Pak. J. Agri. Sci., Vol. 20 (3-4), 1983

PLOT SIZE STUDIES USING EXPERIMENTAL DATA ON WHEAT

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ABSTRACT

The plot size in wheat trials has been found to vary from 1/800th to 1/25th of an hectare for agronomic research. One hundred M.Sc. theses, written at the University of Agriculture, Faisalabad were examined to glean data on grain and straw yield alongwith the information about plot size, error degree of freedom, coefficient of variation (C.V.) and the experimental designs used therein. Surprisingly high values of C.V. in 30 – 33 per cent of the experiments were noted. It should be a cause of concern to the supervisors of graduate students who conduct research using field experiments. It demands more attention and proper checks on field conditions at the time of planning the experiments.

INTRODUCTION

Researchers in crop sciences often use experimental designs for collecting necessary data. For this the size of the experimental units should be in accordance with the local field conditions. Factors such as the kind of crop, plant density, number and type of treatments, type of implements to be used, availability of land, labour and other similar factors are equally important (though not necessarily from a statistical point of view) in the choice of the plot size. The major consideration behind all this planning is to get the best possible results using the minimum resources.

Most of the field experiments conducted at the University of Agriculture, Faisalabad, use randomized complete block, factorial and split plot designs. Plot sizes vary widely from one experiment to another and were observed to range from 1/800th to 1/25th hectare in the experiments of some postgraduate students involving the wheat crop. This motivated the present study on the

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distribution of error mean squares (per unit basis) and their possible relationship with (i) error degree of freedom and (ii) plot sizes and as such to find the suitable plot size and the number of replications necessary for drawing inferences at the desired precision level.

The previous studies reveal a decrease in C. V. with an increase in the size of plot. As the probability of obtaining significant results depends on the standard error per unit which itself is dependent on the number of replications as well as the error degree of freedom(Cochran and Cox,1960). The number of replications must be adjusted to the inherent variability of the experimental conditions to enhance the dependability of the data.

Ashfaq and Zafar Yab (1973) studied the behaviour of plot sizes in a uniformity trial on wheat. They found that increase in plot size decreased the C.V. and that the plot size of 1/80th of an acre was suitable as all the C.V. values remained less than 10 per cent and further rate of decline with increase in plot size was negligible. On similar grounds, Syed and Akram (1974) recommended a plot size of 1/10th of an acre for experiment on the sugarcane crop.

METHODOLOGY

About one hundred M.Sc. theses (written at the University of Agriculture, Faisalabad) involving field trials on the wheat crop were examined to glean data on grain and straw yields alongwith the following additional information:

1. Plot size
2. Error mean square
3. Coefficients of variation (percentage)
4. Error degree of freedom
5. General mean
6. Experimental design used

In case of split plot design, separate values for the main plots and for sub-plots were recorded for each of the above items from 1-5. Moreover, the values on grain yield and straw yield were transformed on per hectare basis to facilitate comparisons among various plot sizes as well as error degree of freedom.

RESULTS AND DISCUSSION

In almost all the field experiments on wheat, the research workers collected data on grain and straw yield, plant height, number of tillers per plant, thousand grain weight, number of grains per spike, per cent germination, etc. Some of these variables were recorded on per plot basis while others on per plant or even on a part of the plant. The first two factors were generallay more variable and therefore, were included in this study.

