Agric. Res. J. Kerala 1988, 26 (1) 102—108

COMPARISON OF DIFFERENT STATISTICAL TECHNIQUES FOR ASSESSING SOIL HETEROGENEITY

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Soil heterogeneity is a major source of error in field experiments. An adequate characterisation of soil heterogeneity in an experimental site is a good guide and even a prerequisite in choosing a good experimental technique. A good idea about the nature of soil fertility in the experimental field will surely improve the efficiency of field experiments.

Kalamkar (1932), Bose (1935) Hutchinson and Panse (1935) and Agarwal *et al.* (1968) constructed the productivity contour maps for the crops potato, barley wheat, cotton and arecanut to study the nature of soil heterogeneity. Gomez and Gomez (1976) gave the methods of serial correlation and mean square among strips to find out the direction of fertility gradient for the experiments with rice crop.

Smith (1938) proposed the soil heterogeneity index 'b' as a quantitative measure of soil heterogeneity in an area. This index is based on the empirical law:

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

Where Y is the coefficient of variation, X is the plot size a and b are constants used to define the relationship between the plot size and coefficient of variation. Several research workers adopted Smith's relation to establish the relationship between plot size and variability (Gupta and Raghavarao 1971 on onion bulbs; Bhargava *et al.* 1973 on apple; Bist *et al.* 1975 on potato and Rambabu *et al.* 1980 on grass).

Materials and Methods

A uniform crop of colocasia (*Colocasia esculenta* L.) variety 'Tamarakannan' was raised as test crop during Kharif over an area of 125.28 m^2 at the College of Agriculture, Vellayani, Kerala Agricultural University. The crop was sown during the second week of April 1984. The field comprised of 29 rows and 16 columns with a spacing of 60 cm between rows and 45 cm between plants within row. In total there were 464 plants. A border row from all sides was left out and the crop was harvested in basic units in an area of 102.06 m^2, thus giving rise to 378 such units. The basic or unit plot selected in this study was 0.27 m^2. Observations on biometrical characters such as height, girth, number of suckers, number of leaves and leaf area were taken at 60 days and 90 days after sowing (DAS). Yield characteristics such as yield, weight of mother sucker, weight of marketable tubers, numbr of emarketable tubers, weight of small tubers and number of small tubers were also recorded.

Using the yield data obtained from the uniformity triai, a productivity contour map was prepared. For constructing the map, the percentage deviation of each observation from the grand mean was calculated and the units are combined into different classes according to the magnitude of the observed mean around the overall mean yield. The experimental units which produce the same amount of deviation from the overall mean yield was assumed to be similar in fertility. The regions of similar fertility status were marked with different gradings systems, so that within the same system the homogeneity is maintained.

The direction of soil heterogeneity could be accurately measured by calculating the mean sum of squares due to rows and columns. For this purpose, the units are combined into horizontal and vertical strips and calculated the mean sum of squares for each strip separately. The relative size of the two mean squares indicates the possible direction of the soil heterogeneity.

Serial correlation can be used to characterise the trend of soil heterogeneity in the field. In order to compute the row-wise and columnwise serial correlation coefficients, first arrange the data row-wise or columnwise in pairs of Xi and X(j + 1). Then calculate the correlation coefficients for the two arrangements. A low serial correlation indicates that fertile areas occur in spots and a high value indicates soil heterogeneity.

Smith (1938) proposed an empirical law, $Y=aX^{-b}$. The value of the index 'b' which generally lies between 0 and 1 indicates the degree of correlation between adjacent plots suggesting that fertile spots are distributed randomly (Gomez and Gomez 1976).

