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Variability Analysis in Field Experiments on Maize - A Case Study of Godhra Farm

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ABSTRACT

The present study, being location as well as crop specific, was initiated to study the experimental factors responsible for high variability in field experiments on maize crop conducted at Godhra Farm. The variability estimated through coefficient of variation for grain yield data revealed that plot size, number of treatments and number of replications were responsible factors for high variability in field experiments.

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INTRODUCTION

Reliability of the results of any field experiment depends on the amount of experimental error which is usually expressed in terms of coefficient of variation (CV). Soil fertility variation is a prime source of experimental error (Federer, 1955) which is also influenced by the experimental factors such as size and shape of experimental units (plots), block size, number of replications, number of treatments, experimental designs etc. (Panse and Sukhatme, 1978). It has been reported that CV is considerably higher (> 20 per cent) in case of field experiments on pulse crops, maize, drilled paddy and bidi tobacco [Anon. (1993), Patel (1994) and Patel *et al.* (1995)]. The findings based on such experiments are not reproducible. It puzzles the scientists because they have to repeat the same experiment over space and time to arrive at some definite conclusion.

In Gujarat State, research work on maize crop is being carried out at Godhra (Dist. Pachmahals). This crop is raised as rainfed crop during *kharif* season showing large variation (CV per cent > 20). Besides climatic factors, soil factors are also responsible for large variation in experimental results. Soil factors are location specific. The soil of the research station is very shallow, sandy in texture, which moves with water easily, poor in moisture retention, as well as in organic matter and nutrient content. Large variation in maize experiments being conducted at Godhra (Gujarat State) has, therefore, become a base for initiating present investigation to study the

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experimental factors responsible for high variability in the field experiments on maize crop.

MATERIALS AND METHODS

Data collection

The grain yield data (secondary data) of 231 field experiments on maize crop, conducted during the years 1983 to 1992 at the Maize Research Station, Gujarat Agricultural University, Godhra were collected to study experimental factors influencing variability in those experiments. During the year 1984, there was no experiment because of severe drought condition in the Gujarat State. The information on the year of experiment, plot size, number of replications, number of treatments etc. of each experiment was also recorded.

Statistical analysis

The data on maize experiments were subjected to statistical analysis using analysis of variance technique (Das and Giri, 1985). Coefficient of variation in per cent (hereafter referred as CV) for yield data of each experiment was worked out using following relation.

$$CV = [\{(\hat{\sigma e})^2\}^{0.5} / \bar{Y}] \, 100$$

$$= \left[\frac{(\text{Error Mean Square})^{0.5}}{\text{Overall Experimental Mean}}\right] 100$$

where $\hat{\sigma e}^2$ = Error mean square from analysis of variance

$\bar{Y} = (Y... / r\,t)$ = Overall experimental mean (Simple Arithmetic mean)

$Y..$ = sum of all the observations (values)

r = number of replications

t = number of treatments

The estimated CV of each field experiment was classified to study the experimental factors responsible for high variation in experimental data. Factors studied were year of experiments, plot size, number of replications and number of treatments. Since 96 per cent of the field experiments (231) were conducted in Randomized Block Design (RBD), the design factor was not included in the study.

RESULTS AND DISCUSSION

The CV of 231 field experiments on maize were grouped in summary form in Table 3.1.

TABLE 3.1

Frequency distribution of CV.

Class	*Frequency*	*Class*	*Frequency*	*Class*	*Frequency*
< 9	0	29 - 33	28	53 - 57	7
9 - 13	9	33 - 37	27	57 - 61	3
13 - 17	14	37 - 41	17	61 - 65	3
17 - 21	24	41 - 45	15	65 - 69	0
21 - 25	31	45 - 49	12	69 - 73	4
25 - 29	30	49 - 53	5	≥ 73	2

Scrutiny of the results indicated that CV ranged from 9.70 per cent to 74.52 per cent with a mean of 31.98 per cent. Only 10 per cent of the total experiments, i.e., 23 experiments (Table 3.1) have CV between 9 to 17 per cent which is the acceptable range of variation (Panse and Sukhatme, 1978).

About 66 per cent of the total experiments had a high CV, i.e., 25 per cent and above.

The CVs were further analyzed to study the influence of experimental factors, viz., plot size, number of treatments, (i.e., block size) and replication on the experimental variability (CV). The factor-wise distribution of mean CV are presented in Tables 3.2 through 3.5. The standard statistical techniques of analyzing the data of many classifications with unequal numbers in each class/group/cell are not directly applicable. Therefore, test of significance was not attempted.

The information furnished in Table 3.2 indicated that the mean CV varied from 21.72 per cent in 1983 to 54.85 per cent in 1987 due to seasonal variation.

