. This modified equation of Smith was used by several workers. They include Gupta and Raghavarao (1971) on onion bulbs, Saxena et al.(1972) on oat, Prabhakaran and Thomas(1974) on tapioca, Bist et al.(1975) on potato, Kaushik et al. (1977)on mustard, Hairiharan(1981)on brinjal, Mangat(1984) on cotton and Nair(1984) on turmeric.

Apart from studying plot size, he discussed the method of obtaining suitable block sizes which minimises the error. Sometimes the fertility variation of the field is greater in one direction. In such fields the shape of the plot will have a greater influence on the experimental error. On this subject extensive work has been done by workers like Christids (1931) and Cochran(1940).

2.5.3.Hatheway's method

Hatheway and Williams(1958) pointed out that the method of Koch and Rigney(1951) often resulted in inaccurate estimates of plot size because they assigned equal weights to the different components of variation even though they are based on different degrees of freedom. Koch and Rigney(1951) used the quantity 'b', the regression coefficient as the measure of soil heterogeneity. Essentially it is the regression of the logarithm of variance of different sized plots on the logarithm of the number of units per plot. Hatheway and Williams(1958) developed the relation ,

$$E(\log V_X)=E(\log V_1)-B\log X$$

where 'B' is the regression coefficient of V(X) on logX, V(X) is the among plot variance, X is the number of units per plot, V_1 is the variance among plot of size unity and V_X is the variance of mean per unit area for plots of size X units.

Hatheway(1961) developed a procedure to determine optimum plot size, where the number of replications and expected magnitude of difference between the treatments were specified, but he did not take care of the experimental cost. The basic equation of Hatheway is of the form,

$$X^b=2(t_1+t_2)^2(C_x)^2/rd^2$$

where, X is the plot size, b is the index of soil heterogeneity, t_1 is the observed value of student's-t in the test of significance, t_2 is the tabulated value of student's-t corresponding to 2(1-p) where p is the probability of obtaining a significant result, C_x is the coefficient of variation of plots of size X units, d is the true difference between two means expressed as percentage and r is the number of replications.

2.6. Method of estimation of plot size for perennial crops

Perennial crops are those crops which have the following distinguishable features.

1) Unlike the annual crops the perennial plants are large enough to be treated separately.

2) Perennial plants last for many seasons and data are usually collected from the same plant for a large number of years.

3) Generally there is a large amount of biological variation from plant to plant in addition to positional variation. Where as on annual crops, contribution due to such biological variation is small in relation to positional variation.

The studies of these crops suggested that there is a large variation from tree to tree even if a small plot is adopted. The large variation from tree to tree is due to the fact that this variation is made up of two types of variation, namely one arising due to genetic variation of the material and the other due to the positional variation which is commonly known as soil heterogeneity.

Freeman(1963) suggested a modification to Smith's law to take care of genetic variation among trees of the same plot. A simple hypothesis between environmental and plant variation is proposed. The hypothesis has the consequence that the serial correlations between neighbouring plants satisfy a mathematical equation and this equation is fitted quite well by some data from apple trees. The fundamental equation takes the form

$$V_X/V_1 = (a/X^b)+(1-a)/X$$

'a' being the proportion due to environment of the variance of a unit plot and V_X is the total variance per plant of a plot of X units.

If this hypothesis is justified then 'a' should be zero for plots of small number of plants and unity for plots with many plants; but intermediate in other cases. The case of a=1 represent Fairfield Smith's original law and he showed this to be justified for many experimental crops. It was found that a=0 is very small with large seedling trees of various species. With the apple trees considered here 'a' takes values between 0 and 1 and the hypothesis may be regarded as verified for these trees in series of years. There is a further point that 'a' (the amount of environmental variation) in these trees tend to rise with time. The results for other perennial species not described in detail also show general agreement with the hypothesis.

Smith(1938) has given the empirical relationship between variability and plot size:

$$V_X = V_1 X^{-b}$$

and this model was found adequate in accounting for variability in irrigated uplands. However, in dryland agriculture, moisture is crucial, and variability could not be explained by plot size alone. In fact, plot shape and orientation are equally important. Ramanandachetty(1985) has incorporated these factors and given the modified model as:

$$V_X = V_1/((X_1)^{(b_1)}(X_2)^{(b_2)})$$
$$= V_1/(X_1X_2)^{B_1}(X_1X_2)^{B_2}$$

Where, X_1 is the length of the plot, X_2 is the breadth of the plot, X_1X_2 is the plot size, X_1/X_2 is the rectangularity, B_1 and B_2 are the heterogeneity coefficients and found that this modified model fits in several situations.

2.7. Cost function

The optimum plot size was computed by assuming arbitary values of the cost proportional to the number of replications and the cost proportional to the total area per treatment.

When costs are included, the optimum plot size was computed by the relation,

$$X=bC_1/(1-b)C_2$$

where, X is the number of basic units per plot, C_1 is the cost proportional to the number of plots in test area, C_2 is the cost proportional to the total area. He obtained the optimum plot size as two basic units.

Taking the cost function for field experiments as:

$$C=C_1+C_2X$$

Sreenath(1973) on sorghum showed that the optimum plot size was given by $X_{opt}=bc_1/(1-b)C_2$. Further assuming C_1 will not exceed 10 x C_2 the optimum plot size for various block sizes was worked out to be $2m^2$. Rambabu et al.(1980) on natural grass showed the similar result and by making use of the assumption that C_1 will not exceed C_2, he concluded that the optimum plot size for various block sizes was worked out to be about 3 to $4m^2$. Hariharan (1981) on brinjal showed that the optimum plot size was about $8.64m^2$. He made use of the assumption that C_1 will not exceed 50 x C_2 and the value of b as 0.1388.

In short there are several research workers who assumed the cost function for calculating the optimum plot size. They include Peterson and Chamblee (1955) on forage crop, Brim and Mason(1959) on soyabean, Crews et al.(1963) on tobacco, Saxena et al.(1972) on oat, Prabhakaran and Thomas (1974) on tapioca and Biswas et al.(1983)on cabbage.

2.8. Inappropriate application of Smith's cost concept

Smith's procedure showed the empirical law:

$$V_X = V_1 X^{-b}$$

where, V_X is the variance among plots that are of X basic units in size on a per unit basis, V_1 is the variance among plots of one basic unit and b is the index of soil heterogeneity. He also showed that if the costs per plot without guard rows is,

$$C = C_1 + C_2 X$$

then the cost per unit of information would be minimum and the optimum plot size was given by the relation,

$$X = bC_1/(1-b)C_2$$

where, X is the size of the plot, C_1 is the part of the cost assosciated with number of plots only and C_2 is the cost per unit area. Smith defined C_1 in manhours and C_2 in manhours as per sq.ft. Since Smith did not specificlly define the basis for calculating C_1 and C_2 many authors used Smith's procedure wrongly.

Marani(1963) pointed out that Smith's cost concept had been misused by several workers and indicated that both C_1 and C_2 should be estimated on a per unit of area basis.The correct definition of C_1 and C_2 were used by Hodnett(1953) on groundnut, Wallace and Chapman(1956) on oat forage, Crews et al. (1963)on tobacco,Sardana et al.(1967)on potato and Binns et al. (1983) on tobacco.

MATERIALS AND METHODS

MATERIALS AND METHODS

3.1. Materials.

A uniform crop of colocasia (Colocasia esculenta. Linn) variety 'Thamarakannan' was raised during Khariff season over an area of 15.6m x 6m=93.6m^2 at the College of Agriculture, Vellayani, Kerala Agricultural University. The crop was sown during the second week of April (1984). The site was located at a longitude of 76°57$'$ and latitude of 8°29$'$. The experiment was laid out in red soils under Vellayani series.

All cultural and management practices were performed according to the package of practices recommended by Kerala Agricultural University, Trichur. The fertilisers were applied at the rate of 80:50:100 Kg of $N:P_2O_5:K_2O$ per hectare. Suitable plant protection measures were undertaken. In this context a spray of Eckalax was given during the experiment. The field comprised of 29 rows and 16 columns with a spacing of 60cm between rows and 45cm between plants within row. In total, there were 464 plants. A border row from all sides were left out and the crop was harvested in basic units in an area of 73.44m^2 thus giving rise to 378 such ultimate units. The basic or unit plot selected in this study is 0.27m^2.

Biometrical observations were made for the following characters on 11-6-1984 and on 21-7-1984 from all the plants.

1) Height
2) Girth
3) Number of suckers
4) Number of leaves
5) Leaf area

During August (1984) there was severe attack of aphids and biometrical observations cannot be recorded for that period. The crop was harvested on 21-10-1984 and the following yield characteristics were observed.

1) Yield
2) Weight of mother sucker
3) Weight of marketable tubers
4) Number of marketable tubers
5) Weight of small tubers
6) Number of small tubers

The lay out of the experiment is as shown in Fig.I.

3.2. Methods

3.2.1. Productivity contour map.

A productivity contour map was prepared to know the pattern of heterogeneity existing in the field. With the yield figures, only productivity can be measured. It reflects the fertility variation in the field. Fertility contour map may be a misnomer in this regard.

For preparing the map, the percentage deviation of

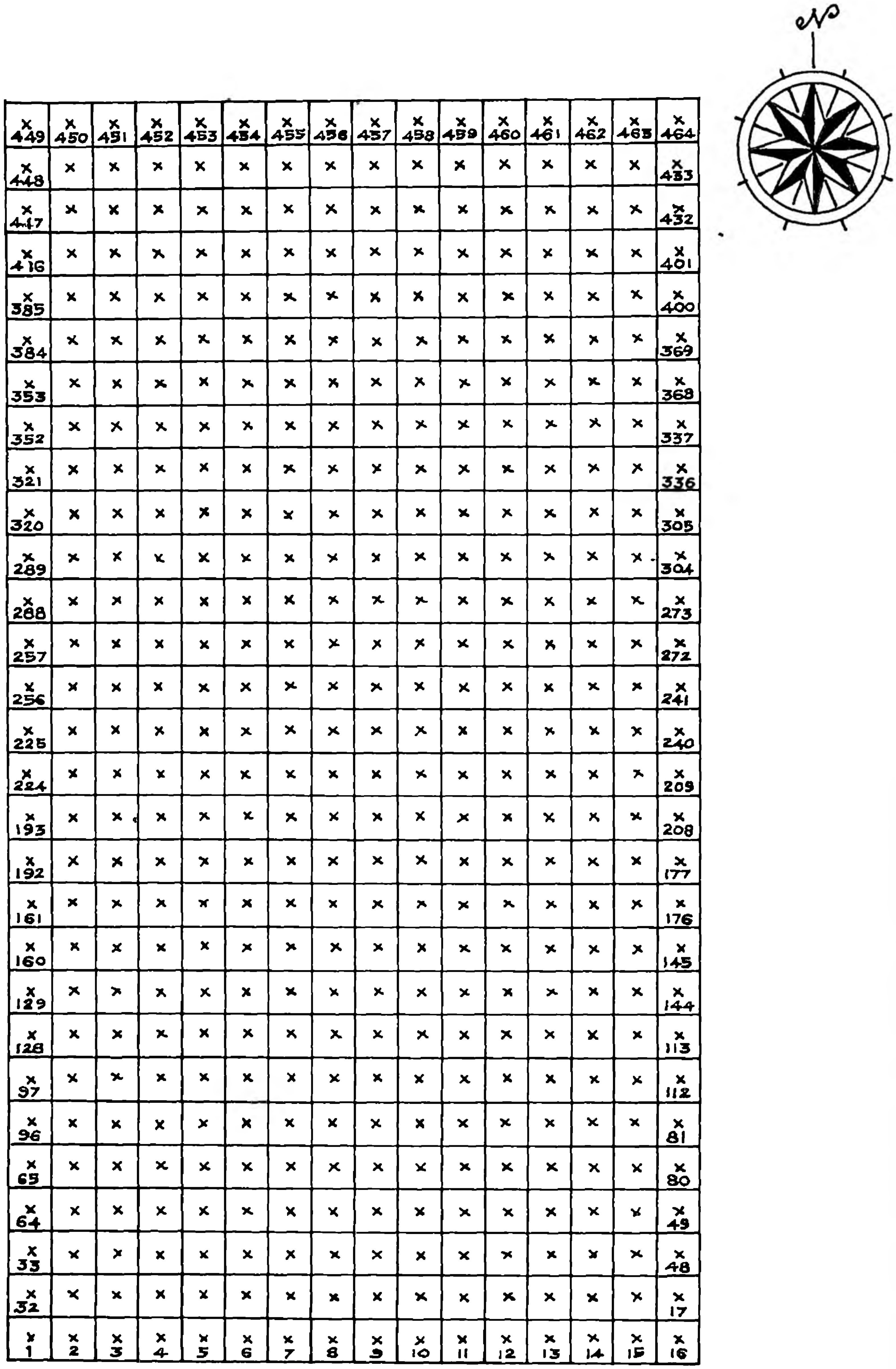

FIG 1 LAY OUT PLAN OF THE UNIFORMITY TRIALS ON COLOCASIA

each observation from the grand mean was calculated by the relation ,

$$d_i = (Y_i - \bar{Y}) \times 100/\bar{Y}$$ (Rao,G.N. ;1983)

where,

d_i is the percentage deviation of the i^{th} unit from the grand mean, Y_i is the yield of the i^{th} and Y is the grand mean.

Then the units are combined into different classes according to the magnitude of the observed deviation around the overall mean yield. The experimental units which produce the same amount of deviation from the overall mean yield were assumed to be similar in fertility. Regions of similar fertility status were identified and marked with different systems of grading.

3.2.2. Mean square among strips

To measure the direction of the fertility gradient (along columns or rows) more accurately, row and column mean sum of squares (27 rows and 14 columns) were calculated and compared. (Gomez and Gomez, 1976). For this, the units are first combined into horizontal and vertical strips. Variability among the strips in each direction is then measured by the sum of squares among strips. The relative size of the two mean squares indicates the possible direction of the fertility gradient and suitable orientation for both plots and blocks.

The following formulae were used to compute the row and column mean square per plot.

Mean sum of squares due to row gradient $=1/26[\Sigma R_i^2/14]-(\Sigma R_i)^2)/378$

Mean sum of squares due to column gradient $=1/13[\Sigma C_j^2/27]-(\Sigma C_j)^2/378)$

Where, R_i is the row total of the i^{th} row and C_j is the column total of the j^{th} column.

3.7.3. Serial correlation

To test the randomness of the data set, serial correlations were calculated for all charecters. (Gomez and Gomez ;1976). This can be used to characterise the trend of soil fertility of the field.

Serial correlation can be computed by the formula:

$$r_s=[\Sigma X_i X_{i+1}-(X_i)^2/n] / [\Sigma X_i^2-(X_i)^2/n]$$

where $X_{(n+1)} = X_1$. A serial correlation can be viewed as a simple correlation between two variables; one at location 'i' and another at location '(i+1)'.

