Optimum Plot Size and Shape Estimates for Sunflower Yield Trials

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ABSTRACT

In a uniformity trial on sunflower, coefficient of variation (CV) decreased with an increase in plot size. Efficiency was higher for smaller plots. Smaller plots required more replications but less area than larger plots. Smith's coefficient of heterogeneity (b) was found to be 0.2133 with 93.92 per cent of variation explained. A plot size of 20 basic units (i.e. 9 m\textsuperscript{2}) appeared as an optimum plot size with the shape of 10 rows each of 2 m long.

Key words : Coefficient of variation, plot size and shape, relative efficiency, soil heterogeneity index.

Efficient planning of agricultural field experiments depends on the adoption of optimum size and shape of plot which in turn depends on the nature of experiment and variability present in the experimental material as well as the materials involved in conducting the experiment. Though data from uniformity trials have been used with many oleseed crops, Bhattachar et al. (1991); Gupta et al. (1991), and Kaushik et al. (1977), to help estimate the optimum plot size and shape to use in experiments. No such investigation is carried out in sunflower. Therefore, the study was undertaken with a view to evaluate an optimum size and shape of plot and number of replications for field experiments on sunflower.

MATERIALS AND METHODS

Sunflower for this study was grown during the rabi season of the year 1991 at the Zonal Agricultural Research Station, Indira Gandhi Agricultural University, Raipur to collect the necessary information. The crop was sown in rows along East-West direction with a spacing of 45 cm between rows covering an area of 45 m long and 25 m wide.

A block of 50 rows each of 40 m long was harvested in a continuous unit of 1 m row giving in all 2000 units. The yield of adjacent units were combined to form plots of different sizes and shapes. The coefficient of variation (CV) for each such arrangement was calculated.

Estimation of optimum plot size was carried out according to the concept of Smith (1938).

$$Y = a X^{-b} \hspace{1cm} (1)$$

Where,

- \(Y\) is the observed coefficient of variation,
- \(X\) is the plot size,
- \(a\) is the filled constant and \(b\) is an index of soil heterogeneity. Then, the optimum size of plot \((X = pt)\) was obtained through the application of the usual method of maximum curvature (Sethi, 1985) as:

$$x = pt = \left(\frac{a+b}{b+1}\right)^{\frac{1}{b}}$$

...(2)

And on the basis of per unit decrease in CV per unit as:

$$\text{Per Unit Decrease (PUD)} = \frac{CV_{n-1} - CV_n}{X_n - X_{n-1}}$$

...(3)

Where,

- \(CV_{n-1}\) and \(CV_n\) are the average coefficient of variation of the plot size \(X_{n-1}\) and \(X_n\) respectively.

The number of replications for different plot sizes were worked out by the formula:

$$r = \frac{(CV\%)^2}{p^2} \hspace{1cm} (4)$$

Where,

- \(CV\%\) is the average coefficient of variation and \(P\) is the 5 and 10 per cent standard error of the means (Rambabu et al., 1980). The minimum area required for the experimentation to acquire a desired level of percentage (5 and 10\%) of standard error of mean may be expressed as:

$$A_{min} = r X_n \hspace{1cm} (5)$$

Where,

- \(r\) is the number of replications for plot size \(X_n\).

Efficiency of land use for various plot sizes were computed with respect to 1 unit plot area by the formula used by Agarwal and
Deshpande (1967). If \( V_1 \) and \( V_2 \) are the variances for two plots \( a_1 \) and \( a_2 \) expressed on a unit basis, and \( r_1 \) \( r_2 \) are the number of replications possible, the relative efficiency of plot size \( a_2 \) compared with \( a_1 \) is given by

\[
\frac{v_1}{v_2} \times \frac{r_2}{r_1} \quad \ldots \ldots (6)
\]

which in term of coefficient of variation and plot size is

\[
(CV_1/CV_2)^2 \times (a_1/a_2)^2 \quad \ldots (7)
\]

Where,

\( CV_1 \) and \( CV_2 \) are the CVs for the plot sizes \( d_1 \) and \( d_2 \), respectively.

The size and shape of plot with the highest relative efficiency or the smallest Amin or both is conventionally taken as optimum.