The data presented in Table 3.3 revealed that the smallest plot size (3-6 sq.m) had the highest variation (CV = 39.13) in the experimental data. The lowest CV (18.10) was observed with 9-12 sq.m plot size, but for this size, there was only one experiment. Increase in plot size from 3-6 sq.m to 6-9 sq.m showed a decrease in CV from 39.13 to 29.80. There was slight increase in CV (31.22) with the plot of 12-15 sq.m size, thereafter decreasing trend in CV, though not consistent, was observed. It is interesting to note that CV stabilized around 28 per cent when plot size was of 15 sq.m or more. Results indicated that the plot of 6 to 12 sq.m size appeared to be optimum for the field experiments. There was no gain after 12 sq.m size because decrease in CV was not proportional to the area added. The results confirmed that the plots of smaller size showed larger variation than optimum plot size (Katyal and Rajput, 1978. Binas *et al.*, 1983 and Kaushik *et al.*, 1989). It could be inferred that the plot size was a responsible factor influencing variability in experimental data.

TABLE 3.2

Year-wise distribution of CV.

Year	*No. of experiments*	*Mean CV*
1983	10	21.72
1985	11	27.35
1986	27	32.56
1987	2	54.85
1988	36	34.32
1989	39	27.65
1990	55	37.16
1991	34	27.70
1992	17	34.22
Total	231	31.98

The results in Table 3.4 showed that 81.39 per cent of the experiments were conducted with 5 to 29 treatments. The maximum mean CV (45.75) was noticed for the treatment group having 50-54 treatments whereas the lowest mean CV (25.88) was observed for the treatment group having 5-9 treatments. CV increased with the increase in number of treatments (with slight deviation in-between) per experiment (except treatment group < 5 treatments). The findings thus

TABLE 3.3

CV as influenced by plot size and number of treatments.

Plot size (sq.m.)	*Treatment*							
	< 5	*5-9*	*10-14*	*15-19*	*20-24*	*25-29*	*≥ 30*	*Mean CV*
3-6	—	37.89 (2)	41.34 (9)	46.81 (22)	38.02 (4)	31.18 (4)	33.95 (29)	39.13 (70)
6-9	—	25.30 (9)	25.99 (14)	31.02 (16)	36.35 (14)	28.45 (11)	29.49 (8)	29.80 (72)
9-12	—	—	—	18.10 (1)	—	—	—	18.10 (1)
12-15	—	34.44 (2)	32.16 (8)	24.20 (2)	—	—	—	31.22 (12)
15-18	29.23 (4)	25.52 (24)	31.82 (5)	30.45 (4)	36.60 (1)	—	—	27.55 (38)
18-21	—	24.79 (9)	40.07 (3)	—	—	—	—	28.61 (12)
21-24	28.89 (2)	24.94 (19)	37.70 (5)	—	—	—	—	27.70 (26)
Mean	29.11 (6)	25.88 (65)	33.20 (44)	38.10 (45)	36.73 (19)	29.18 (15)	32.98 (37)	31.98 (231)

supported the influence of number of treatments on experimental variability (Federer, 1955). These results are deviating from the results reported by Patel (1994) where he did not get any contribution of number of treatments in pulse crop on the experimental variability.

TABLE 3.4

Treatment-wise distribution of CV.

Treatment	*No. of experiments*	*Mean CV*
< 5	6	29.11
5 - 9	65	25.88
10 - 14	44	33.20
15 - 19	45	38.10
20 - 24	19	36.73
25 - 29	15	29.18
30 - 34	6	36.23
35 - 39	13	32.86
40 - 44	5	32.63
45 - 49	11	29.19
50 - 54	2	45.75
Total	231	31.98

The two-way distribution of CV (Table 3.3) indicated that the block of 5-9 treatments coupled with plot of 6-9 sq.m area per treatment appeared to be optimum combination for field experiments at Godhra Farm. This combination had an mean CV of 25.30 per cent, with the same treatment group, the plot sizes 18-21 and 21-24 sq.m had slightly lower CV. The decrease in CV was not proportional to the increase in plot size. A combination of plot size 9-12 sq.m and treatment group 15-19 had the lowest mean CV (18.10), but this combination had only one experiment. Therefore, it could not be considered reliable for generating the results. Similar was the case with the combination of plot size 12-15 and treatment group 15-19.

The Replication-wise data are presented In Table 3.5.

TABLE 3.5

Replication-wise distribution of CV.

Replication	*No. of experiments*	*Mean CV*
2	73	37.82
3	13	26.45
4	136	29.76
5	1	20.08
6	8	26.91
Total	231	31.98

The results in Table 3.5 reveals that 58.88 per cent of experiments were conducted with 4 replications and 31.60 per cent with 2 replications. There was one experiment conducted in 5 replications and 13 experiments with 3 replications. The highest mean CV as 37.82 per cent was observed when experiment was with 2 replications and the least mean CV as 20.08 per cent was observed in designs with 5 replications. Though, there was a decreasing trend in mean CV, the rate of reduction in mean CV was inconsistent with an increase in number of replications. Results indicated that number of replications had a vital role in controlling the variability in the field experimentation.

Conclusion

The present study leads to the conclusion that the factors responsible for high variability in field experimentation with maize

crop at Godhra farm was influenced by the experimental plot size, number of treatments and number of replications. It indicates a need to generate information on plot techniques for field experiments on maize crop and to evaluate statistical approaches to minimize the experimental error.

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