(i) *GRAIN YIELD*

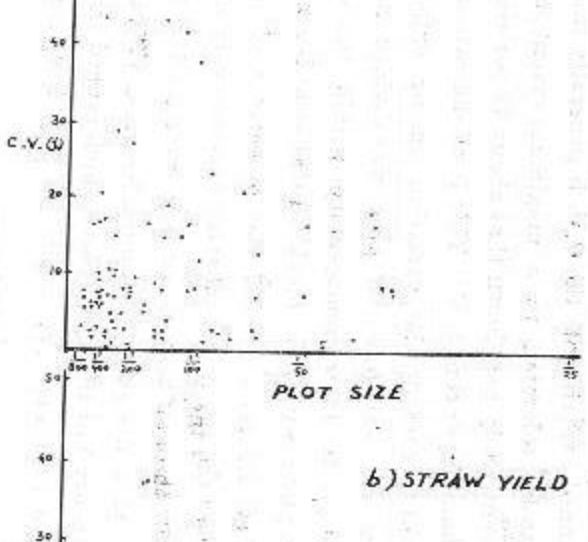
The distribution for the C.V. with respect to plot size and error degree of freedom are shown on scatter diagram (Fig. 1a and 2a). The frequency distribution is given in Tables 1 and 2.

Tab e 1. *Distribution of coefficients of variation according to plot size for grain yield data*

	Ccefficients of variation (%)				
	0 – 5	5 – 10	10 – 20	20 & above	Total
Plot size as part of hect					
$\frac{1}{400}$	7	11	2	2	22
$\frac{1}{400} - \frac{1}{200}$	12	6	7	4	29
$\frac{1}{200} - \frac{1}{100}$	6	5	5	2	18
$\frac{1}{100} - \frac{1}{50}$	6	2	3	3	14
$\frac{1}{50} - \frac{1}{25}$	5	5	2	1	13
Total	36	29	19	12	96

FIG. 1 DISTRIBUTION OF COEFFICIENTS OF VARIATION IN RELATION TO PLOT SIZE.

a) GRAIN YIELD



b) STRAW YIELD

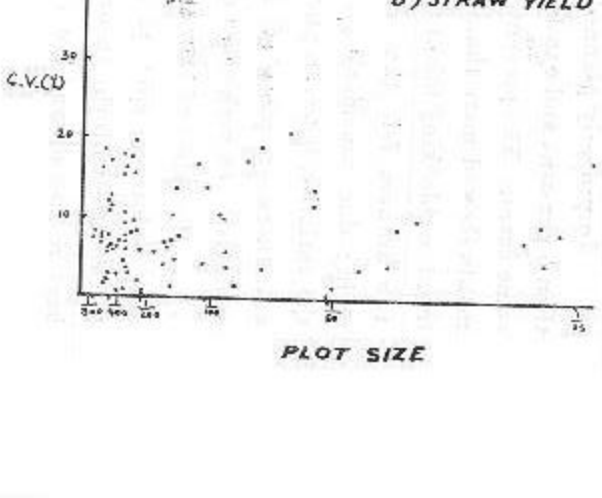
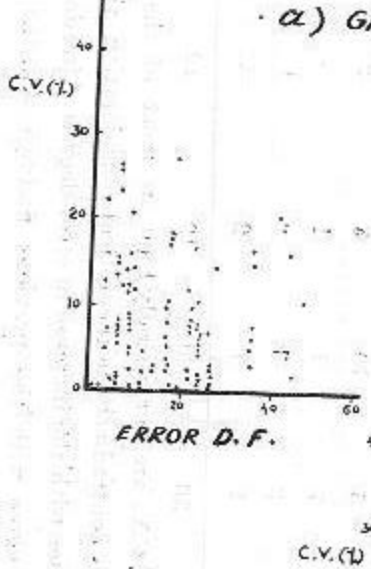


FIG. 2 DISTRIBUTION OF COEFFICIENTS OF VARIATION IN RELATION TO ERROR DEGREE OF FREEDOM

a) GRAIN YIELD



b) STRAW YIELD

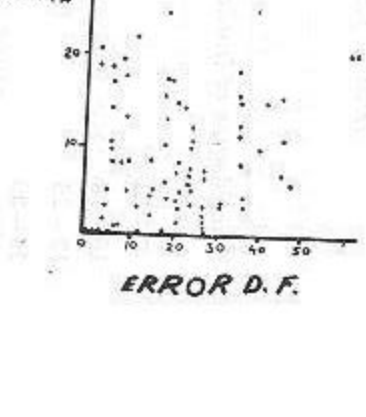


Table 2. *Distribution of coefficients of variation according to error degree of freedom for grain yield data*

