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# OPTIMUM PLOT SIZE FOR FIELD EXPERIMENTS WITH TAPIOCA

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Plot sizes and shapes for field experiments vary with crops, soil types and treatments. The technique of uniformity trial is generally adopted to find the best size and shape of plots for different crops. One of the earliest studies of plot size on Wheat was made by Mercer and Hall (1912) of the Rothamstead Experimental Station in the year 1911. Kulkarni *et al* (1936), Brim and Mason (1959) and Sardana and Sreenath (1967) obtained the best size and shape of plots and blocks for Jowar, Soybean and Potato. An attempt has been made to obtain the best size and shape of plots for conducting field experiments on Tapioca, the second major food crop of Kerala.

## Materials and Methods

A uniformity trial was conducted at the College of Agriculture, Vellayani during the year 1972. The variety of tapioca planted was $M_4$. The spacing adopted for the trial was 1m x 1m. There were altogether 28 rows of plants in the north-south direction, each 24m long and 1m apart. At the time of harvest, 2 rows of plants on the four sides of the field were discarded to avoid border effect. The central 24 rows were then divided into units each 1 row wide and 2m long. There were thus 240 ultimate units of size 1m x 2m. The yield of each basic unit was recorded separately, which formed the basis of the study of variations in plot sizes and shapes and the arrangement of plots in blocks of different sizes for the crop. The data were examined statistically for a study of variation amoung plots of different sizes and shapes, variation among blocks of different sizes and the estimation of optimum plot size. Smith's (1938) equation in the modified form $y=a.x^{-b}$, where y is the average coefficient of variation, x is the plot size and b is a measure of correlation among contiguous units (Saxena *et al,* 1972) was fitted for the data without arrangement in blocks and for blocks of different sizes.

## Results and Discussion

The variability of each plot size and shape was determined by calculating the coefficient of variation. The coefficients of variation for plots of different sizes and shapes are given in Table 1.

It can be seen that an increase in the plot size in either direction decreases the coefficiant of variation. The coefficient of variation decreased from 34.4 to 9.1. The shape of the plot does not seem to have a consistent effect on the coefficient of variation. However, for a given plot size, long and narrow

Table 1

**Coefficient of variation of yield of tapioca for plots of different sizes and shapes.**

| Breadth in units | Length in units 1 | 2 | 3 | 5 | 8 | 10 |
|---|---|---|---|---|---|---|
| 1 | 34.4 | 24.6 | 26.0 | 22.8 | 16.0 | 15.8 |
| 2 | 27.3 | 20.3 | 22.4 | 19.9 | 13.2 | 13.4 |
| 3 | 22.3 | 20.6 | 18,9 | 18.7 | 13.0 | 13.0 |
| 4 | 21.8 | 20.2 | 18.6 | 16.8 | 12.8 | 11.9 |
| 6 | 20.4 | 19.3 | 18.1 | 17.2 | 12.6 | 11.6 |
| 8 | 16.9 | 16.2 | 17.6 | 14.1 | 9.6 | 9.1 |
| 12 | 14.2 | 13.7 | 14.4 | 13.6 | — | — |
| 24 | 12.1 | 11.9 | 11.3 | 10.5 | — | — |

plots generally yielded lower coefficient of variation than approximately square plots. With the smaller plot sizes, the effect of size is more predominant so that larger plots are more efficient than smaller ones irrespective of their shape. As the size of the plot increases, shape also is important, so that broad plots are often less efficient than longer plots of a smaller size. Defining efficiency of a plot by $1/x.(c.v)$, where x is the number of basic units constituting the bigger plot and C. V is the coefficient of variation (Kalamkar, 1932), the efficiency decreased as the size of the plot was increased. Hence the smaller plot in which agricultural operations can conveniently be carried out, may easily be taken and the number of replications increased accordingly.

A free hand curve has been drawn (Fig. 1), in which the plot size is plotted against the the average coefficient of variation. It can be seen that the coefficient of variation decreased rapidly, when the size of the plot is increased upto 16 $m^2$ and there after the decrease is rather slow. Thus the best plot size according to the method of maximum curvature (Federer, 1967) is about 20 $m^2$.

The ultimate units were combined to form blocks of sizes 4, 6 and 8 units respectively. The coefficient of variation for different block sizes are given in Table 2.