A low serial correlation indicates that fertile areas occur in spots and a high value indicate a fertility gradient.

From one set of uniformity trial data we can compute two serial correlation coefficients one for the horizontal and another for the vertical arrangement.

In order to compute the serial correlation coefficients, first arrange the data row wise or column wise in pairs of X_i and $X_{(i+1)}$. Then using the formula,the serial correlation for both sequences can be computed. If the coefficients are equally high, then we can infer the existence of fertility gradient in both directions.

3.2.4. Size and shape of plots

We are basically interested to find the optimum size and shape of plots to be used in an experiment. Here size of the experimental unit is measured in terms of number of basic units. (One unit in the present case.) The shape of experimental unit has two aspects; direction or orientation i.e.; along or across length:breadth ratio. A shape 2x3 means two unit plots along rows and three unit plots along columns, thus making experimental units of six plots. 3x2 is similarly defined. Coefficient of variation (cv) was found out for each combination for comparing variation of plots of different sizes and shapes. The results were rearranged to study the effect of plot size and shape, separately and in combination on the variability among plots.

3.2.5. Heterogeneity index method

Smith (1938) developed an empirical relatioship between plot size (X) and plot variance (V_X). The law states that:

$$V_X=V_1/X^{-b}$$

which after log transformation becomes

$$\log V_X=\log V_1-b\log X$$

where V_X is the variance of the yield per unit area among plots of X units in size, V_1 is the variance among plots of one basic unit in size, and 'b' is the charecteristic of soil and 'a' measure of correlation among continguous units. Generally the value of 'b' varies between zero and unity. The larger the value of the index, the lower is the correlation between adjacent plots indicating that fertile spots are distributed randomly.

Smith's empirical relation in the modified form is given by

$$Y=aX^{-b}$$

where Y is the coefficient of variation and X is the plot size, 'a' and 'b' are constants which were used to define the relationship between plot size and coefficient of variation. These constants of the function were estimated by transforming it into the linear form

$$\log Y=\log a-b\log x$$

or

$$Y=A-bX$$

where Y=logY, A=loga and X=logX

The method of least squares were used to solve for 'a' and 'b'.

The normal equations are :

$$Y=nA-b\sum X$$

$$XY=A\sum X-b\sum X^2$$

From this we get,

$$\hat{b}= (n\sum XY-\sum X\sum Y)/N\sum X^2-(\sum X)^2$$

$$\hat{a}=\text{antilog}(\bar{Y}-b\bar{X})$$

Then the fitted line will be $\hat{Y}=\hat{a}X^{-\hat{b}}$.

3.2.6. Maximum curvature method.

This method is used to obtain the optimum plot size graphically. The average coefficient of variation for different plot shapes of a particular plot size was plotted against the plot size in basic units. A smooth free hand curve was drawn through the resulting coordinates. The optimum plot size is the point on the curve where the rate of change for the variability index per increment of plot size is the greatest. The optimum plot size was determined as the one just beyond the point of maximum curvature and the shape of the plot that gives least coefficient of variation for that optimum size wil lbe recommended. But Federer (1963) pointed out a few weaknesses of this method.

1) It is affected by the size of the basic unit selected.

2) The scale of measurements used and does not take cost into consideration.

3.2.7. Modified maximum curvature method.

This is a more precise method which locates mathematically the exact region of maximum curvature by maximising the curvature of the curve relating the plot size (X) to the coefficient of variation (Y).

A curve of the type,

$$Y=aX^{-b}$$

was fitted to the data and the parameters 'a' and 'b' were estimated by transforming it into the linear form

$$\log Y=\log a-b\log X$$

Thus the estimates of 'a' and 'b' are given by

$$b=(n\Sigma XY-\Sigma X\,\Sigma Y)/n\,\Sigma X^2-(\Sigma X)^2$$

$$\hat{a}=\text{antilog}\ (\overline{Y}-b\overline{X})$$

Then the fitted curve will be

$$\hat{Y}=\hat{a}X^{-\hat{b}}$$

The curvature at any point of the curve can be determined by the equation

$$C=Y_2/[1+(Y_1)^2]^{3/2}$$

Where 'C' is the curvature of the curve

$$Y=aX^{-b}$$

Y_1 and Y_2 are the first and second derivatives with respect to X of this function.

The maximum curvature is attained when the first derivative of C with respect to X is zero and the second derivative with respect to X which makes the first derivative zero is negative.

$$Y=aX^{-b}$$

$$\log Y=\log a-b\log X$$

Differentiating both sides with respect to X we get,

$$Y_1/Y=-b/X$$

$$Y_1=-b(Y/X)=-baX^{-b}/X$$

$$Y_1=-abX^{-(b+1)}$$

$$Y_2=-b[XY_1-Y]/X^2$$

$$=-b[-(XbY/X)-Y]/X^2$$

$$=b(b+1)aX^{-b}/X^2$$

$$Y_2=ab(b+1)X^{-(b+2)}$$

Substituting the value of Y_1 and Y_2 in $C=Y_2/[1+(Y_1)^2]^{3/2}$

$C=ab(b+1)X^{-(b+2)}/[1+(ab)^2X^{-2(b+1)}]^{3/2}$

We then maximise the curvature C.

$$\log C=\log A-(b+2)\log X-3/2\log[1+(ab)^2X^{-2(b+1)}]$$

Where, $A=ab(b+1)$

$d(\log C)/dX=-[(b+2)/X]+[3(ab)^2(b+1)X^{-2(b+1)}-1]/[1+(ab)^2X^{2(b+1)}]$

$[3(ab)^2(b+1)X^{-2(b+1)}-1]/(b+2) =1+(ab)^2X^{-2(b+1)}$

$$DX^{-2(b+1)}=1+(ab)^2X^{-2(b+1)}$$

$$\text{Where, } D=3(ab)^2(b+1)/(b+2)$$

$$1+[(ab)^2-D]X^{-2(b+1)}=0$$

$$X^{2(b+1)}=(ab)^2(2b+1)/(b+2)$$

The optimum plot size can be determined by substituting the values of 'a' and 'b' in the relation,

$$X=[(ab)^2(2b+1)/(b+2)]^{1/2(b+1)}$$

Five other models were also tried to express the relation between plot sizes and coefficient of variation. The fitted models were,

1) $Y=a+b\log X$
2) $Y=a+b/X^{1/2}+c/X$
3) $1/Y=a+b\log X$
4) $1/Y=a+bX^{1/2}+cX$
5) $Y=ar^{-g_1}c^{-g_2}$

In all the five models the parameters were estimated by the principles of least squares. The modified maximum curvature method to find out the optimum plot size is also tried to the four models among the five models.

Consider the curve

$$Y=a+b\log X$$

Differentiating both sides with respect to X,

$$Y_1=b/X$$

$$Y_2=-b/X^2$$

$$C=Y_2/[1+(Y_1)^2]^{3/2}$$

$$C=-bX/(X^2+b^2)^{3/2}$$

The maximum curvature is attained when equating dC/dX to zero.

dC/dX=0 implies:

$$[-b(X^2+b^2)^{3/2}+bX3/2(X^2+b^2)^{1/2}2X]/(X^2+b^2)^3$$

i.e.; $$b(X^2+b^2)^{1/2}(-b^2+2X^2)=0$$

which implies either

$$b(X^2+b^2)^{1/2}=0 \qquad \text{or} \qquad -b^2+2X^2=0$$

If $$b(X^2+b^2)^{1/2}=0$$

Then, X=+ib or X=-ib which is impossible

Then, $$2X^2=b^2$$

or

$$X=+b/\sqrt{2} \qquad \text{or} \qquad X=-b/\sqrt{2}$$

The optimum plot size is therefore obtained by substituting the value of 'b' in the relation $X=+b/\sqrt{2}$ or $X= -b/\sqrt{2}$.

With regards to the curves (2),(3) and (4) the method of obtaining optimum plot size is as given below. As we cannot obtain C value directly, here we found out the first and second derivative of Y separately and substituted them in the formula for the curvature,

$$C=Y_2/[1+(Y_1)^2]^{3/2}$$

By the iterative procedure, the maximum value of 'C' can be obtained. i.e.; draw a graph between plot sizes and expected coefficient of variations. Then from the graph find out two points of X within which the maximum value of C may lie. Then use trial and error method to get the exact value of C. Continue the trial and error method until we get the maximum 'C' value for two consecutive X values.

3.2.8. Cost function

Given an estimate of soil heterogeneity index, b, and cost estimates for conducting the experiment, optimum plot size can be calculated as:

$$X_{opt}=b(K_1+K_gA)/(1-b)(K_2+K_gB)$$

Where K_1 is the part of the cost assosciated with the number of plots only; K_2 is the cost per unit area; K_g is the cost assosciated with the borders; B is the ratio of side borders to the test area; A is the area of the plot end borders; and b is the Smith's index of soil heterogeneity. If unbordered plots are used, K_g is zero. Therefore for unbordered plots,

$$X_{opt}=bK_1/(1-b)K_2$$

The assumptions under which the estimates were obtained are,

1) Costs other than labour were ignored.

2) Relative monetary costs of manhours for the various

operations were not considered, and

3) The collection of data included measurement of plant height, girth and yield charecteristics at two growth stages.

RESULTS

RESULTS

The results of the statistical analysis for uniformity trial on colocasia (<u>Colocasia</u> <u>esculenta</u>.I) conducted during Khariff 1983 are presented below.

4.1. Produtivity contour map

A productivity contour map was prepared to describe the heterogeneity of land by the method described in 3.2.1, using the yield data obtained from the uniformity trial. The map of the experimental field was given in Fig.2. An inspection of the map indicated that there was a wide variation in soil fertility. But this variation did not show any systematic pattern. Therefore we can conclude that this soil was heterogeneous in nature. It could also be seen that small areas were relatively more homogeneous with regarded to soil fertility than large areas.

4.2. Mean square among strips

Mean squares for the horizontal and vertical arrangement was found out for all characters and were presented in Table.1. For the characters Yield, number of suckers,number of leaves and number of small tubers mean squares due to the horizontal strips were obtained as 4670.45, .5124, 18.1832, and 18.5824 repectively and mean squares due to the vertical strips were obtained as

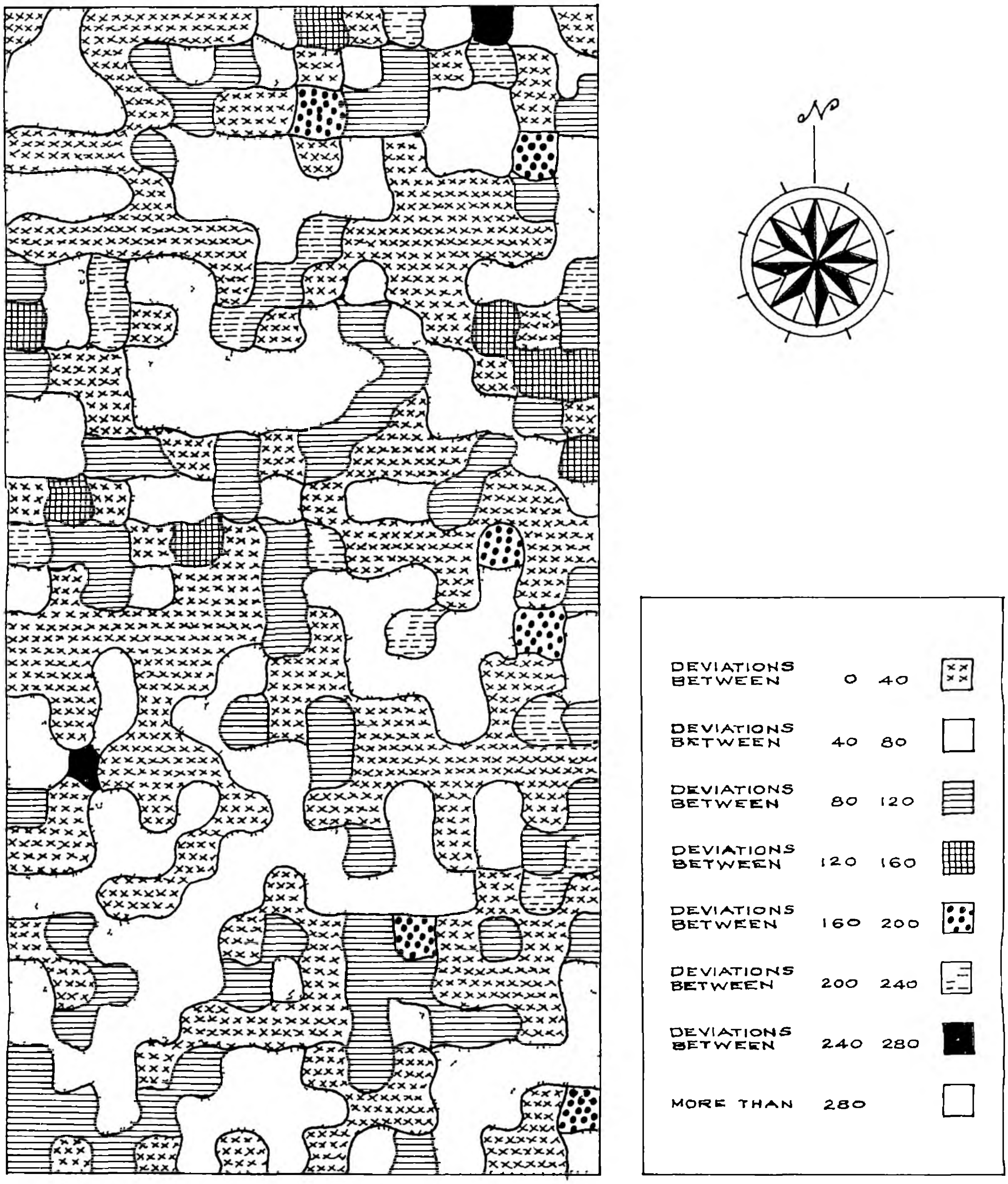

FIG 2 PRODUCTIVITY CONTOUR MAP

1656.912, .4145, 3.7537, and 11.3773 respectively. From the values of these two mean squares it was very clear that mean squares among the horizontal strips were greater than that among the vertical strips. This result emphasized that the trend of soil fertility was more pronounced along the rows(length) than along the columns(width).But for height, girth, weight of mother sucker and leaf area mean squares due to rows were 693.0989, 9.0095, 1140.909 and 45603.78 repectively and that due to columns were 1191.664, 13.8524, 3504.655 and 66267.72. While looking at these values we could see that mean squares due to columns were greater than that due to rows, thereby establishing that the soil fertility was greater along the columns.

4.3. Serial correlation.

From the uniformity trial data, two serial correlation coefficients, one for the horizontal and another for the vertical arrangement was computed for all the characters and was presented in Table 2. The rowwise serial correlation for yield, height, girth, weight of mother sucker and leaf area were 0.03903, 0.12380, 0.15383, 0.08770,and -0.00053 respectively. The columnwise serial correlations for the same characters were 0.01155, 0.11919, 0.07082,0.15405 and 0.01047 respectively. i.e.; both the serial correlation coefficients were small. Hence we could infer that the fertile areas occur in spots which was in agreement with the productivity contour map.

