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OPTIMUM PLOT SIZE FOR FIELD TRIALS WITH BANANA

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For successful experimentation it is necessary to have some idea about the variability of the experimental material. The generally accepted technique of estimating the variability in the experimental material is by conducting a uniformity trial. The results obtained from such trials can also be used to determine the suitable size and shape of plots and blocks in conducting field experiments. Numerous uniformity trials with vatious crops have been reported in India. Hutchinson and Parse (1935) conducted a uniformity trial to obtain the optimum plot size for field trials in cotton. Kulkarni *et al.* (1936), Narasinga Rao (1937), Sardana and Sreeneth (1967), Agarwal et al. (1968), Abraham et al. (1969), Menon and Tyagi (1971), Prabhakaran and Thomas (1974), Bhargava and Sardana (1975) obtained the best size and shape of plots and blocks for jowar, rice, potato, arecanut, pepper, orange, tapioca and apple respectively. No such information is available with regard to banana, an important fruit crop of Kerala. Field experiments on banana have been conducted on plots with size and shape determined largely on the basis of practical considerations or on the results of research carried out in other places or on other similar crops. The present study was therefore undertaken to obtain the optimum plot size for field experiments on banana. As the shape of the pilot does not seem to have any significant effect on variability (Smith H. F. 1938) that aspect of the problem has not been included in this investigation.

A uniformity trial on banana was concucted at the Banana and Pineapple Research Station, Kannara using Monsmarie variety during 1976. A spacing of 2.4 m x 2.4 m was adopted for the trial. As some of the border plants had been affected by the bunchy top disease, the final observations were confined to the middle 6 rows each of 24 plants. Thus altogether there were 144 plants in a 24 x 6 arrangement in the experimental area. Plots of different sizes were formed by combining adjacent plants, a plant representing the basic unit. The plots were arranged in blocks of different sizes in the row-wise direction. The bunch weight was recorded from each plant separately which formed the basis of the study of variations due to varying plot sizes for the crop.

Several methods have been suggested from time to time for obtaining the optimum plot size. Among them the well-known emperical relationship between plot size and variance of mean per plot developed by Smith (1938) is considered to be the best. Smith's equation is of the form $V_x = V_1/x^b$ where V_x is the variance of yield per unit area among plots of size x units V_1 is the variance of yield of plots of size unity and b is a measure of correlation among contiguous units. The limiting values of b are zero and one unless inter experimental competition is present (Federer, 1955). As the equation is logarithmically linear the best estimates of V_1 and b can be obtained by the principle of least squares. The fitted regression eqation provides the expected values of Vx for different values of >'.

Fairfield smith has also considered the cost function $C = c_0 + c_1 x$ where C_0 is the cost which is independent of plot size and C_1 is the contribution to the cost by a unit increase in plot size. Optimum plot size is the one which minimises the cost per unit of information, namely $(c_0 + c_1 x)\ V_1\ x^b$. However for a crop like banana a plant is the ultimate unit and therefore the entire cost is proportional to the number of plants per plot. Thus it is more logical to define the optimum plot size as the one giving maximum information from the data per unit plant. The optimum plot size was estimated with this objective in view.

Results and Discussion

The variability of plots of different sizes was estimated by calculating the co-efficient of variation and is given in Table 1. It can be seen that both with and without blocking arrangements the C. V. decreases as the plot size increases. The observed variances of plot means for plots of differenr sizes are presented in Table 2. The results indicate that an increase in plot size is followed by a decrease in variance of plot means both in the case of with and without blocking arrangements.

Table 1

Co-efficient of variation with plots and blocks of different sizes

Plot size (No. of plants)	Without blocking	Number of plots per block			
		2	3	4	6
1	22.5!	20.30	21.72	21.75	21.80
2	17.54	16.89	17.08	17.60	16.20
3	13.95	12.77	..	11.87	..
4	12.60	12.90	10.20	..	10.60
6	10.60	6.90	..	12.50	..

Table 2

Observed variance of plot means based on plots of different sizes

Plot size (No. of plants)	Without blocking	Number of plots per block			
		2	3	4	6
1	7.38	6.03	6.85	6.87	6.90
2	4.46	4.14	4.23	4.80	3.81
3	2.82	2.37	. .	2.05	. .
4	2.30	2.42	1.51	. .	2.30
6	1.65	0.70	. .	1.68	. .

Table 3

Estimates of constants in fair Smith Law

Constants	Without blocking	Number of plots per block			
		V 2	3	4	6
V_1	7.796	5.444	6.495	7.063	6.797
b	0.904	0.724	0.787	0.849	0.793

Fair Field Smith equation was fitted on the basis of the observed variance of plot means and the constants V_1 and b were estimated by the principle of least squares. The best estimates of V, and b are given in Table 3. The estimates of b are seen to be fairly close to 1. This indicates that the x units making up the post are not strongly correlated. Genetic variation is more important than positional variation. The expected variance of the plot means corresponding to plots of different sizes in cases of blocking and not blocking were computed from the regression equation. These are presented in Table 4.