It was seen that the coefficient of variation decreased with an increase in the plot size in every case. Smith's empirical law was fitted to the values. The coefficient of heterogeneity 'b' was found to vary between 0.2730 and 0.4076. The equations are given in Table 3,

**Table 4**

**Optimum plot sizes for different values of $C_1$ and $C_2$.**

| $C_1$ | $C_2$ | Optimum plot size ($m^2$) |
|---|---|---|
| 19 | 1 | 19.5 |
| 18 | 2 | 9.2 |
| 17 | 3 | 5.9 |
| 16 | 4 | 4.1 |
| 15 | 5 | 3.1 |
| 14 | 6 | 2.2 |
| 13 | 7 | 1 9 |
| 12 | 8 | 1.5 |
| 11 | 9 | 1.2 |

**Summary**

A uniformity trial on tapioca was laid out at the College of Agriculture, Vellayani, during the year 1972 with the variety $M_4$. The coefficient of variation of yield decreased steadily with increasing plot size. The shape of the plot did not have a consistent effect on the coefficient of variation. However long and narrow plots showed on the average lesser variation than square plots of the same area. Smith's equation was fitted to the data for blocks of different sizes and without blocking. The optimum plot size was worked out by using (1) maximum curvature method and (2) Fairfield Smith's variance law. The most efficient plot size for any given field experiment on tapica was worked out to be about $20m^2$.

മരച്ചീനിയിലുള്ള ക്ഷേത്രപരീക്ഷണങ്ങളിൽ പ്ലോട്ടിന്റെ അനുകൂലതമ വിസ്തൃതി

സംഗ്രഹം

1972–ൽ വെള്ളായണി കാർഷിക കോളേജിൽ $M_4$ എന്ന ഇനം മരച്ചീനിയിൽ നിർവഹിക്കപ്പെട്ട ഒരു ഏകസമാനതാ പരീക്ഷണത്തിന്റെ ഫലങ്ങളെ നിർദ്ദിഷ്ട വിളയിൽ ക്ഷേത്രപരീക്ഷണങ്ങൾ രൂപനിർദ്ദേശം ചെയ്യുമ്പോൾ പരീക്ഷണ പ്ലോട്ടിന് കല്പിക്കേണ്ട അനുകൂലതമ വിസ്തൃതിയും അനുയോജ്യമായ ആകൃതിയും സുനിശ്ചിതപ്പെടുത്തുന്നതിന് ഉപയോഗിക്കുകയു

**Table 2**

**Coefficient of variation of yield of tapioca for blocks of different sizes**

| No. of basic units | 4-plot block | 6-plot block | 8-plot block |
|---|---|---|---|
| 1 | 30.1 | 32.1 | 31.9 |
| 2 | 24.9 | 25.2 | 23.2 |
| 3 | 20.2 | — | 20.4 |
| 4 | 16.9 | 19.0 | — |
| 5 | 18.1 | 17.2 | 19.7 |
| 6 | 17.8 | — | 18.1 |
| 10 | 12.7 | 12.1 | 14.2 |

**Table 3**

**Smith's equation fitted to the uniformity trial data on tapioca.**

| No. of plots per block | Equation | Coefficient of determination |
|---|---|---|
| 4 | $30{,}59\ x^{-0.3585}$ | 95 |
| 6 | $32.75\ x^{-0.4076}$ | 94 |
| 8 | $30.66\ x^{-0.3183}$ | 96 |
| Without blocking | $28.09\ x^{-0.2730}$ | 78 |

Tt is evident that all the four equations give a fairly satisfactory fit to the experimental data. Taking the cost function for field experiment as $C = C_1 + C_2 x$, where $C_1$ is the cost proportional to the number of replications and $C_2$ is the cost proportional to the area required with the basic plot of x $m^2$, (Sardana *et al*, 1967) and assuming that the variance is governed by Smith's law, it can be shown that for a fixed cost, the optimum plot size, (X opt) is given by the equation,

$$X_{opt} = \frac{b.C_1}{(1-b).C_2}$$

As it is difficult to get actual values for $C_1$ and $C_2$, the optimum plot size was computed by assuming arbitrary values for the ratio $C_1 : C_2$ and taking an average value of b to be equal to 0.3393 (Saxena et *al*, 1972). The optimum plot size calculated against different values of $C_1$ and $C_2$ are given in Table 4. Further assuming that $C_1$ will not exceed 20. $C_2$ the optimum plot size is about 20 $m^2$