4.4. Size and shape of plots

The yield of adjacent units were combined suitably, both in East-West and North-South direction to form plots of different sizes and shapes. The coefficient of variation(C.V.)in the different arrangements were calculated and this has been done for all data sets. The results were presented in Tables 3 to 18.

It could be seen from Tables 3 to 18 that an increase in plot size in either direction decreased the coefficient of variation. The coefficient of variation decreased from 74.6396 to 1.9081 percent for the yield data. The decrease in coefficient of variation for height, girth, number of leaves, weight of mother sucker and leaf area were respectively 30.8308% to 8.4328%, 28.6750% to 4.9952%, 24.3911% to 6.4780%, 71.3605% to 17.1120% and 107.9004% to 17.3692%. i.e.; coefficient of variation decreased with the increase in plot size in either direction for all the characters concerned.

For a given size of the plot, the shape of the plot which gives the least coefficient of variation may be selected for further studies. For a given plot size long and narrow plots gave lower coefficient of variation than approximately square ones. For example, consider a plot of size 12 units. A plot of size 12 could be obtained by 2x6, 3x4, 4x3, 6x2 and 12x1 arrangements. From Table 3, it was clear that the least coefficient of variation could be obtained by taking the 12x1 arrangement. This was true for any given plot size. But, in general the shape of the plot did not seem to have any consistent effect on the coefficient of variation.

4.5. Heterogeneity index method

The Fairfield Smith's modified equation,

$$Y=aX^{-b}$$

(Where, Y is the average coefficient of variation and X is the plot size.)

was fitted and parameters were estimated for all characters. The results were given in Table 19. The coefficient of heterogeneity 'b' was found as 0.60676 for the yield data. The 'b' values for height at 60 days after sowing(DAS), Height at 90 DAS, girth at 60DAS, girth at 90DAS, number of suckers at 60DAS, number of leaves at 60 DAS, weight of mother sucker, leaf area at 60DAS and leaf area at 90DAS were estimated as 0.22182, 0.24120, 0.3300, 0.3508, 0.5156, 0.2369, 0.1906, 0.3804 and 0.3793 respectively. That is in general, the 'b' values were ranged from 0.1906 to 0.5156. Since the 'b' value was between 0.2 and 0.7 we could assume that there existed a positive correlation between neighbouring plots, and the plot size should be increased further. Also, it was obvious that the 'b' value was higher for yield than for all other characters. The sum of squares due to fitted equations lie between 52.16 to

97 57% Hence the curve gave a good fit to the data The values of 'a' in the fitted equations were lying between 14 9103 and 101 8684

4 6 Alternate models

Five equations; namely,

1) $Y=a+b\log X$

2) $Y=a+b/X^{1/2}+c/X$

3) $1/Y=a+b\log X$

4) $1/Y=a+bX^{1/2}+cX$

5) $Y=ar^{-g_1}c^{-g_2}$

were also fitted for all the characters under consideration The parameters were estimated by the method of least squares and coefficient of determinations were also found out The results were given in Tables 20,21,22,23 and 24

From the equation $Y=a+b\log X$ the value of 'b' and 'a' were estimated The coefficient of determination was in the range 49 63% to 87 5% The values of the parameters together with their coefficient of determinations were presented in Table 20 Therefore this fit also gave a satisfactory fit to our data

The equation $1/Y=a+b\log X$ was also fitted and the values of the parameters 'a' and 'b' for all characters together with their R^2 values were estimated and was given in Table 21 The sum of squares due to the fitted equation in Table 21. The sum of squares due to the fitted equation was ranged from 0.1904 to 0.9353.

The equation $Y=a+b/X^{1/2}+c/X$ was also fitted for all characters. The values of the parameters 'a', 'b' and 'c' were estimated. The coefficient of determinations were ranged from 0.7658 to 0.9856. The results obtained from this fit were presented in Table 22. Since the R^2 values were highly significant, it was well established that this equation gave a good fit to the uniformity trial data on colocasia.

The nonlinear model $1/Y=a+bX^{1/2}+cX$ was also tried. The values of 'a' 'b' and 'c' were estimated. For this model R^2 was found within the limit 0.7522 to 0.9854. The results obtained from this fit were presented in Table 23. As R^2 values were very high, this model also gave a good fit to the data under consideration.

The generalisation of Smith's law in the form $Y=ar^{-g_1}c^{-g_2}$ was also tried to compare the heterogeneity of rows(r) and columns(c), where g's denote the corresponding heterogeneity coefficients. The results were presented in Table 24.The row wise heterogeneity coefficients 'g_1's for yield, height at 60DAS, height at 90DAS , girth at 60 DAS, girth at 90DAS, number of suckers at 60DAS, number of leaves at 60DAS and leaf area at 60DAS and 90 DAS were repectively 0.71863, 0.22108, 0.26861, 0.37244, 0.27477, 0.5505,0.29691,0.3665 and 0.4037. The column wise heterogeneity coefficients for the same characters were respectively 0.45626, 0.21878, 0.20443, 0.27293, 0.23317, 0.46870, 0.15661, 0.3991 and 0.3465. On comparing the row and column heterogeneity coefficients of different characters it was found that the row wise heterogeneity coefficient was significantly higher than columnwise heterogeneity coefficients, thereby emphasizing that formation of plots with more number of rows will give more homogeneous blocks for the experiment. The significance of the equation was tested by calculating the coefficient of determination. The range of R^2 was 0.6088 to 0.9769, showing that this generalised equation also gave a good fit to the data.

4.7. Maximum curvature method

Smooth free hand curves were drawn between plot size (X) and average coefficient of variation(C.V) of all characters. They were presented in Figures in 3(a), 3(b),3(c),3(d),3(e) and 3(f). It was found that coefficient of variation decreased rapidly at first when the plot size was increased, but after a certain point the rate of decrease was slow and then tends to zero. Optimum plot size was found using the yield data by the method described in 3.2.6 as 12 units which was equivalent to $3.24 m^2$.