**RESULTS AND DISCUSSION**

Sunflower seed yield from 2000 basic units ranged from 5 to 150 g with an average of 37.95 g. The comparisons were made on the basis of coefficient of variation per cent among fifteen different sizes which covered thirty nine different shapes of the plots.

**Influence of plot size and shape:** The coefficient of variations obtained for different sizes and shapes are given in Table 1.

It can be revealed from Table 1 that coefficient of variation per cent decreased with an increase in the plot size in either directions. This result is similar to those reported by Agarwal and Deshpande (1967); Katyal and Rajput (1978) and Kaushik et al. (1977). The decrease was more rapid with an increase in

<table>
<thead>
<tr>
<th>Plot size (units)</th>
<th>Shape of plot</th>
<th>Coefficient of variation (%)</th>
<th>Av. of CV% for the plot CV% (PUD)</th>
<th>Per unit decrease size of average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width in rows</td>
<td>Length (m)</td>
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<td></td>
<td></td>
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<td>8</td>
<td>19.0</td>
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</table>

**Table 1. Coefficient of Variation per cent (CV%) for different dimensions of plot with/unit decrease (PUD).**
the units in the breadth than in the length. The CV per cent decreased from 34.26 to 15.42 per cent when the area/plot increased from 1 to 25 units. Thereafter, consistent decreasing trend was not observed.

**Optimum plot size**: Smith's equation in an estimated form was found to be:

\[ Y = 30.93 X^{-0.2133} \]

with percentage of variation explained as 93.92 per cent, thus, indicating a good fit.

The optimum size of the plot by the method of maximum curvature (eq.2) was obtained as:

\[ X_{opt} = 3.95 = 4 \text{ units} \]

Secondly, per unit decrease (PUD) in CV per cent was observed to be minimum (Table 1) at plot size 16 units. Hence, according to the equation 3, the 16 unit plot size was considered as an optimum size for the field experiments on sunflower.

**Optimum shape of the plot**: For a fixed size of plot, the shape of plot indicate consistent effect on CV per cent. However, compact plots in general showed less variability than the long and narrow plots elongated along rows (E-W direction). The shape of 16 units sized plot was appeared as 2 rows each of 8 m long. This shape is long and narrow shape and since the practical difficulties arises in layout of field trials with such a narrow plots, a plot of size 20 units appeared to be suitable. Also, CV per cent for plot of size 20 units was found less than the plot of size 16 units (Table 1).

Among all combinations of 20 units plot, a plot of 10 rows each of 2 m long had minimum CV per cent (14.91%) as can be observed from Table 1. Therefore, a plot of 20 units having the shape of 10 rows each of 2 m long could be considered as an optimum shape.

**Number of replications and relative efficiency**: From the estimated CV per cent, the minimum number of replications and area of land required for different plot sizes at 5 per cent and 10 per cent standard error of mean has been computed. These results are presented in Table 2.

Table 2 showed that as the size of plot increases the number of replications decreases. For a fixed precision, less area is required for smaller plots than the larger plots which means efficiency is more for smaller plots. These results are in agreement with the results reported by Katyal and Rajput (1978); Kaushik et al. (1977) and Sethi (1985). The efficiency of smallest plot was maximum and it decreased drastically when the plot size was increased from 1 to 2 units. Further, the decrease in efficiency was proportionately less as the plot size increased from 16 units.

The average number of replications decreased with an increase in the plot size from 1 to 20 units at 5 per cent standard error of mean. Thereafter, there was no appreciable change. The area required for the experiment increased with an increase in the plot size up to 25 units, beyond which the increase in area was more.

In view of these results and the results obtained through Smith's and PUD approaches as well as practical difficulties in layout of field trials with small plots, a plot of size 20 units was found to be optimum for sunflower experiment.

<table>
<thead>
<tr>
<th>Plot size (m²)</th>
<th>C.V. (%)</th>
<th>No. of replications</th>
<th>Area required (units)</th>
<th>Relative efficiency</th>
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<td>%</td>
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</table>

* Efficiency of smallest plot size is taken as 100 per cent.
20 units with the shape of 10 rows each of 2 m long appeared to be optimum plot size and shape of the plot for yield trials of the sunflower crop.

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LITERATURE CITED