The relative percentage information per plant for plots of different sizes is given in Table 5. It is calculated by first finding the information per plant from plots of size x units and thereafter expressing it as a percentage of the information obtained from single plant plots. As the efficiency of a plot size can be defined in terms of the relative percentage information per plant, the optimum

Table 4

Expected variance of plot means computed from fair field Simth Law

Plot size	Without blocking	Number of plots per block			
		2	3	4	6
1	7.80	5.44	6.50	7.06	6.70
2	4.16	3.30	3.74	3.90	3.92
3	2.88	2.46	. .	2.75	. .
4	2.23	1.99	2.18	. .	2.26
6	1.55	1.49		1.52	. .

Table 5

Relative percentage information per plant for plots and blocks of different sizes

Plot size	Without blocking	No. of plots per block			
		2	3	4	6
1	100.00	100.00	100.00	100.00	100.00
2	93.75	82.42	86.90	90.51	85.46
3	90.28	73.71	. .	85.58	. .
4	87.44	68.34	74.54	. .	74.12
6	83.87	60.85	. .	77.41	. .

Table 6

Number of replications required for providing with 5% standard error

Plot size	Without blocking	No. of plots per block			
		2	3	4	6
1	21	16	19	19	19
2	12	11	12	12	11
3	8	7	. .	6	. .
4	6	7	5	. .	5
6	5	2	. .	5	. .

plot size is the one providing maximum amount of relative percentage information. It can be seen that the relative percentage information is maximum for single plant plots both in the case of arrangements in blocks and without blocking. Thus single plant plots are the most efficient in conducting field trials on banana. It may be noted that these findings are similar to some other earlier results obtained (Agerwal *et al.,* 1968; Menon *et al.* 1971, Bhargava and Sardana, (1973) in respect of certain other horticultural crops cultivated in India.

The number of replications required for estimating the mean yield with 5% standard error has been worked out. It is given by the relation $n = (c.\ v)/p^2$ where n is the expected number of replications p is the percentage standard error and c. v is the co-efficient of variation. It can be observed in all cases that the number of replications required decreases with an increase In plot size. Despite this phenomena, the population of experimental plants declines with enlarged plots. Thus single plant plots provide maximum information with a fewer number of plants. Thus it can be safely concluded that for all practical purposes single plant plots should be recommended for conducting field experiments on banana. As banana plants are liable for disease incidence, as a safety measure, three plant plots would however be advisable.

Summary

The data from a uniformity triai on banana was analysed for finding the optimum plot size for conducting field experiments. The results showed that single plant plots were most efficient. The co-efficient of variation of yield decreased steadily with increasing plot size. The empirical law suggested by Fairfield Smith gave a satisfactory fit to the data. The number of replications required for providing estimates with 5% standard error decreased with increased plot size, but the total experimental material required was minimum when single plant plots were used. However, as banana plants are liable for disease incidence, three plant plots are suggested for experiments.

സംഗ്രഹം

കേരളത്തിലെ ഒരു പ്രധാന തോട്ടവിളയായ വാഴയിൽ കൃഷി പരീക്ഷണങ്ങൾ ആസൂത്രണം ചെയ്യുമ്പോൾ പരീക്ഷണ പ്ലോട്ടിന് കല്പിക്കേണ്ട വിസ്തൃതി നിർണ്ണയിക്കുന്നതിന് ഒരേകസമാനതാ പരീക്ഷണം നിർവഹിക്കുകയുണ്ടായി. ദത്തങ്ങളെ സാംഖ്യികീയമായി വിശ്ലേഷണം ചെയ്തപ്പോൾ 'ഏകസസ്യപ്ലോട്ടുകൾ' സാപേക്ഷ വിസ്തൃതി കൂടിയ ഇതര പ്ലോട്ടുകളെക്കാൾ കൂടുതൽ ക്ഷമതയുള്ളതായി കാണപ്പെട്ടു. പ്ലോട്ടിന്റെ വലിപ്പം വർദ്ധിക്കുന്നതോടുകൂടി വിചരണ ഗുണാംകം ക്രമേണ കുറയുന്നു. ഫെയർ ഫീൽഡ് സ്മിത്ത് നിർദ്ദേശിച്ച

വിചരണ നിയമം ദത്തങ്ങളെ തൃപ്തികരമായ വിധത്തിൽ പ്രതിനിധീകരിക്കുന്നു. വലിപ്പം കൂടിയ പ്ലോട്ടുകൾ ഉപയോഗിക്കുന്നതായാൽ പുനരാവൃത്തികളുടെ എണ്ണം കുറയ്ക്കാം. എന്നാൽ പരീക്ഷണത്തിന് ആവശ്യമായി വരുന്ന സസ്യങ്ങളുടെ എണ്ണം കുറയ്ക്കുന്നതിന് ഏക സസ്യ പ്ലോട്ടുകൾ ഉപയോഗിക്കുകയാണ് അഭികാമ്യം പക്ഷേ വളരെയധികം രോഗ വിധേയത്വം പ്രകടിപ്പിക്കുന്ന ഒരു വിളയാണ് വാഴ എന്നതിനാൽ മൂന്നു സസ്യങ്ങൾ ഉൾക്കൊള്ളുന്ന പ്ലോട്ടുകൾ പരീക്ഷണങ്ങൾക്ക് ഉപയോഗിക്കുകയായിരിക്കും നല്ലത്.

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