4.8. modified maximum curvature method

Optimum plot size was determined by maximising the

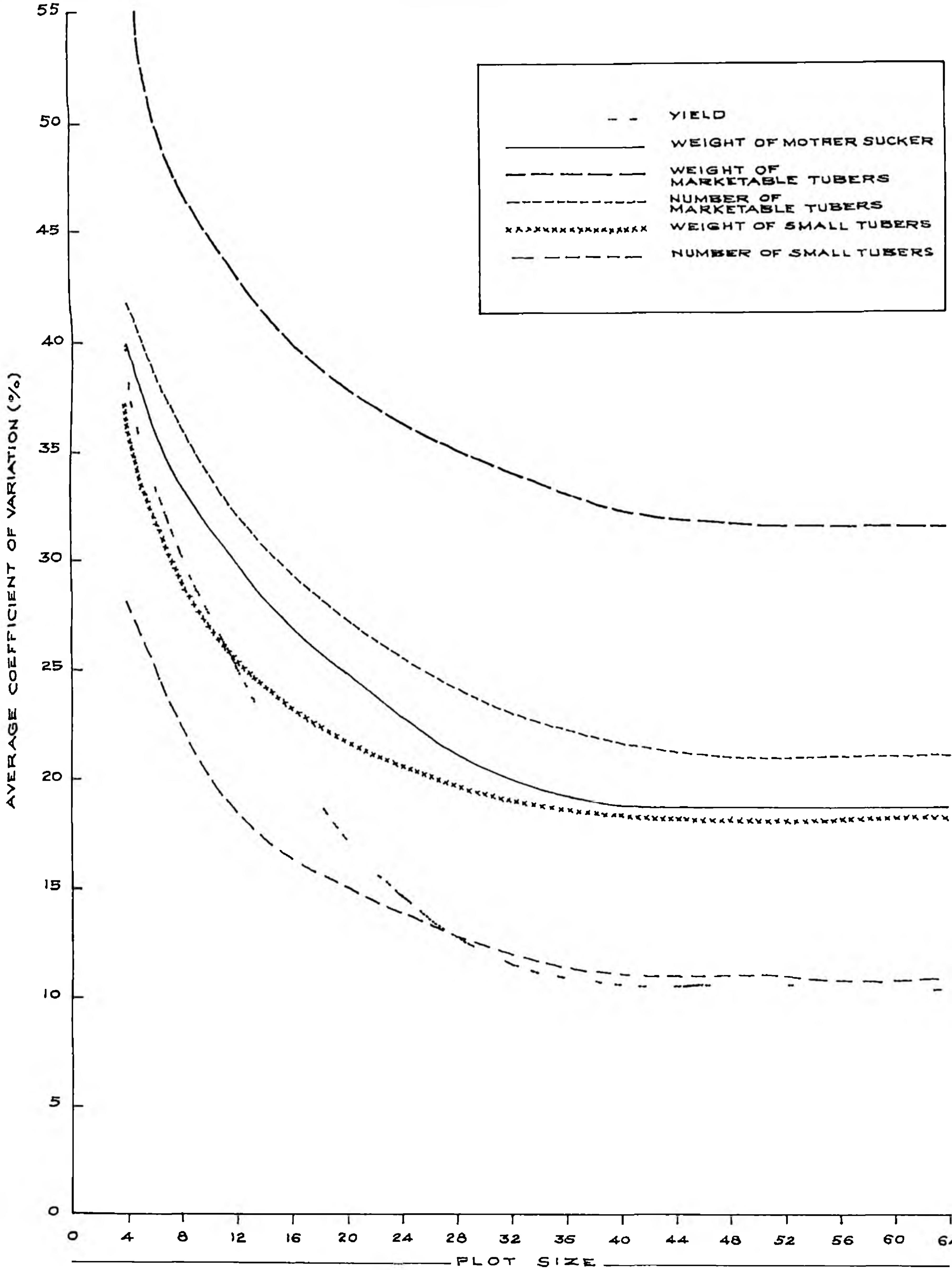

FIG 3(a) EFFECT OF PLOT SIZE ON VARIABILITY-YIELD COMPONENTS

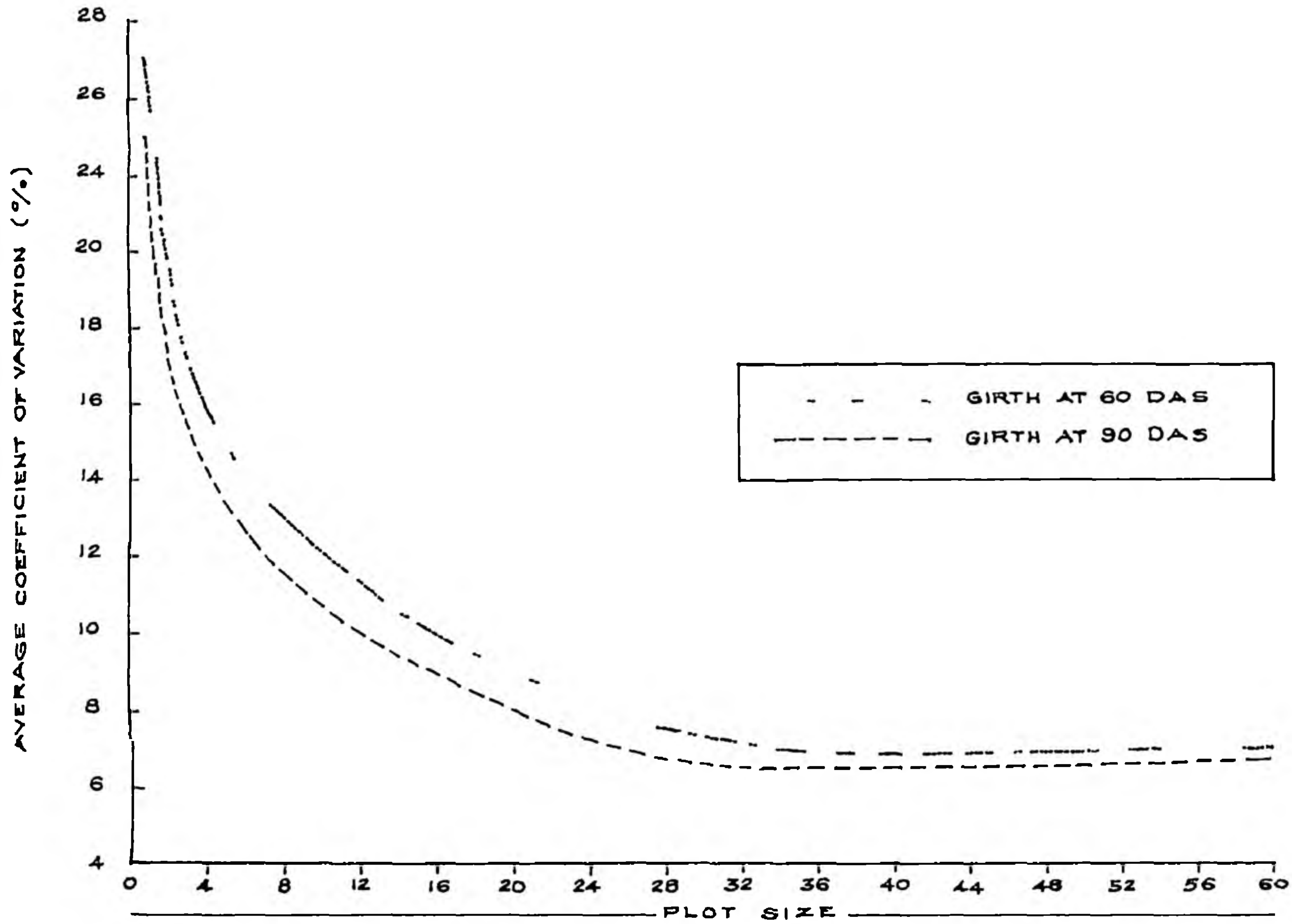

FIG 3(b) EFFECT OF PLOT SIZE ON VARIABILITY - GIRTH

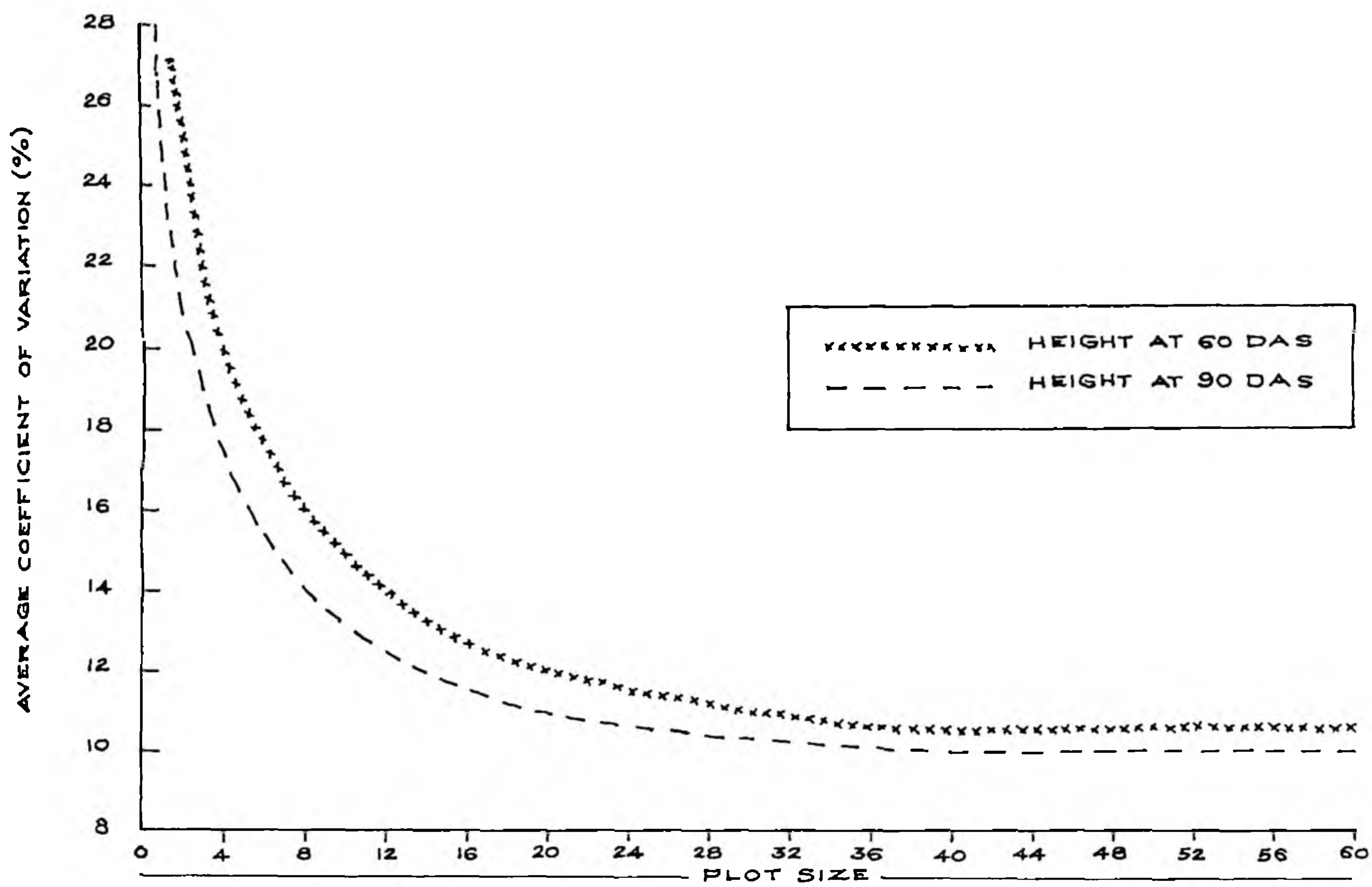

FIG 3(C) EFFECT OF PLOT SIZE ON VARIABILITY - HEIGHT

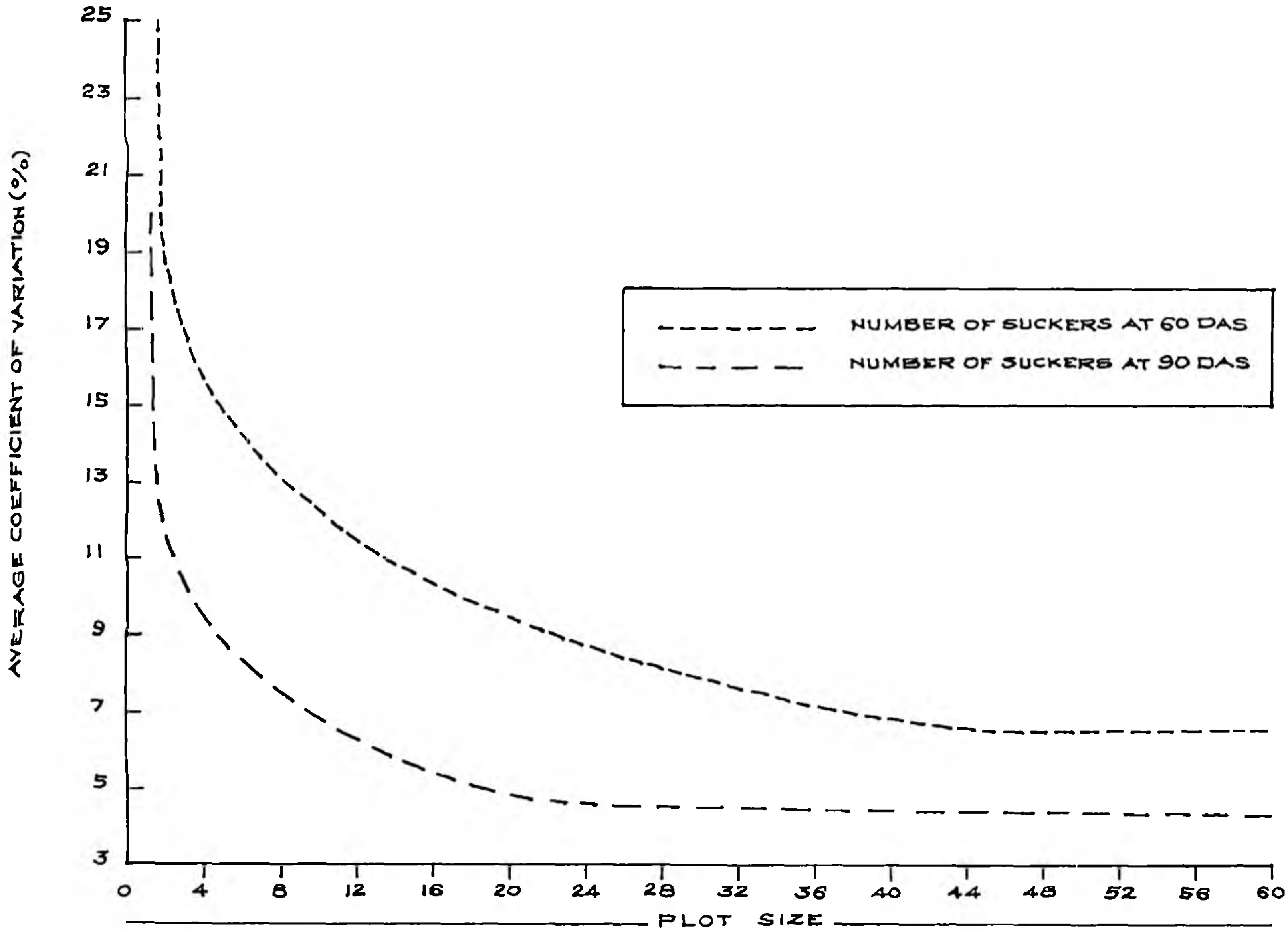

FIG 3(d) EFFECT OF PLOT SIZE ON VARIABILITY (NUMBER OF SUCKERS)

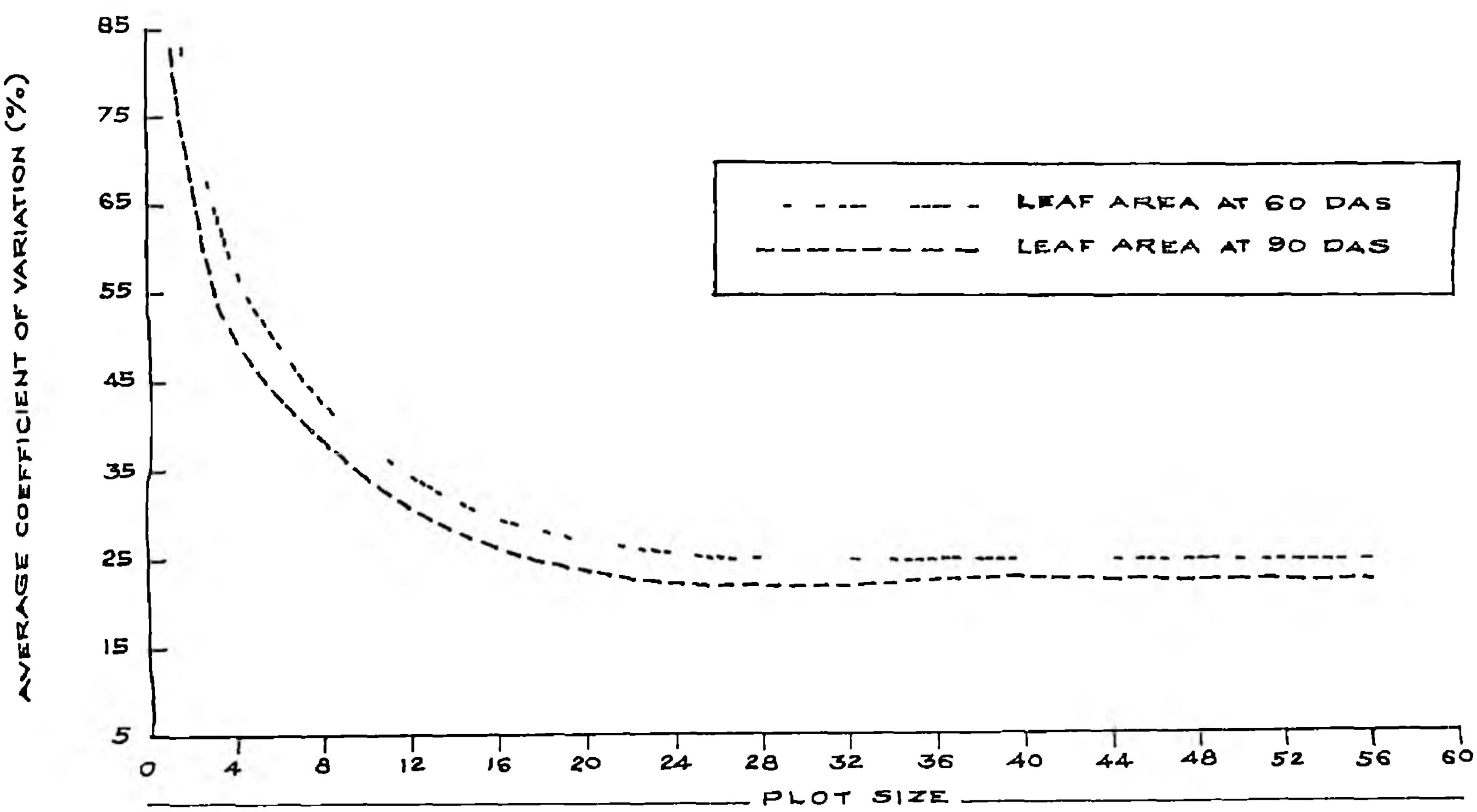

FIG 3(e) EFFECT OF PLOT SIZE ON VARIABILITY - LEAF AREA

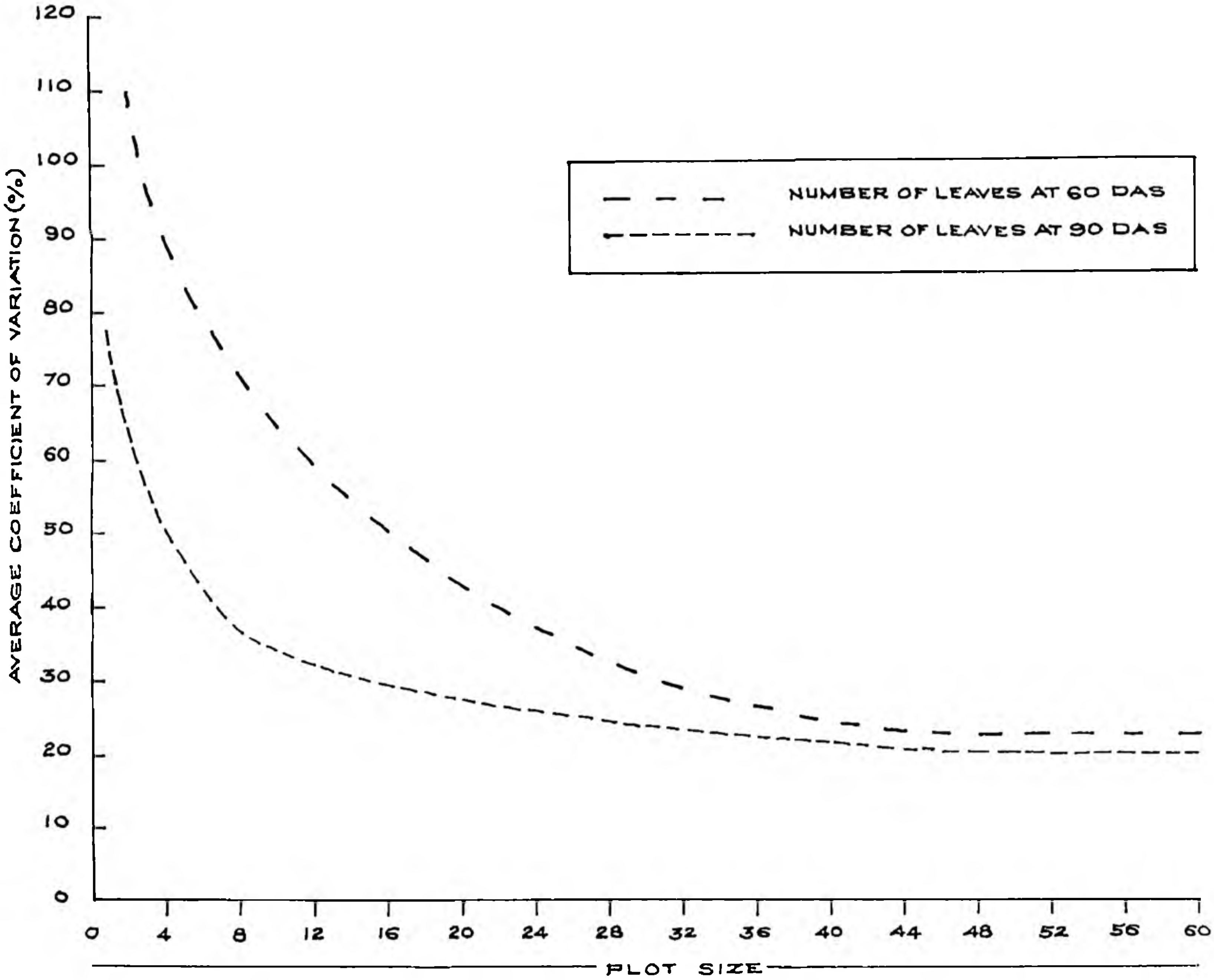

FIG 3(f) EFFECT OF PLOT SIZE ON VARIABILITY - NUMBER OF LEAVES curvature, using the method described in 3.2.7. This method was tried for all the curves fitted and for all the characters. The results were given in Table 25.