Results and Discussion

The productivity contour map obtained using yield data of the uniformity trial was as shown in Fig 1. The map indicated that there were no specific trend of fertility variation in the field and hence the experimental site was considered as heterogeneous with regard to soil fertility. Moreover, small areas were relatively more homogeneous than large areas. This result was in agreement with the findings of Kalamkar (1932) in potato and Bose (1935) in wheat. Mean square analysis was also carried out and mean squares obtained for different characters were given in Table 1. From Table 1, it was obvious that one can not predict any general trend of fertility variation based on this analysis, because, for certain characters mean squares due to row was greater than that due to columns and for others the result obtained was just the reverse to the above result. Serial correlation coefficients were also calculated and are presented in Table 2. This has been used for characterising the fertility variation prevailing in the field. On inspection it was found that both row wise and column wise serial correlation coefficients for all characters were significantly small and one could infer from that the fertile areas occur in patches. Smith's law in the form $Y = aX^{-b}$ (symbols as explained before) was fitted and the values of the parameters together with their R^3 values ware given in Table 3. The 'b' value ranges between 0.19 and 0.60 and hence there is no considerable correlation between neighbouring plots. Also it could be noticed that the value of 'b' was higher for yield than for other characters. Similar conclusion was drawn by Crews *et el.* (1963) in tobacco.

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	603.099	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	Leaf area at 60 DAS	45603.780	66267.720
11	Leaf area at 90 DAS	209372.800	287716.300
12	Weight of mother sucker	1140.909	3504.655
13	Weight of marketable tubers	5089.492	16381.640
14	Number of marketable tubers	7.318	30.265
15	Weight of small tubers	870.870	1603.846
16	Number of small tubers	18.582	11.377

Out of the four methods discussed above the productivity contour map method and the serial correlation method were leading to the same conclusion in predicting the fertility gradient namely; the fertile areas occur in patches. Mean square analysis method and Smith's method were not leading to any conclusion as