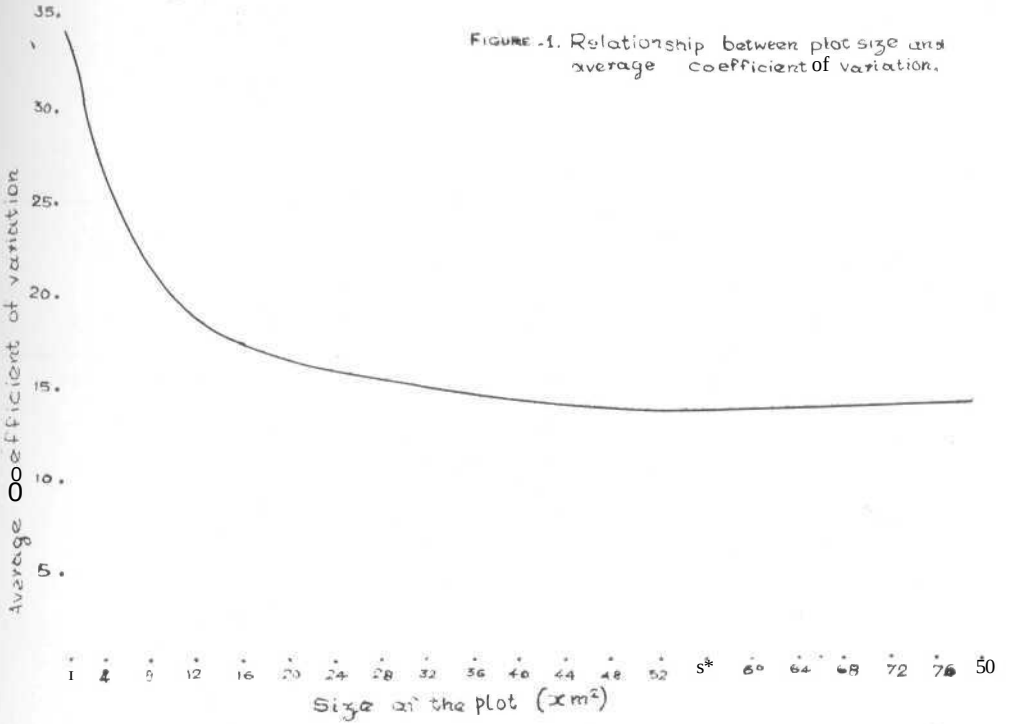


FIGURE -1. Relationship between plot size and average coefficient of variation.

ണ്ടായി. പ്രേക്ഷിതദത്തങ്ങളിൽനിന്നും പ്ലോട്ടിന്റെ വലിപ്പം വർദ്ധിക്കുന്നതിനനുസരിച്ച മരച്ചീനി വിളവിന്റെ വിചരണ ഗുണാങ്കം ക്രമാനുഗതമായി കുറയുന്നതായി നിരീക്ഷിക്കപ്പെട്ടു. പ്ലോട്ടിന്റെ ആകൃതിക്കു് വിചരണ ഗുണാങ്കത്തിൽ പ്രബലമായ എന്തെങ്കിലും സ്വാധീനമുള്ളതായി ദത്തങ്ങളും തെളിവു നൽകിയില്ല. എങ്കിലും സമചതുര രൂപത്തോടു സാദൃശ്യമുള്ള ആകൃതിയിലുള്ള പ്ലോട്ടുകളും തുല്യ ക്ഷേത്രഫലമുള്ള നീണ്ടു ഇടുങ്ങിയ ആകൃതിയിലുള്ള പ്ലോട്ടുകളേക്കാളും ഉയർന്ന തോതിലുള്ള വിചരണം പ്രകടിപ്പിച്ചു. പ്ലോട്ടുകളെ ഖണ്ഡങ്ങളായി വേർതിരിക്കാത്ത സ്ഥിതിയിലും, വിവിധ വലിപ്പത്തിലുള്ള ഖണ്ഡങ്ങളായി സമൂഹനം ചെയ്യുതിനുശേഷവും സ്ലിത്തിന്റെ വ്യതിയാന നിയമം അനുസരിച്ചുള്ള സമീകരണങ്ങളും ആസംജനം CTnJcgjsiajട്ടു. പരീക്ഷണ പ്ലോട്ടിന്റെ അനുകൂലതമ വിസ്തൃതി അധികതമ വക്രതാ സമ്പ്രദായത്തിലും, ഫെയർ ഫീൽഡ് സ്ലിത്തിന്റെ വ്യതിയാനനിയമം അനുസരിച്ചും ആകലനം ffjjaJt^siപ്പെട്ടു. മരച്ചീനിയിൽ ആസൂത്രണം ചെയ്യപ്പെടുന്ന ക്ഷേത്രപരീക്ഷണങ്ങളുടെ ഏകദേശം 20 ചതുരശ്രമീറ്റർ ക്ഷേത്രഫലമുള്ള പ്ലോട്ടുകളും ഉപയോഗിക്കുന്നതായിരിക്കും കൂടുതൽ പ്രയോജനപ്രദം എന്നു പരീക്ഷണഫലങ്ങളും സൂചിപ്പിക്കുന്നു.

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