The optimum plot size determined by maximising curvature of the Smith's equation was 12.3761 units(3.3415m^2) when considering the data on yield.

The calculus method of determining optimum plot size was tried for the equation Y=a+blogX. The optimum plot size was 20.1796 units(5.4484m^2) when the data under consideration was yield. The optimum plot sizes computed while taking the coefficient of variation for other characters were given in Table 25.

The optimum plot sizes were found out by maximising the curvature of all other equations 1/Y=a+blogX, $Y=a+b/X^{1/2}+c/X$ and $1/Y=a+bX^{1/2}+cX$ by the method described in 3.2.7. The expected coefficient of variations were found out and were presented in Tables 26,27, 28, 29, and 30. The figure showing the relationship between plot size and expected coefficient of variation was presented in Fig.4.

While comparing the optimum plot size calculated from all these equations for the yield it was found ranging between 10.8700 to 21.9003 units. As the R^2 were highly significant for the equation $Y=a+b/X^{1/2}+c/X$, the optimum plot size corresponding to this equation was taken for

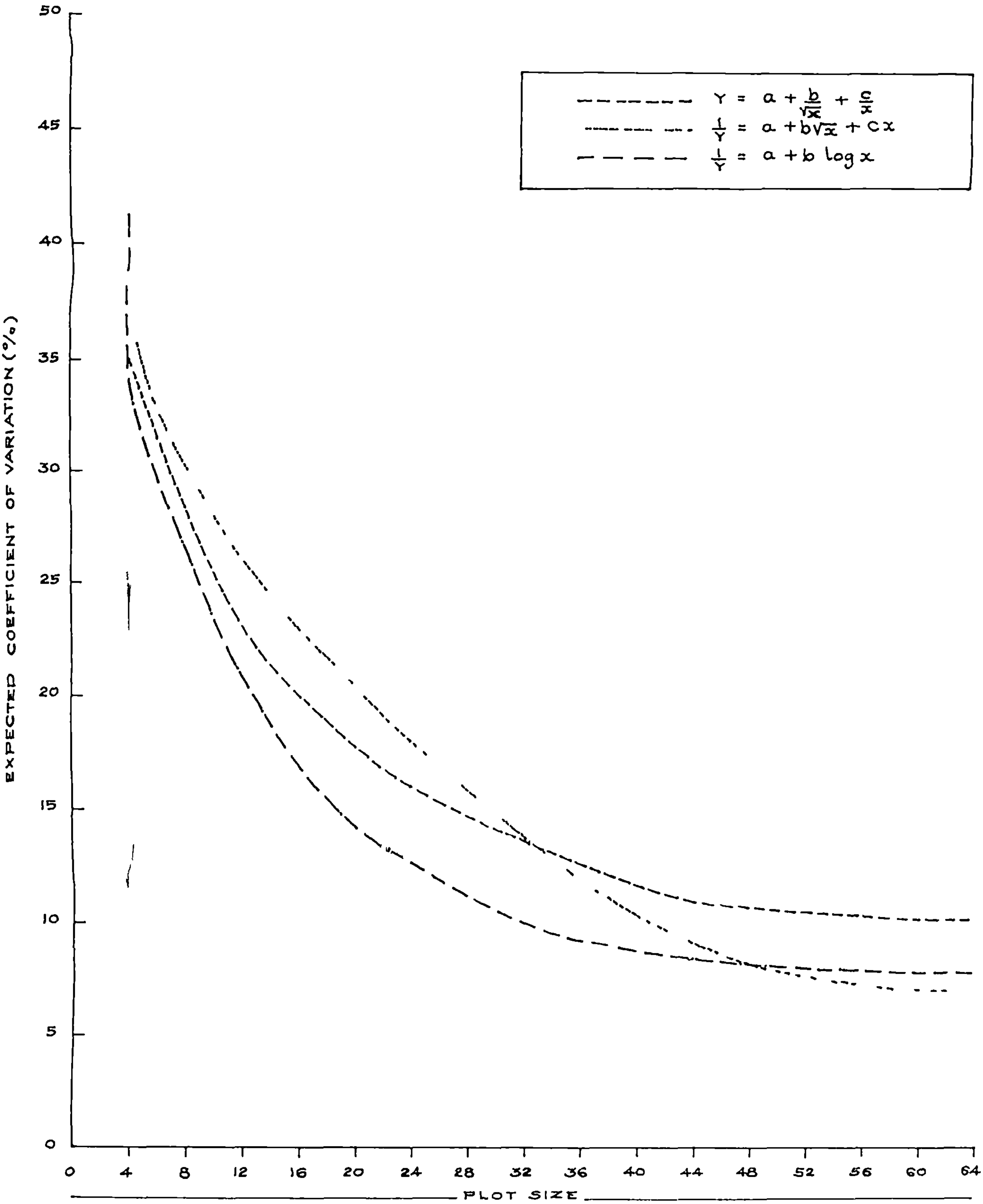

FIG 4 EFFECT OF PLOT SIZE ON EXPECTED VARIABILITY

further investigations with colocasia. i.e.; the optimum plot size with field trials with colocasia was found to be 10.87 units($2.93m^2$)

4.9. Cost function

Optimum plot size was also computed by considering the cost incurred in conducting the experiment. It could be shown that for a fixed cost, the optimum plot size was given by the equation,

$$X_{opt}=bK_1/(1-b)K_2$$

where K_1 and K_2 were as explained in 3.2.7. With the cost estimates given in Table 31 and 'b' value of 0.60676, the optimum plot size computed by using the above formula was $1.636m^2$ (approximately $2m^2$).

Table 1. Mean square among strips for different characters

Number	Character	Mean squares (Row)	(Column)
1	Yield	4670.450	1656.912
2	Height at 60 DAS.	187.272	250.285
3	Height at 90 DAS.	693.099	1191.664
4	Girth at 60 DAS.	9.009	13.852
5	Girth at 90 DAS.	37.826	41.864
6	Number of suckers at 60 DAS.	0.512	0.414
7	Number of suckers at 90 DAS.	18.183	3.736
8	Number of leaves at 60 DAS.	2.254	1.125
9	Number of leaves at 90 DAS.	0.540	0.937
10	Weight of mother sucker	1140.909	3504.655
11	Weight of marketable tubers	5089.492	16381.640
12	Number of marketable tubers	7.318	30.265
13	Weight of small tubers	870.870	1603.846
14	Number of small tubers	18.582	11.377
15	Leaf area at 60 DAS.	45603.780	66267.720
16	Leaf area at 90 DAS.	209372.800	287716.300

Table.2. Serial correlation coefficients for different charecters

Number	Character	Serial correlation (Row)	(Column)
1	Yield	0.03903	0.01155
2	Height at 60 DAS.	0.12380	0.11919
3	Height at 90 DAS.	0.01512	0.08359
4	Girth at 60 DAS.	0.15383	0.07082
5	Girth at 90 DAS.	0.16527	0.18748
6	Number of suckers at 60 DAS.	0.02274	0.02274
7	Number of suckers at 90 DAS.	0.23314	0.27512
8	Number of leaves at 60 DAS.	0.18576	0.17082
9	Number of leaves at 90 DAS.	0.00273	-0.01075
10	Weight of mother sucker	0.08770	0.15405
11	Weight of marketable tubers	0.19177	0.23748
12	Number of marketable tubers	0.10872	0.15101
13	Weight of small tubers	0.04669	0.09365
14	Number of small tubers	0.03042	-0.01399
15	Leaf area at 60 DAS.	-0.00053	0.01047
16	Leaf area at 90 DAS.	0.06483	0.03855

Table.3. Coefficient of variation for different plot sizes and shapes

		Yield. Number of units along North-South direction.						
		1	2	3	4	5	6	7
	1	74.6396	58.2339	46.5557	41.6171	42.5563	37.2679	35.7009
Number	2	52.9661	42.3627	35.9202	33.4605	32.8419	30.8897	23.9134
of	3	44.8348	36.7616	33.4764	30.9701	31.6226	29.1771	22.6678
units	4	33.0494	25.3009	20.0279	18.1036	24.1250	15.3701	10.0744
along	5	32.6628	25.7416	22.2443	20.7675	24.8126	20.0236	15.5882
East-	6	26.9002	21.9659	20.8630	19.3287	20.8138	17.7501	15.8568
West	7	27.0085	23.6032	18.7175	20.8638	21.2589	16.2783	13.1774
direction	8	22.5488	18.1494	14.1496	11.9500	11.2138	11.0366	8.0500
	9	22.1254	15.1344	12.8218	7.6564	9.2964	10.2068	4.8112
	10	21.7189	17.3117	15.5873	9.5958	10.8575	13.4028	5.9532
	11	18.9886	15.2570	14.6442	11.4715	8.1647	12.5695	8.3258
	12	17.1408	11.9267	9.9039	6.4005	1.9081	5.2144	5.0905
	13	16.4974	12.0464	8.9744	6.4482	3.9980	4.3401	5.1043

Table 4. Coefficient of variation of different plot sizes and shapes.

		Height at 60 DAS. Number of units along North-South direction.						
		1	2	3	4	5	6	7
	1	30.8308	21.7483	19.7273	17.2062	17.3642	15.6922	13.7001
Number	2	22.6919	18.1636	16.0012	14.8533	14.7749	13.1437	13.9241
of	3	20.6551	16.7003	15.7344	14.0009	13.8767	13.2341	13.8326
units	4	19.1760	15.3263	14.0777	12.7102	13.2410	11.5280	12.1304
along	5	17.0511	14.1029	12.8219	11.3113	11.1105	10.2417	11.0194
East-	6	15.7699	13.0738	12.6499	10.9910	11.5066	9.8919	10.7985
West	7	14.3796	11.7191	10.9402	9.1706	9.3472	8.4328	10.0801
direction	8	14.8047	12.4924	11.7006	10.5150	11.0438	9.4626	9.2778
	9	13.1123	11.9790	11.8092	9.9671	10.8243	9.9154	9.7625
	10	13.6227	11.0654	12.1871	10.4615	10.7186	8.9862	8.4818
	11	14.3263	11.8512	13.0438	11.2961	12.1200	10.2030	9.7372
	12	13.8572	11.6237	12.7102	11.0310	12.0603	10.4569	10.3423
	13	13.2454	10.8158	11.6124	9.5350	10.2315	10.2413	10.2513

Table.5. Coefficient of variation for different plot sizes and shapes.

		Height at 90 DAS. Number of units along North-South direction.						
		1	2	3	4	5	6	7
	1	40.0328	30.0328	24.0651	20.7360	13.8210	18.3924	8.5006
Number	2	30.7960	23.7090	19.1643	16.9626	13.4128	15.6586	14.9450
of	3	16.0264	19.8332	16.0095	14.2335	12.8389	13.6265	13.2140
units	4	15.0158	13.9953	13.0672	12.0413	12.0820	12.2743	11.9207
along	5	20.7502	16.5302	14.2321	11.8658	11.5403	10.4720	10.9274
East-	6	13.4707	12.5431	11.7898	10.8604	11.3799	11.2431	10.6499
West	7	12.4431	11.5938	10.3828	9.2703	9.8362	9.9069	10.5296
direction	8	12.4794	11.6863	11.0746	9.7371	10.8616	10.5895	10.1776
	9	11.4140	13.0658	11.0388	8.7030	11.4166	9.1133	9.3858
	10	12.4165	12.0150	10.6906	10.1795	10.3481	10.3865	11.4425
	11	12.2192	11.7057	10.7977	10.0532	10.8099	10.9063	10.9234
	12	12.4968	12.1240	11.6676	10.7828	11.8718	11.8052	11.0890
	13	14.5751	12.0838	10.3908	7.9389	12.0025	8.3661	8.6172

Table 6. Coefficient of variation of differeent plot sizes and shapes.

		Girthat 60 DAS. Number of units along North-South direction.						
		1	2	3	4	5	6	7
	1	28.6750	20.9990	19.2004	16.5525	14.7687	15.1397	13.8491
Number	2	20.0311	15.3061	13.6889	12.2792	11.4899	10.7786	11.8312
of	3	17.8924	15.2513	14.1105	12.4874	11.0919	11.4037	12.2167
units	4	15.3131	11.9720	10.6095	9.1598	9.0202	8.6218	8.9089
along	5	14.0625	10.7613	9.6084	8.3544	8.9094	8.3938	9.2268
East-	6	13.0249	10.4490	8.2653	7.2325	6.9336	6.6136	7.4323
West	7	11.4745	9.1921	5.3954	6.5525	4.9952	5.2001	7.0336
direction	8	11.2238	8.7108	7.2514	7.1242	5.6967	6.1855	6.0993
	9	9.8620	9.5845	8.0476	8.0733	6.7005	8.1076	7.9858
	10	9.9640	8.3315	6.8442	6.5220	5.6291	6.4462	6.5965
	11	11.0971	9.3410	7.0912	7.7442	6.3021	7.1276	6.9264
	12	9.7194	8.2121	7.0601	6.2428	5.9262	6.5129	6.5555
	13	10.1101	8.6006	7.1534	7.1297	6.0670	7.4689	8.3956

Table 7. Coefficient of varriation for different plot sizes and shapes.

		Girth at 90 DAS. Number of units along North-South direction.						
		1	2	3	4	5	6	7
	1	24.8726	18.6082	15.9394	14.6381	13.3726	12.7807	11.5020
Number	2	18.3767	15.1989	12.2549	11.6024	11.0166	10.1830	11.4833
of	3	15.6676	14.8407	12.5202	12.1409	11.6813	10.9326	12.2046
units	4	14.0045	11.9611	9.3082	8.0554	6.5810	7.7828	9.6426
along	5	12.9694	11.5944	8.7473	8.3642	6.6659	7.8707	9.7816
East-	6	11.6184	10.4589	8.0180	6.7066	5.6428	6.8646	8.8047
West	7	11.6409	10.2586	8.0350	7.2654	6.4665	7.6250	9.4572
direction	8	11.4302	10.5424	7.9433	6.8020	6.1316	7.4923	9.4780
	9	10.8810	11.3012	9.1928	9.2026	7.7893	8.9896	10.8095
	10	10.9528	10.0914	6.7581	6.3439	5.8080	6.9859	9.5525
	11	10.1130	8.9265	6.4881	5.3292	4.5964	6.1118	8.3400
	12	10.4335	9.6297	7.3445	6.4443	5.7722	7.0013	8.8440
	13	10.7815	10.2128	8.1097	8.2308	6.6255	7.9459	10.1011

Table 8. Coefficient of variation for different plot sizes and shapes.

