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DETERMINATION OF OPTIMUM PLOT SIZE AND ADEQUATE NUMBER OF REPLICATIONS TO EVALUATE POTATO SEEDLING POPULATIONS

(Détermination de la dimension optimale des parcelles et du nombre des répétitions pour évaluer les populations de plantules de Pomme de Terre)

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SUMMARY

The optimum experimental plot size and the adequate number of replications are of foremost importance in agricultural research. Research in this area is still more important for evaluation of potato seedling populations since there is no available information. A uniformity trial was installed and analyzed as a split plot design utilizing an open pollinated progeny of the clone DTO-33. Experimental plot sizes of 1, 5, 15, 30, 90, and 180 units were considered. Each unit was formed by seedlings. The analysis showed that the optimum plot size was between 5 and 15 units or 20 and 60 seedlings. An intermediate number of 40 plants per plot was considered optimum. The adequate number of replication was determined as 4

RESUME

Il n'y a toujours pas d'information disponible en ce domaine. Un essai d'homogénéité en split-plot a été réalisé avec la descendance en pollinisation ouverte du clone DTO-33. L'analyse établit que la dimension optimale de la parcelle se situe entre 5 et 15 unités ou 20 à 60 plantules ; le nombre intermédiaire de 40 est retenu. Le nombre adéquat de répétition s'établit à 4.

INTRODUCTION

The determination of the optimum plot size and adequate number of replications are aspects of primary importance in agriculture research. Optimizing these factors reduce the magnitude of the experimental error increasing the dependability of the results obtained from experiments. The use of true potato seed as means of producing either ware or seed tubers or both, required a knowledge on these experimental factors which were determined as a function of the variability of the experimental materials and the costs of the experiment.

MATERIALS AND METHODS

The experimental work was carried out at the International Potato Center (CIP) experiment station at San Ramon in Peru. This station is located at the Chanchamayo Valley at 800 m.a.s.l. and 11°08' of South latitude. The annual precipitation is 1800 mm. and mean temperature of 24°C.

For this experiment a seedling population obtained from open pollinated seed from CIP's hybrid DTO-33 was utilized. This progeny has a good adaptation to grow in warm environments and represents a good sample of CIP's populations adapted to these zones.

A uniformity trial was installed in a field with 24 rows spaced .9 m and having each 72 m of length. Seedling were transplanted at a spacing of 4 m.

At harvest time each row was divided in sections of 1.6 m to evaluate the yield per basic unit. Each basic unit represented an area of 1.44 m^2 (1.6 x .9 m) containing four plants. In this way 45 sections per row were obtained. Then, the total number of basic units in the field was 1080 (45 x 24 rows).

For the statistical analysis the uniformity trial was divided following a criteria of hierarchical classification with six divisions to simulate an arrangment in split plots. These six main divisions were taken as replications. Each rep had two blocks and each block had three plots. Each plot was divided in two subplots wich were also divided each in three sub-subplots and finally each sub-subplot was divided in five sub-sub-subplots.

The scheme of the analysis of variance and the plot number n_j for each source of variation are presented in Table 1.

To determine the optimum plot size four methods were compared : maximum curvature, comparison of variances, SMITH, HATHEWAY, and WILLIAMS.

The first method uses the coefficients of variability for each plot size. The second method uses the estimates of variances of average yield per basic unit for the different plot sizes. The two last methods utilize variances and costs.

Table 1. Analysis of variance for the uniformity trial following a hierarchical classification with six subdivisions

Source of Variation		df	MS	nj	xj
Replication	(f=6)	(f-1)	V_1	6	180
Block/Reps	(e=2)	f(e-1)	V_2	12	90
Plots/Blocks	(d=3)	ef(d-1)	V_3	36	30
Sub-plots/Plots	(c=2)	def(c-1)	V_4	72	15
Sub-subplots/Sub plots	(b=3)	cdef(b-1)	V_5	216	5
Sub-sub-subplots/Sub-subplots	(a=5)	bcdef(a-1)	V_6	108	1

The determination of the adequate number of replications was made by following the methods of KEMPTHORNE and also HATHEWAY. The first considers variances in costs, the second method estimates the number of replications independently from cost.

The analysis of variance of the experiment including the coefficient of variation and variance estimates for average yields per basic unit of x_j units for the various plot sizes (V_x) are presented.

Table 2. Coefficient of variation and variance estimates for various plot sizes.

Source of Variation				
Replications	5	180	1.09	0.034186
Blocks/Replications	6	90	0.56	0.033524
Plots/Blocks	24	30	1.75	0.041669
Sub-plots/Plots	36	15	2.30	0.047467
Sub-subplots/Sub-plots	144	5	6.41	0.068821
Sub-sub-subplots/sub-subplots	864	1	25.34	0.149816

In Table 2 one can see that both the coefficient of variation as well as variances increased as the plot size decreases. A test for homogeneity of variances indicated that there were significant differences. However, when the test was carried out without considering the variance for sub-sub-subplot/sub-subplot the test was non significant, indicating that for the plot sizes x = 5, 15, 30, 90, 180 the variances were similar. Also, the coefficient of variation for a plot size of 1 and 5 units was considerably higher than for the rest of sizes.

In Table 3, the comparison of optimum plot sizes for the four methods utilized are presented.

Table 3. Optimum plot sizes obtained with the four methods compared

Method	Factor of Analysis	N° of Basic Units	N° of Plants	Area (m^2)
Smith	Variance & costs	5.7439	22.975	8.271
Hatheway & Williams	Variance & costs	4.7669	19.060	6.864
Maximum curvature	Coef. of variability	10	40	14.4
Comparison of variances	Variance of basic unit	10	40	14.4

For the method of comparison of variance the optimum plot size is from 5 to 15 basic units (20 to 60 plants per plot). It has been considered an intermediate number, 10 units, because it is always expected to lose a certain number of plants after the transplanting and during vegetation. So, the extra number we are allowing is to compensate for these loses.

Finally, by utilizing the methods of KEMPTHORNE and HATHEWAY and on the bases of utilizing 10 basic unit plots (40 plants) the adequate number of replications was four.