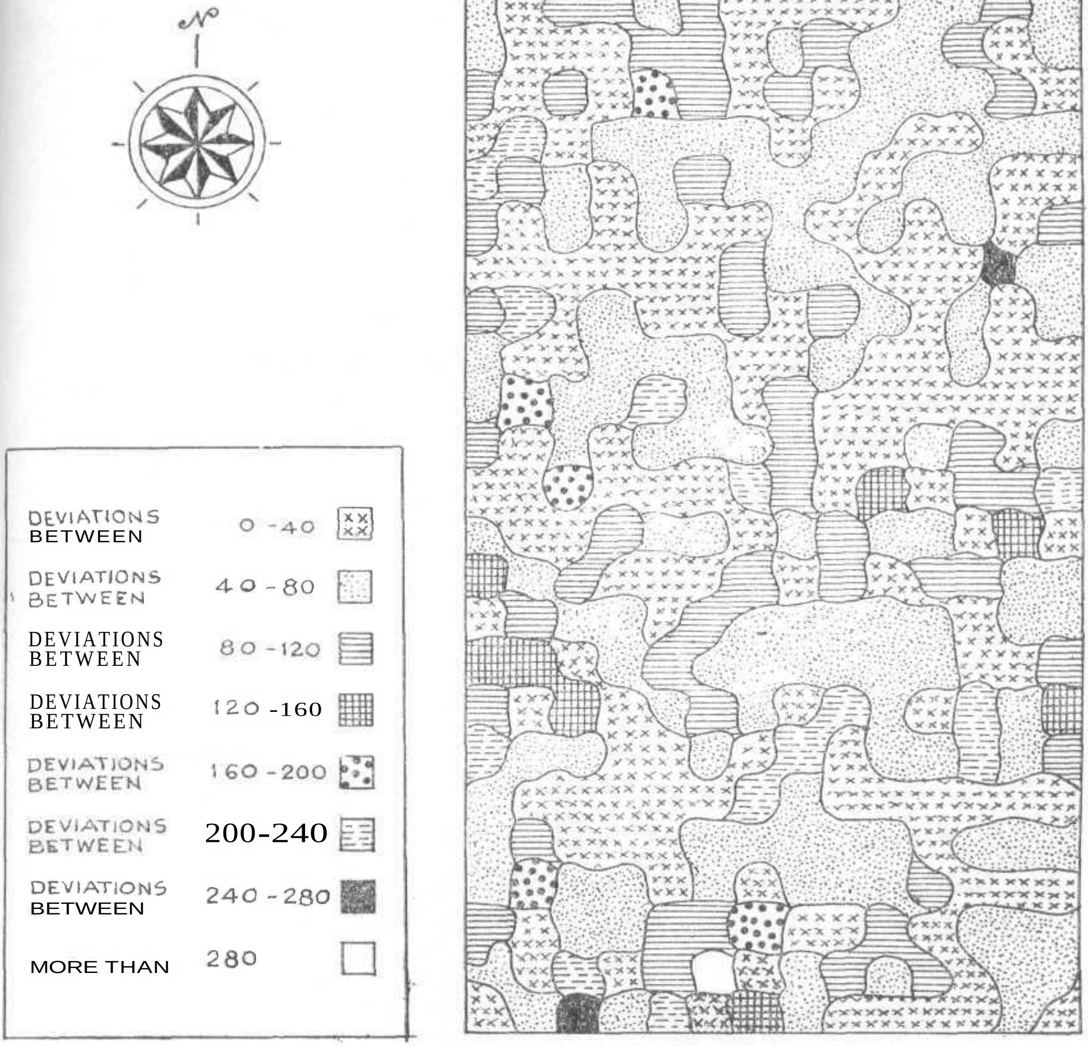

Fig. 1 Productivity contour map

per the reasons stated in the above paragraph. The productivity contour map method is only an approximate and time consuming method where as serial correlation takes into account the individual plots row-wise and columnwise and it is a standard mathematical method. Hence more reliable in expressing inter-relationship among plots. Moreover it is easy to calculate. Hence serial correlation method can be recommended for future studies. Among the four methods, productivity contour map method, serial correlation method, mean square analysis method and Smith's method, only the first two lead to the same conclusion namely fertile areas occur in patches. As far as this crop is considered the serial correlation being a sound mathematical method it is being recommended for future studies.

Table 2

Serial correlation coefficients for different characters

Number	Character	Serial correlation (Row)	(Column)
1	Yield	0.0390	0.0115
2	Height at 60 DAS	0.1238	0.1192
3	Height at 90 DAS	0.0151	0.0836
4	Girth at 60 DAS	0.1538	0.0708
5	Girth at 90 DAS	0.1653	0.1875
6	Number of suckers at 60 DAS	0.0227	0.0227
7	Number of suckers at 90 DAS	0.2331	0.2751
8	Number of leaves at 60 DAS	0.1858	0.1708
9	Number of leaves at 90 DAS	0.0027	-0.0107
10	Leaf area at 60 DAS	—0.0005	0.0105
11	Leaf area at 90 DAS	0.0648	0.0385
12	Weight of mother sucker	0.0877	0.1540
13	Weight of marketable tubers	0.1918	0.2375
14	Number of marketable tubers	0.1087	0.1510
15	Weight of small tubers	0.0467	0.0936
16	Number of small tubers	0.0304	-0.0140

Table 3

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

Number	Character	a	b	R^2
1	Yield	101.8684	0.6068	0.8652
2	Height at 60 DAS	24.1420	0.2218	0.8873
3	Height at 90 DAS	25.6584	0.2412	0.7223
4	Girth at 60 DAS	24.3367	0.3300	0.9090
5	Girth at 90 DAS	21.1385	0 3508	0.7099
6	Number of suckers at 60 DAS	211.8763	0.5156	0.9643
7	Number of suckers at 90 DAS	57.0924	0.2483	0.5216
8	Number of leaves 60 DAS	20.3567	0.2369	0.8388
9	Number of leaves at 90 DAS	14.9103	0.3578	0.9339
10	Leaf area at 60 DAS	91.8800	0.3804	0.9741
11	Leaf area at 90 DAS	86.0824	0.3793	0.9757
12	Weight of mother sucker	49.7438	0.1906	0.7360
13	Weight of marketable tubers	82.2197	0.2534	0.7955
14	Number of marketable tubers	59.7818	0.2072	0.6771
15	Weight of small tubers	53.1881	0.2730	0.8750
16	Number of small tubers	56.4019	0.4521	0.9267

Summary

A uniformity trial on colocasia was conducted at the College of Agriculture, Vellayani, Kerala Agricultural University, during kharif 1984. Biometrical observations on 16 characters as indicated in Tables 1,2 and 3 were taken from all plants. The nature of soil heterogeneity was studied from the productivity contour map. The map revealed that the field could be considered heterogeneous in nature. Based on the mean square analysis, we could not predict any general trend of fertilty variation existing in the field. The low serial correlation coefficients established that fertile areas occur in patches. The 'b' value was found higher for yield than for other characters. While comparing all the four methods we could assume that the method of serial correlation, is more reliable than all other methods.

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