		Number of suckers at 60 DAS. Number of units along North-South direction.						
		1	2	3	4	5	6	7
	1	204.0286	148.4942	120.2673	103.2955	79.5991	81.6456	67.3704
Number	2	146.1555	110.7773	93.6737	81.5369	62.6626	68.4295	60.3692
of	3	121.4628	88.7462	78.4448	71.6182	54.7444	58.6707	53.1983
units	4	95.5520	76.8058	58.5142	50.2292	45.6853	51.9506	46.9410
along	5	85.2203	65.0944	53.6312	41.6857	37.0011	42.1015	31.7846
East-	6	84.6123	63.4678	56.4374	45.5397	41.6617	45.2067	39.2130
West	7	69.2837	47.1721	34.0925	33.1395	30.5059	28.8222	31.1538
direction	8	67.9637	57.2424	44.2744	31.4447	36.0801	37.7078	32.4839
	9	63.7898	49.3908	43.1535	29.9873	30.4158	33.6489	26.3764
	10	58.9929	41.6981	32.0406	20.5226	17.4955	16.6617	19.1179
	11	63.2803	45.8696	39.6813	22.3109	22.9767	21.9239	23.1776
	12	51.3449	40.5117	28.5218	19.7642	22.7421	25.2304	21.9190
	13	50.0529	40.5392	32.2266	26.6776	25.3108	30.3989	27.5456

Table 9. Coefficient of variation for different plot sizes and shapes.

		Number of suckers at 90 DAS. Number of units along North-South direction.						
		1	2	3	4	5	6	7
	1	63.3883	50.2742	45.5044	42.1011	40.3956	38.5006	36.9340
Number	2	49.3599	42.9906	39.9784	37.4404	37.4476	36.3220	36.4203
of	3	43.6596	38.2438	36.0196	34.4545	34.5388	34.0764	34.4013
units	4	42.7754	38.4683	37.1549	35.7454	35.8185	35.2152	35.1783
along	5	39.8074	36.1630	36.1117	34.4985	35.1270	35.0201	34.0051
East-	6	35.1249	32.8241	31.8254	30.4597	30.8133	30.8552	30.6614
West	7	24.6314	20.3344	19.9068	19.0148	18.6996	18.0402	15.2691
direction	8	33.9526	31.22774	32.0339	30.8592	31.6899	31.6372	30.1600
	9	14.5172	30.6809	30.5273	29.4421	31.4697	30.9673	30.6016
	10	15.1077	11.8155	11.8902	10.8511	8.2267	11.0675	8.4544
	11	19.3916	17.3105	17.7352	17.4142	15.3590	17.8705	15.6816
	12	24.2923	22.7881	23.3912	22.7174	21.2171	23.7688	22.4204
	13	26.7166	25.1183	25.4296	25.1733	23.7666	26.3668	25.9361

Table 10. Coefficient of variation for different plot sizes and shapes.

		Number of leaves at 60 DAS. Number of units along North-South direction.						
		1	2	3	4	5	6	7
	1	24.3911	18.8538	15.8533	15.3789	14.6092	13.5812	13.8539
Number	2	18.4308	15.7417	13.5380	13.4605	12.9279	12.1268	12.2868
of	3	16.0607	14.2681	12.6494	12.4985	12.0278	11.7872	12.0174
units	4	14.3121	12.2447	10.1699	10.6760	10.6225	9.5603	10.1169
along	5	14.2171	12.3093	10.5537	10.7950	10.5347	9.9985	10.4993
East-	6	11.7792	10.0619	8.2960	8.2530	8.5695	7.6487	8.4872
West	7	12.5789	11.5737	10.1594	9.9097	9.9642	9.7702	9.7652
direction	8	11.3498	10.1967	8.7565	9.0023	8.8871	8.4970	8.7010
	9	9.8372	9.7228	8.9702	9.0205	9.0795	8.8881	9.5739
	10	9.7487	8.2939	7.1597	7.2920	6.8698	6.4758	6.6915
	11	9.2900	7.8998	7.4278	7.2020	6.7510	6.4780	6.7114
	12	8.9617	7.9261	7.5006	7.4738	7.5712	7.3648	7.2491
	13	9.9196	8.9475	9.1748	9.0679	9.5619	9.6331	9.3968

Table 11. Coefficient of variation for different plot sizes and shapes.

		Number of leaves at 90 DAS. Number of units along North-South direction						
		1	2	3	4	5	6	7
	1	18.0077	12.8973	10.2197	9.3551	7.6518	7.6061	6.7215
Number	2	12.3799	9.9916	8.3998	7.7868	6.1901	6.5744	6.5508
of	3	9.9240	7.8609	5.7588	5.9661	4.7408	4.4092	4.7403
units	4	9.3301	7.8043	6.0244	5.7307	4.8045	4.7208	5.0519
along	5	8.3217	6.5694	4.7267	4.2171	3.3312	3.5635	4.1256
East-	6	7.8006	6.3435	4.5132	4.6108	3.4408	3.6605	4.2504
West	7	7.5138	5.5210	4.3315	4.1620	3.5486	3.7654	4.5467
direction	8	7.8443	6.4868	4.9853	4.3604	3.6728	3.9165	4.5378
	9	6.9303	5.8835	4.2715	4.0200	3.2409	3.5194	4.0926
	10	6.7703	5.6536	4.4201	3.8153	2.9274	3.8300	4.8830
	11	6.6250	5.5059	4.1753	3.5172	3.1676	3.4286	4.3961
	12	6.4752	5.3207	4.0554	3.3953	2.9444	3.1100	3.9902
	13	6.0962	4.8882	3.6479	3.3376	3.1782	3.2096	4.1688

Table 12. Coefficient of variation for different plot sizes and shapes

		Weight of mother sucker. Number of units along North-South direction.						
		1	2	3	4	5	6	7
	1	71.3605	49.9037	42.7287	36.3056	35.7732	34.5982	23.8579
Number	2	54.1622	42.5215	34.3168	29.6356	27.5960	29.3646	31.7027
of	3	47.5687	37.9618	31.4958	27.1947	28.7437	28.1320	30.8885
units	4	41.2977	33.4391	28.5602	23.3424	25.2439	26.8098	29.8763
along	5	38.1046	30.6739	27.3706	21.2914	25.3184	24.9927	27.2116
East-	6	37.4148	31.8133	27.4450	22.4058	24.8292	26.0181	28.7639
West	7	36.8390	29.1522	25.8460	20.6119	24.4744	24.7318	28.9338
direction	8	34.5881	28.7064	25.6822	20.4087	25.0448	25.2432	27.3685
	9	33.3678	27.5834	23.7426	18.4307	25.1559	23.4921	26.8341
	10	32.5024	28.0536	23.8047	20.0719	24.3584	23.7317	27.6151
	11	32.4834	27.8961	24.5107	19.9117	24.9490	25.5391	29.4786
	12	32.1981	27.6513	25.6857	21.4100	25.9260	26.5856	29.0956
	13	28.7076	24.6960	22.6298	17.1120	24.7126	22.8894	26.1891

Table 13. Coefficient of variation for different plot sizes and shapes.

		Weight of marketable tubers. Number of units along North-South direction						
		1	2	3	4	5	6	7
	1	98.2581	81.0123	73.4003	60.2142	53.3091	61.8283	43.0848
Number	2	76.7760	63.6590	62.9492	52.4219	45.0784	54.5624	39.4219
of	3	64.3643	58.4178	59.7762	49.1620	44.0274	54.9396	39.2948
units	4	57.6764	47.5890	45.8584	39.1901	35.9074	43.9640	28.1385
along	5	54.8740	46.3819	44.2284	39.1093	34.3890	43.6236	26.4375
East-	6	52.8196	43.6941	42.4141	34.4971	29.8862	40.0947	23.1751
West	7	54.0583	44.9765	44.1786	36.1627	31.7294	43.6422	23.1863
direction	8	48.9460	41.5508	40.0967	33.7254	29.4475	39.9777	21.8025
	9	47.0802	45.1128	46.3760	38.3195	35.9636	48.1047	31.4965
	10	49.8959	42.7015	40.3752	35.4046	31.9490	42.8809	21.9211
	11	47.5224	40.6797	39.0043	31.8538	28.3593	41.7808	21.5015
	12	49.1512	42.2912	40.9161	33.9367	30.8194	42.2297	22.0929
	13	47.5988	42.1495	43.2630	34.0492	32.1344	46.5321	26.9470

Table 14. Coefficient of variation for different plot sizes and shapes

Number of marketable tubers.
Number of units along North-South direction.

		1	2	3	4	5	6	7
	1	82.5500	55.2428	49.0356	43.0856	36.2841	39.2934	31.4251
Number	2	63.2449	49.1436	41.4577	36.6400	31.5347	34.1201	41.9031
of	3	54.4703	43.1880	35.5928	32.4801	28.2551	31.2098	39.8113
units	4	48.4882	38.1836	33.2669	29.7947	26.2517	29.8055	36.8293
along	5	46.2172	36.2953	32.3520	28.0366	24.6547	28.5794	35.9112
East-	6	43.9167	35.2184	30.0383	25.7445	19.6176	25.4780	33.7951
West	7	44.3192	34.7838	30.1097	25.5247	20.0445	26.3499	37.2181
direction	8	39.8281	32.3237	29.8310	25.4282	20.5542	26.7470	34.6055
	9	39.2785	32.1714	29.5347	25.7617	21.5239	27.8917	37.2694
	10	39.4966	31.0942	27.5116	24.1461	21.2289	26.2992	35.8958
	11	39.8414	30.8872	27.2681	23.6042	19.0286	25.4550	36.0826
	12	39.9379	31.7173	29.2473	25.3089	19.8513	27.4337	36.2508
	13	39.6235	32.0284	29.4041	26.2038	20.1403	28.8913	38.7573

Table 15.Coefficient of variation for different plot sizes and shapes.

		Weight of small tubers. Number of units along North-South direction						
		1	2	3	4	5	6	7
	1	67.3264	47.3813	40.4414	34.6810	34.2794	31.7637	30.3652
Number	2	49.1350	36.6810	29.7458	25.9604	24.6756	24.4048	28.2924
of	3	43.8996	33.6689	27.2274	24.6464	25.0096	24.1419	28.4428
units	4	39.6596	30.6220	26.1281	23.1927	22.6080	22.1806	26.3220
along	5	37.3680	30.0352	25.3209	22.6913	21.8302	21.3482	25.3166
East-	6	33.8528	26.9214	22.0087	19.1906	19.4605	19.4013	24.3122
West	7	33.1799	26.6156	20.5464	21.3062	19.8898	17.7753	24.2836
direction	8	31.1708	23.7552	21.7498	17.6933	19.0462	17.9423	21.2674
	9	23.1957	24.1175	22.1707	19.3251	20.7106	20.5809	23.8050
	10	28.0322	21.1695	16.9013	16.1248	14.1095	13.3071	19.4876
	11	28.1869	21.4126	17.5116	16.7711	15.9365	14.6057	21.1165
	12	28.1227	22.0197	18.6682	17.0442	16.5042	15.7369	22.3692
	13	26.9737	21.3662	17.9136	17.3866	15.8158	15.8128	22.5749

Table 16. Coefficient of variation for different plot sizes and shapes.

		Number of small tubers. Number of units along North-South direction.						
		1	2	3	4	5	6	7
	1	55.9889	41.0251	34.3434	29.2710	27.1741	26.3820	26.2691
Number	2	38.7626	29.7566	23.3455	21.620	17.7766	17.8220	20.5841
of	3	33.0598	25.4085	20.3291	19.7908	17.3357	16.8357	19.0633
units	4	28.9002	23.6365	17.8092	17.4836	13.9276	13.8994	16.7939
along	5	27.2840	22.7657	18.1575	17.4119	13.7504	14.7382	16.1065
East-	6	24.8130	19.4598	15.2880	13.8994	12.4883	12.3341	16.0864
West	7	23.9369	18.2226	12.1463	13.3531	10.3080	6.1032	13.6758
direction	8	19.7866	16.0957	13.1669	12.1616	10.2980	10.2756	12.6118
	9	15.3341	15.1974	14.1678	12.4985	9.7462	11.9403	13.4007
	10	18.1039	14.2508	10.9849	8.6452	4.6937	2.2323	7.7017
	11	17.3705	13.3966	10.4344	8.8648	5.3503	4.7446	10.2173
	12	18.6834	14.3706	11.4572	10.2338	7.3740	7.5530	13.0450
	13	17.1583	14.2894	10.0865	11.3495	6.4527	7.3265	13.1220

Table 17. Coefficient of variation for different plot sizes and shapes.

		Leaf area at 60 DAS Number of units along North-South direction.						
		1	2	3	4	5	6	7
	1	94.6386	72.0422	60.2930	52.9639	50.8934	42.1203	42.4864
Number	2	68.1150	50.5374	44.2366	39.4930	37.8180	30.9688	29.1038
of	3	60.2471	42.1620	38.3331	33.8267	32.2836	26.8981	25.5966
units	4	50.5116	39.8640	35.9582	31.4108	29.0487	27.3708	25.9499
along	5	46.4805	35.7222	32.6300	29.4374	26.7408	24.5397	23.7984
East-	6	42.5923	32.4740	29.3622	27.1953	25.0445	21.8571	21.6677
West	7	42.0738	33.0741	28.8480	27.0344	21.6999	22.1008	22.6677
direction	8	34.5840	28.3729	24.1822	21.3993	18.4113	19.8521	18.8934
	9	35.2318	25.6861	22.5670	20.3067	15.1897	18.4162	17.8551
	10	33.4659	27.2127	22.9737	20.7622	16.3307	18.2049	19.2991
	11	31.6452	25.9643	22.9605	20.6539	18.0199	19.2251	19.7177
	12	29.6017	24.8837	22.3073	20.4557	17.2850	19.3049	19.1778
	13	27.6951	23.4361	20.4813	19.4695	13.9978	18.0789	18.2418

Table. 18. Coefficient of variation for different plot sizes and shapes.