	Coefficients of variation (%)				
	0 – 5	5 – 10	10 – 20	20 & above	Total
Error degree of freedom					
– 6	7	6	4	6	23
7 – 12	8	5	6	1	20
13 – 18	6	3	1	1	11
19 – 25	5	10	3	2	20
25 – 30	7	1	1	--	9
31 – 36	2	3	2	1	8
37 and above	1	1	2	1	5
Total	36	29	19	12	96

The values of C.V. are surprisingly high in most of the cases with no obvious trend. This contradicts the theoretical consideration that the experimental error decreases with the increase in error degree of freedom. Also, these observations do not agree with the previous findings that the increase in plot size generally diminishes the experimental error.

In properly planned experiments the C.V. is generally thought to be less than 5 per cent and can be tolerated to a maximum extent of 10 per cent in some cases. The present study has shown that about 33 per cent of the experiments showed more than 10 per cent C.V. This is an indication of poor planning, i. e. blocking failed to control the variation among experimental units. The authors felt that the experimental area was divided into plots without giving due consideration to their homogeneity within the same block. If the variation between plots within a block (intrablock) is similar to the variation between plots of different blocks, the objectives of blocking are not achieved. In such cases the experimental error becomes very high.

Plot sizes of 1/500th of an hectare or less were used by few investigators as sub-plots in split plot design and showed lesser C.V. values. This is in accordance with the theory but the main plots which ranged from 1/50th-1/25th hectare also showed low values of C.V. inspite of very low error degree of free-

dom. This could be due to unnecessary blocking introduced in the already homogeneous experimental material.

(ii) *STRAW YIELD*

This characteristic was consistently recorded by most of the research workers. Like grain yield, this was also more variable than the other variables, e.g. plant height, number of tillers, ear length, etc. The distribution of C.V. according to plot size and error degree of freedom are shown in Fig. 1b and 2b and Tables 3 and 4.

Table 3. *Distribution of coefficients of variation according to plot sizes for straw yield data*

	Coefficients of variation (%)				
	0–5	5–10	10–20	20 & above	Total
Plot size as part of hect.					
$\frac{1}{400}$	6	8	7	1	22
1/400–1/200	7	8	8	--	23
1/200–1/100	1	7	4	1	13
1/100–1/50	5	1	6	1	13
1/50 –1/25	5	3	1	2	11
Total	24	27	26	5	82

Table 4. *Distribution of coefficients of variation according to error degree of freedam for straw yield data*

	Coefficients of variation (%)				
	0–5	5–10	10–20	20 & above	Total
Error degree of freedom					
–6	5	3	8	3	19
7–12	3	5	2	–	10
13–18	4	4	4	1	13
19–24	4	8	4	–	16
25–30	6	2	–	–	8
31–36	2	3	5	–	10
37 and above	–	2	3	1	6
Total	24	27	26	5	82

The data with respect to straw yield do not depict a better picture as 30 per cent of the values exceed even 10 per cent limit of coefficients of variation.

Thus, the data on both the characteristics indicate some faulty planning in choosing the design or in understanding the fertility movement of the soil. In majority of the cases, the replications are made without giving due consideration to the blocking of units, i. e. making replications according to the similarity of experimental units. The decisions on proper size and shape are very important although they may vary from one experiment to another. In no cases a layout plan should be prepared without having a thorough knowledge about the fertility of the field. This can best be accomplished by examining the previous crop standing in the field.

REFERENCES

Cochran, W.G. and G.M. Cox, 1960. Experimental Designs. John Wiley & Sons, Inc., New York.

Ashfaq, M. and M. Zafar Yab. 1973. Size and shape of plots/blocks for wheat yield trials. Proc. 8th All Pakistan Stat. Conf.

Syed, M.S. and M. Akram: 1974. Size and shape of plots/blocks for sugarcane yield trials. Proc. 9th All Pakistan Stat. Conf.