		Leaf area at 90 DAS. Number of units along North-South direction						
		1	2	3	4	5	6	7
	1	94.6386	72.0422	60.2930	52.9639	50.8934	42.1203	42.4864
Number	2	68.1150	50.5374	44.2366	39.4930	37.8180	30.9688	29.1038
of	3	60.2471	42.1620	38.3331	33.8267	32.2836	26.8981	25.5966
units	4	50.5116	39.8640	35.9582	31.4108	29.0487	27.3708	25.9439
along	5	46.4805	35.7222	32.6300	29.4374	26.7408	24.5397	23.7984
East-	6	42.5923	32.4740	29.3622	27.1953	25.0445	21.8571	21.6677
West	7	42.0738	33.0741	28.8480	27.0344	21.6999	22.1008	22.2797
direction	8	34.5840	28.3729	24.1822	21.3993	18.4113	19.8521	18.8934
	9	35.2318	25.6861	22.5670	20.3067	15.1897	18.4162	17.8551
	10	33.4659	27.2127	22.9737	20.7622	16.3307	18.2049	19.2991
	11	31.6452	25.9643	22.9605	20.6539	18.0199	19.2251	19.7177
	12	29.6017	24.8337	22.3073	20.4557	17.2850	19.3049	19.1778
	13	27.6951	23.4361	20.4813	19.4695	13.9978	18.0789	18.2418

Table 19 Fitting of the curve $Y=aX^{-b}$

Number	Character	a	b	R-square
1	Yield	101 8684	60676	8652
2	Height I	24 1420	22182	8873
3	Height II	25 6584	24120	7223
4	Girth I	24 3367	33000	9090
5	Girth II	21 1385	35080	7099
6	Number of suckers I	211 8763	51560	9643
7	Number of suckers II	57 0924	24830	5216
8	Number of leaves I	20 3567	23690	8388
9	Number of leaves II	14 9103	35780	9339
10	Weight of mother sucker	49 7438	19060	7360
11	Weight of marketable tubers	82 2197	25340	7955
12	Number of marketable tubers	59 7818	20720	6771
13	Weight of small tubers	53 1881	27300	8750
14	Number of small tubers	56 4019	45210	9267
15	Leaf area I	91 8800	38040	9741
16	Leaf area II	86 0824	37930	9757

Table 20. Fitting of the curve Y=a+blogX

Number	Character	a	b	R-square
1	Yield	57.3506	-28.5380	0.8567
2	Height at 60 DAS.	22.4628	-7.4459	0.8165
3	Height at 90 DAS.	25.0576	-9.2500	0.6208
4	Girth at 60 DAS.	20.8157	-8.5775	0.8216
5	Girth at 90 DAS.	17.7245	-7.4709	0.7700
6	Number of suckers at 60 DAS.	144.1465	-70.7609	0.8750
7	Number of suckers at 90 DAS.	51.1250	-16.9110	0.4963
8	Number of leaves at 60 DAS.	18.6402	-6.3586	0.7784
9	Number of leaves at 90 DAS.	12.4334	-5.3365	0.8332
10	Weight of mother sucker	48.4765	-15.0585	0.7489
11	Weight of marketable tubers	78.2339	-27.0225	0.7489
12	Number of marketable tubers	56.8794	-18.1150	0.6005
13	Weight of small tubers	47.7298	-17.8113	0.7789
14	Number of small tubers	40.4901	-18.5249	0.8506
15	Leaf area at 60 DAS.	74.5616	-32.9256	0.8709
16	Leaf area at 90 DAS.	69.3187	-30.3739	0.8860

Table 21. Fitting of the curve 1/Y=a+blogX

Number	Character	a	b	R-square
1	Yield	-0.0560	0.1027	0.0014
2	Height at 60 DAS.	0.0340	0.0372	0.9353
3	Height at 90 DAS.	0.0345	0.0372	0.8116
4	Girth at 60 DAS.	0.0191	0.0749	0.7908
5	Girth at 90 DAS.	0.0161	0.0991	0.5975
6	Number of suckers at 60 DAS.	-0.0076	0.0251	0.1904
7	Number of suckers at 60 DAS.	0.0108	0.0268	0.4973
8	Number of leaves at 60 DAS	0.0378	0.0501	0.8602
9	Number of Leaves at 90 DAS.	0.0203	0.1442	0.6945
10	Weight of mother sucker	0.1863	0.1367	0.8086
11	Weight of marketable tubers	0.0073	0.0138	0.7740
12	Number of marketable tubers	0.0144	0.0137	0.7423
13	Weight of small tubers	0.1259	0.0244	0.8994
14	Number of small tubers	-0.0215	0.0774	0.2003
15	Leaf area at 60 DAS.	0.0015	0.0266	0.4986
16	Leaf area at 90 DAS.	0.0013	0.0286	0.4132

Table 22. Fitting of the curve $Y=a+b/X^{1/2}+c/X$

Number	Character	a	b	c	R-square
1	Yield	-3.5085	102.4939	-26.3067	0.8902
2	Height at 60 DAS.	7.6591	18.8345	3.9587	0.9368
3	Height at 90 DAS.	8.6725	8.8306	24.5854	0.8549
4	Girth at 60 DAS.	3.2767	25.0648	0.2555	0.9235
5	Girth at 90 DAS.	2.2100	23.6364	-2.3253	0.8411
6	Number of suckers at 60 DAS.	-1.0259	211.4039	-5.8463	0.9465
7	Number of suckers at 90 DAS.	15.6978	56.1187	-9.3691	0.5253
8	Number of of leaves at 60 DAS.	5.6311	18.7049	-0.0866	0.8651
9	Number of leaves at 90 DAS.	1.7110	14.2695	1.8683	0.9498
10	Weight of mother sucker	20.7045	21.8229	30.7584	0.8671
11	Weight of marketable tubers	21.8835	87.4849	-11.6531	0.8537
12	Number of marketable tubers	22.5258	33.0990	27.7959	0.7658
13	Weight of small tubers	12.3295	44.8069	10.0525	0.9135
14	Number of small tubers	2.1915	57.5267	-4.5569	0.9264
15	Leaf area at 60 DAS.	8.2934	88.9874	9.9852	0.9856
16	Leaf area at 90 DAS.	6.9036	91.2618	-2.8875	0.9813

Table 23. Fitting of the curve $1/Y=a+bX^{1/2}+cX$

Number	Character	a	b	c	R-square
1	Yield	0.0333	-0.0099	0.0032	0.7522
2	Height at 60 DAS.	0.0216	0.0190	-0.0012	0.9128
3	Height at 90 DAS.	0.0176	0.0214	-0.0014	0.7859
4	Girth at 60 DAS.	-0.0123	0.0411	-0.0026	0.9017
5	Girth at 90 DAS.	0.0031	0.0403	-0.0200	0.8392
6	Number of suckers at 60 DAS.	-0.0031	0.0062	-0.0001	0.9577
7	Number of suckers at 90 DAS.	0.0101	0.0081	-0.0003	0.5185
8	Number of leaves at 60 DAS.	0.0242	0.0241	-0.0014	0.8562
9	Number of leaves at 90 DAS.	-0.0256	0.0719	-0.0004	0.9310
10	Weight of mother sucker	0.0059	0.0109	-0.0008	0.8737
11	Weight of marketable tubers	0.0081	0.0043	-0.0002	0.7800
12	Number of marketable tubers	0.0018	0.0109	-0.0008	0.7971
13	Weight of small tubers	0.0039	0.0127	-0.0008	0.9132
14	Number of small tubers	-0.0049	0.0178	-0.0001	0.9134
15	Leaf area at 60 DAS.	-0.0005	0.0101	-0.0005	0.9854
16	Leaf area at 90 DAS.	-0.0003	0.0105	-0.0005	0.9799

Table 24. Fitting of the curve $Y=ar^{-g_1}c^{-g_2}$

Number	Character	a	g_1	g_2	R-square
1	Yield	102.9723	0.71863	0.45626	0.9028
2	Height at 60 DAS.	24.1477	0.22408	0.21878	0.8874
3	Height at 90 DAS.	25.7263	0.26861	0.20443	0.7317
4	Girth at 60 DAS.	24.4365	0.37244	0.27293	0.9249
5	Girth at 90 DAS.	20.0750	0.27477	0.23317	0.7928
6	Number of suckers at 60 DAS.	212.5925	0.55050	0.46870	0.9639
7	Number of suckers at 90 DAS.	57.7617	0.36930	0.08561	0.6088
8	Number of leaves at 60 DAS.	20.4741	0.29661	0.15661	0.8813
9	Number of leaves at 90 DAS.	14.8940	0.34643	0.37309	0.9351
10	Weight of mother sucker	49.7198	0.18543	0.19747	0.7386
11	Weight of marketable tubers	88.0718	0.23591	0.27705	0.7910
12	Number of marketable tubers	59.7022	0.19309	0.22616	0.6856
13	Weight of small tubers	53.2583	0.28660	0.25470	0.8710
14	Number of small tubers	56.6165	0.49415	0.39913	0.9306
15	Leaf area at 60 DAS.	91.7584	0.36650	0.39910	0.9769
16	Leaf area at 90 DAS.	86.2868	0.40370	0.34650	0.9789

Table 25. Optimum plot sizes computed by the method of maximum curvature using all the fitted equations

No.	Character	$Y=aX^{-b}$	$Y=a+b\log X$	$1/Y=a+b\log X$	$Y=a+b/X^{1/2}+c/X$	$1/Y=a+b^{1/2}X+cX$
1	Yield	12.3761	20.796	17.7503	10.8730	21.9000
2	Height at 60 DAS.	3.3102	5.2650	7.2000	4.7933	5.1315
3	Height at 90 DAS.	3.6763	6.5408	2.0000	6.0000	5.5256
4	Girth at 60 DAS.	4.2156	6.0653	8.3661	5.0148	6.8464
5	Girth at 90 DAS.	3.9110	5.2828	2.9999	4.3535	2.0000
6	Number of suckers at 60 DAS.	20.6200	50.0360	27.1588	20.5103	23.4654
7	Number of suckers at 90 DAS.	7.1057	11.9573	13.4970	7.5614	10.1961
8	Number of leaves at 60 DAS.	3.0142	4.9962	6.7506	4.0636	4.5636
9	Number of leaves at 90 DAS.	3.2200	3.7735	2.0000	3.8027	4.9606
10	Weight of mother sucker	5.4500	7.5299	2.1478	7.9999	10.0000
11	Weight of marketable tubers	10.1580	19.1080	14.0000	5.0000	13.8572
12	Number of marketable tubers	2.3586	12.8094	10.0000	4.9999	6.9999
13	Weight of small tubers	9.7089	12.5946	5.0000	7.9648	10.6424
14	Number of small tubers	8.5256	13.0992	14.6026	8.2485	11.1867
15	Leaf area at 60 DAS.	11.7668	23.2821	18.4861	12.3104	14.1962
16	Leaf area at 90 DAS.	15.3620	21.4770	17.8885	14.0001	14.6710

Table 26 Expected coefficient of variation for different plot sizes and shapes using the Smith's equation

		Yield Number of units along North-South direction						
		1	2	3	4	5	6	7
	1	101 8684	66 8938	52 3046	43 9270	38 3646	34 3668	31 2799
Number	2	66 8938	43 9270	34 3468	28 8455	25 1928	22 5545	20 5405
of	3	52 3046	34 3468	26 8560	22 5545	19 6984	17 6355	16 0608
units	4	43 9270	28 8455	22 5545	18 9419	16 5433	14 8108	13 4883
along	5	38 3646	25 1928	19 6984	16 5433	14 4485	12 9353	11 7803
East-	6	34 3646	22 5545	17 6355	14 8108	12 9353	11 5807	10 5466
West	7	31 2799	20 5405	16 0608	13 4883	11 7803	10 5466	9 6048
direction	8	28 8455	18 9419	14 8108	12 4386	10 8635	9 7258	8 8574
	9	26 8560	17 6355	13 7893	11 5807	10 1142	9 0550	8 2465
	10	25 1928	16 5433	12 9353	10 8635	9 4879	8 4942	7 7358
	11	23 7772	15 6138	12 2085	10 2531	8 9547	8 0169	7 3011
	12	22 5545	14 8108	11 5807	9 7258	8 4923	7 6047	6 9256
	13	21 4852	14 1087	11 0317	9 2647	8 0915	7 2441	6 5973

Table 27. Expected coefficient of variation for different plot sizes and shapes. using the equation $1/Y=a+bX^{1/2}+cX$

		Yield Number of units along North-South direction						
		1	2	3	4	5	6	7
	1	37.4190	38.6731	38.5448	37.7030	36.4731	35.0439	33.5306
Number	2	38.6731	37.7030	35.0439	32.0044	29.0686	26.4036	24.0466
of	3	38.5448	35.0439	30.5087	26.4036	22.9803	20.1836	17.8991
units	4	37.7030	32.0044	26.4036	21.9838	18.6107	16.0193	13.9945
along	5	36.4731	29.0686	22.9803	18.6107	15.4669	13.1447	11.3794
East-	6	35.0439	26.4036	20.1836	16.0193	13.1447	11.0771	9.5536
West	7	33.5306	24.0466	17.8991	13.9945	11.3794	9.5536	8.1730
direction	8	32.0044	21.9839	16.0193	12.3829	10.0020	8.3447	7.1341
	9	30.5086	20.1836	14.4569	11.0771	8.9026	7.4047	6.3179
	10	29.0686	18.6107	13.1447	10.0020	8.0077	6.6451	5.6615
	11	27.6981	17.2323	12.0312	9.1042	7.2670	6.0198	5.1232
	12	26.4036	16.0193	11.0771	8.3447	6.6451	5.4971	4.6744
	13	25.1868	14.9469	10.2524	7.6952	6.1162	5.0542	4.2951

Table 28. Expected coefficient of variation for different plot sizes and shapes. Using the equation 1/Y=a+blogX

		Yield Number of units along North-South direction						
		1	2	3	4	5	6	7
	1	17.8493	39.8203	142.2732	172.3503	63.4738	41.8651	32.5082
Number	2	39.3200	172.3503	41.3651	27.2353	21.4273	18.2478	16.2136
of	3	142.2732	41.8651	23.8264	18.2478	15.4433	13.7202	12.5375
units	4	172.3503	27.2353	13.2478	14.7859	12.8892	11.6664	10.3001
along	5	63.4738	21.4273	15.4432	12.8892	11.4238	10.4528	9.7519
East-	6	41.8651	18.2478	13.7202	11.6664	10.4528	9.6339	9.0354
West	7	32.5082	16.2136	12.5375	10.8001	9.7519	9.0354	8.5070
direction	8	27.2353	14.7859	11.6664	10.1474	9.2166	8.5740	8.0967
	9	23.8264	13.7202	10.9927	9.6339	8.7910	8.2045	7.7664
	10	21.4273	12.8392	10.4528	9.2166	8.4422	7.8999	7.4930
	11	19.6335	12.2196	10.0081	8.8692	8.1498	7.6432	7.2616
	12	18.2478	11.6664	9.6338	8.5740	7.8999	7.4231	7.0626
	13	17.1318	11.1910	9.3136	8.3194	7.6832	7.2314	6.8889

Table 29. Expected coefficient of variation for different plot sizes and shapes using the equation Y=a+blogX

		Yield Number of units along North-South direction						
		1	2	3	4	5	6	7
	1	57.3506	48.7598	43.7345	40.1690	37.4034	35.1437	33.2332
Number	2	48.7598	40.1690	35.1437	31.5782	28.8126	26.5529	24.6434
of	3	43.7345	35.1437	30.1134	26.5529	23.7873	21.5276	19.6171
units	4	40.1690	31.5782	26.5529	22.9874	20.2213	17.9621	16.0516
along	5	37.4034	23.8126	23.7873	20.2218	17.4562	15.1965	13.2360
East-	6	35.1437	26.5529	21.5276	17.9621	15.1965	12.9364	11.0263
West	7	33.2332	24.6424	19.6171	16.0516	13.2860	11.0263	9.1158
direction	8	31.5782	22.9874	17.9621	14.3966	11.6310	9.3713	7.4603
	9	30.1134	21.5276	16.5023	12.9368	10.1712	7.9116	6.0010
	10	28.8126	20.2218	16.1965	11.6310	8.8654	6.6057	4.6952
	11	27.6313	19.0406	14.0153	10.4498	7.6841	5.4245	3.5139
	12	26.5529	17.9621	12.9368	9.3713	6.6057	4.3461	2.4355
	13	35.5609	16.9701	11.9448	8.3793	5.6137	3.3540	1.4435

Table 30 Expected coefficient of variation for different plot sizes and shapes using the equation $Y=a+b/X^{1/2}+c/X$

		Yield Number of units along North-South direction						
		1	2	3	4	5	6	7
	1	72 6788	55 8123	46 8975	41 1618	37 0669	33 9500	31 4725
Number	2	55 8123	41 1618	33 9500	29 4403	26 2723	23 8868	22 0051
of	3	46 8975	33 9500	27 7322	23 8868	21 2016	19 1881	17 6048
units	4	41 1618	29 4403	23 8867	20 4708	18 0945	16 3169	14 9215
along	5	37 0669	26 2723	21 2016	18 0945	15 9380	14 3274	13 0645
East-	6	33 9500	23 8868	19 1881	16 3169	14 3274	12 8431	11 6803
West	7	31 4725	22 0051	17 6048	14 9215	13 0645	11 6803	10 5966
direction	8	29 4403	20 4708	16 3169	13 7889	12 0396	10 7372	9 7181
	9	27 7332	19 1881	15 2422	12 8431	11 1858	9 9520	8 9870
	10	26 2723	18 0945	14 3274	12 0395	10 4602	9 2850	8 3661
	11	25 0031	17 1476	13 5363	11 3452	9 8335	8 7091	7 8302
	12	23 8868	16 3169	12 8431	10 7372	9 2850	8 2052	7 3614
	13	22 8940	15 5804	12 2392	10 1990	8 7996	7 7594	6 9467

Table 31. Estimates of cost in man-hours for conducting a field experiment in colocasia.

Number	Operation	Cost K_2 (man-h/sq.m.)	Cost K_1 (man-h/plot)
1	Land prepration	0.7761	-----
2	Seed bed prepration	0.5038	-----
3	Laying out of plots	-----	0.1960
4	Fertilizer and FYM application	1.0076	-----
5	Periodic observation and after care	-----	1.5677
6	Spraying PP-Chemicals	0.2723	-----
7	Harvesting, weighing and transportation	-----	0.9504

DISCUSSION

DISCUSSION

The present investigation - uniformity trials on colocasia was conducted with the objectives of finding optimum plot size and shape and to determine the direction of blocks to increase the efficiency of experiments on colocasia. For the purpose of finding the direction of blocks, it was essential to find fertility gradient of the area. This has been achieved by studying the productivity contour map, mean sum of squares due to row and column gradients and by rowwise and columnwise serial correlations. The size and shape of plots were determined by two different methods, such as: the heterogeneity index method and maximum curvature method. Six different models were also fitted and the size and shape of plots were investigated through these models. The economic optimum plot size by taking into consideration the cost, was also investigated. The following are the comprehensive discussion of the results obtained from this investigation.

5.1. Productivity contour map

The heterogeneity of land was studied by constructing the productivity contour map. This was constructed by the method described in 3.2.1 and it was as exhibited in Fig.2. From the map it could be concluded that there were no specific trend of fertility variation in the experimental site. On the whole the field could be considered heterogeneous. Further it could be noticed that as the sze of the area decreases, its homogeneity increases. This was in agreement with the findings of Kalamkar(1932a) in potatoes, Bose(1935) in barley and wheat, Huthinson and Panse(1935a) in cotton, Hodnett(1953) in groundnut, Jayaraman(1979) in sunflower, Hariharan(1981) in brinjal and Nair(1984) in turmeric.

5.2. Mean square among strips

Mean sum of squares due to row and column gradients were calculated and compared. Comparison of the row and column mean sum of squares for the yield data indicated a relatively more heterogeneity among strips of rows than the columns. Similar result was obtained by Jayaraman(1979) in sunflower.

5.3. Serial correlation

From the table of serial correlation(Table 2), it was clear that there existed a very low serial correlation. This was the case for both row and column wise serial correlations. The low serial correlation indicated that fertile areas occur in spots. This was in agreement with the contour map already explained.

5.4. Size and shape of plots

A study of variation of plot size and shape is important in a field trial. A measure of studying such variability is coefficient of variation. The coefficient of variation for different plot sizes and shapes was determined for every data set considered. It was found that coefficient of vaariation was found to decrease with an increase in plot size either in North-South or in East-West direction. Further more, the decrease in coefficient of variation was more rapid when units were combined across the rows than along the columns.(See Tables from 3 to 18) The same trend was observed by Kalamkar(1932a) in potatoes, Bose(1935) in wheat, Kulkarni and Bose(1936) in sorghum, Abraham and Vachani(1964) in rice, Sardana et al.(1967) in potatoes, Agarwal et al.(1968) in arecanut,Menon and Tyagi(1971) in orange, Kripasankar et al.(1972) in soyabean, Saxena et al.(1972) in oat fodder, Sreenath(1973) in sorghum, Prabhakaran and Thomas (1974) in tapioca, Kaushik et al.(1977) in mustard, Jayaraman(1979) in sunflower, George et al.(1979) in turmeric, Rambabu et al. (1980) in grass, Hariharan(1981) in brinjal, Nair (1981) in cashew and Nair(1984) in turmeric.

The different combination of unit plot gave rise to a variety of sizes and shapes and coefficient of variation was less for larger plots. It was also clear that for a given plot size, long and narrow plots gave lower coefficient of variation than for square ones. But in general the shape of the plot had no consistent effect on coefficient of variation Similar conclusions were drawn by Sreenath(1973) in sorghum, Prabhakaran and Thomas(1974) in tapioca, Hariharan(1981) in brinjal and Nair(1984) in turmeric

5 5 Heterogeneity index method

Smith's equation in the modified form,

$$Y=aX^{-b}$$

was fitted to all the characters considered The values of constant 'a', Heterogeneity coefficient 'b' and coefficient of determinations were calculated and was presented in Table 19 The soil heterogeneity index was higher for yield than for other characters This result was in agreeement with the findings of Crews et al (1963) in tobacco Since the value of the index 'b' was relatively larger (between 0 2 and 0 6), correlation between continguous plots were lowei, indicating that fertile spots were distributed randomly or in patches This was in agreement with productivity contour map

Since the values of coefficient of determination were significant (between 0 5216 and 0 9757) it could be concluded that this curve gave a good fit to the data

5 6 Alternate models

Five other equations were also fitted and they all gave a good fit to the data concerned Among all, the equation $Y=a+b/X^{1/2}+c/X$ was found to be the best fit as the R^2 values were highly significant. (R^2 values lie within the range 0.7658 to 0.9856). But one could not attribute any physical meaning to the parameters of these equations. However, these models can be utilised to determine the optimum plot size by the maximum curvature method.

Lessman and Atkins(1963a) found that the function $\log Y=a/(a+b\log X)^b$ was an improvement of Smith's function in describing relation between plot size and variability. Nair(1984) found that the models $1/Y=a+b\log X$, $Y=a+b/X^{1/2}+C/X$ and $1/Y=a+bX^{1/2}+cX$ gave good fits to the data and found that the model $Y=a+b/X^{1/2}+c/X$ gave the best fit.

5.7. Maximum curvature method

The optimum plot size estimated by the maximum curvature method was 12.3761 units ($3.34m^2$)using the yield data. This method was adopted by Gupta and Raghavarao(1971) on onion bulbs, Jayaraman(1979) on sunflower,Hariharan(1981) on brinjal, Nair(1984) on turmeric and Lucyamma (1986) on cashew and arrived at a fairly good result. But Federer reported a few drawbacks of this method. viz; It was affected by size of the basic units selected, the scale of measurements used and it does not take cost into consideration.

5.8. Modified maximum curvature method

This is a more precise method proposed by Meir and Lessman(1971) which locates mathematically the exact region of maximum curvature. This method was also tried using all the equations. The optimum plot size using Smith's equation was found out to be 12.3761 units($3.34m^2$) which was very nearer to the optimum plot size obtained by using maximum curvature method. Optimum plot sizes computed by using the models Y=a+blogX, 1/Y=a+blogX, $Y=a+b/X^{1/2}+c/X$ and $1/Y=a+bX^{1/2}+cX$ were repectively 20.1796, 17.7503, 10.87301 and 21.9003 units.($5.45m^2$, $4.79m^2$, $2.94m^2$ and $5.91m^2$). From the R^2 values the model $Y=a+b/X^{1/2}+c/X$ found to be the best. The optimum plot size using this equation was equal to 10.8730 units($2.93m^2$). Therefore the plot size of 11 units ($2.93m^2$) could be used for further investigations in field experiments with colocasia.

5.9. Cost function

The costs of field experimentation must also be reflected in optimum plot size. The plot size which gives maximum information per unit cost could be considered to be optimum for for a given experiment. Smith(1938) gave the relation,

$$X_{opt}=bC_1/(1-b)C_2$$

for determining optimum plot size. Hence optimum plot size was worked out by assuming arbitary values for the cost components C_1 and C_2. The optimum plot size was found out to be nearly $2m^2$. This procedure was followed by Wiedmann and Leininger (1963) on safflower, Saxena et al.(1972) on oat, Prabhakaran and Thomas (1974) on tapioca, Hariharan(1981) on brinjal, Biswas et al.(1982) on cabbage, Binns et al.(1983) on tobacco and Nair(1984) on turmeric.

From the present investigations the following conclusions were drawn.

The productivity contour map showed no specific trend of fertility variation in the experimental site. The study of serial correlation also proved similar result. Through the mean square anlysis among strips it was found relatively more heterogeneity along rows than along columns. The coefficient of variation was found to decrease with an increase in plot size. For a given plot size, long and narrow plots gave lower coefficient of variation than square plots. In the case of Smith's equation, the heterogeneity index 'b' was maximum in yield and also were comparitively higher for all other characters. This also indicated that fertility was distributed randomly in patches. Among all the fitted equations, the equation $Y=a+b/X^{1/2}+c/X$ was found to be the best on the basis of R^2 values. The optimum plot size obtained by using the modified maximum curvature method was approximately 11 units ($2.93m^2$), using this equation. This was very much nearer to that obtained from the Smith's equation (12.3761 units=$3.34m^2$). Hence an optimum plot size of 11 units

$(2.93m^2)$ could be recommended for field experiments with colocasia. The economic optimum in the case of Smith's equation was worked out to be $1.636m^2$. Though, the equations other than Smith's equations were best fitting the relationship between plot size and coefficient of variation, the economic optimum could worked out only for Smith's equation. The economic optima for other equations are yet to arrive at.

SUMMARY

SUMMARY

A uniformity trial on colocasia was conducted at the College of Agriculture, Vellayani, during _Khariff_ season of 1984. Biometrical observations were made on height, girth, number of suckers, number of leaves and leaf area from all plants at 60 and 90 days after planting. At the time of harvest, the yield characteristics were also recorded. The important results obtained from the statistical analysis of the uniformity trial data were given below.

The productivity contour map was prepared to study the nature of heterogeneity of soil in the field. The map showed that the land was not very homogeneous with regard to soil fertility and it was also noticed that as the size of the area increases, its homogeneity decreases.

Mean squares due to row gradient was found greater than that due to column gradient, for yield and certain other chatracters. Hence the trend of soil fertility was more pronounced along the length than along the width of the field.

Serial correlation coefficients for the horizontal and vertical arrangement were found out. Both of them were considerably small, thereby establishing that fertile areas occur in patches.

From the study regarding the size and shape of the

plot, it was found that an increase in plot size either in North-South or in East-West direction decreased the coefficient of variation For a given size of the plot, long and narrow plots gave a lower coefficient of variation than square or nearly square plots

The relationship between plot size and coefficient of variation was studied by the models $Y=aX^{-b}$, $Y=a+b\log X$, $1/Y=a+b\log X$, $Y=a+b/X^{1/2}+c/Y$ and $1/Y=a+bX^{1/2}+cX$ The heterogeneity coefficient 'b' in the Smith's equation was higher for yield than for all other characters The value of 'b' for all biometrical characters was found within the range 0 1 to 0 6

The coefficient of variation of a plot with 'r' rows and 'c' columns was represented by the relation $Y=ar^{-g_1}c^{-g_2}$ The rowwise heterogeneity coefficient was significantly higher than the columnwise heterogeneity coefficient This was true for all characters This showed that formation of plots with more number of rows will give more homogeneous blocks for experiments

The optimum plot size was computed through the maximum curvature and modified maximum curvature methods The optimum, found out by using Smith's equation for yield was nearly 12 units (3 34m^2) through both the methods

The optimum plot sizes were also calculated by using all other models fitted and for all characters. Since the model, $Y=a+b/X^{1/2}+c/X$ gave the best fit to the data, optimum plot size computed by using this equation through the modified maximum curvature method(which was equal to 10.87units($2.93m^2$) could be used for further investigations with colocasia.

A study of the cost of experimentation using $Y=aX^{-b}$ revealed that a plot size of 1.636(approximately $2m^2$) was optimum for conducting experiments with colocasia.

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UNIFORMITY TRIALS ON COLOCASIA *(COLOCASIA ESCULENTA L)*

BY

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ABSTRACT OF A THESIS

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ABSTRACT

A uniformity trial on colocasia was conducted at the experimental field of the College of Agriculture, Vellayani during the period April-September 1984, to study the nature and magnitude of soil heterogeneity and to estimate the optimum size and shape of plots in conducting field trials on colocasia. The various techniques adopted for achieving these objectives were, productivity contour map, mean squares among strips, serial correlation, heterogeneity index method and maximum curvature method. The biometrical observations such as height, girth, yield number of leaves and leaf area were taken from all plants.

Productivity contour map revealed that the field was heterogeneous with regard to soil fertility. The mean squares for the horizontal and vertical arrangements indicated that the fertility was more clear along the length than along the width of the field. The low serial correlation coefficients for both rows and columns established that fertile areas occur in patches. The coefficient of variation decreased with an increase in plot size. For a given size of the plot, the long and narrow plots yield lower coefficient of variation than square plots.

The Smith's variance law in the form $Y=aX^{-b}$ gave a satisfactory fit to the data But among all the fitted models the equation $Y = a+b/X^{1/2}+c/X$ was found to be the best Generalisation of Smith's law in the form $Y=ar^{-g_1}c^{-g_2}$ also gave a good fit to the data and heterogeneity of rows was found to be significantly more than that of columns The optimum plot size found out by using Smith's equation was 12units(3 34m^2) But the optimum plot size computed by using the optimum equation $Y=a+b/X^{1/2}+c/X$ was 10 87 units(2 93m^2) A study of the optimum plot size while considering the cost of experimentation using the Smith's equation was 1 636m^2 In general, it can be recommended that a plot of 2 93m^2 as optimum for conducting field trials on colocasia