THE INFLUENCE OF SPACING, RIDGING AND SEEDLING NUMBER PER HILL ON THE YIELD OF CHILLIES (CAPSICUM FRUTESCENS L.)

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CHILLIES and tobacco are the peasant's most important money crops in the Jaffna peninsula. Chillies are grown in the peninsula under irrigation, in rotation with paddy, tobacco, millets and cassava. Seedlings raised in nurseries are, when from four to six weeks old, transplanted into the field at the rate of two to four per hill. The hills are usually spaced 3 ft. by 3 ft. and are either on ridges or on the flat. Although certain well-established methods of cultivation are adhered to in the growing of chillies, little exact information exists regarding the relative advantages of various methods. This paper reports the results of an experiment designed to determine the effects of spacing, ridging and seedling number per hill on the yield of chillies. The experiment was set down at the Experiment Station, Peradeniya, during the *maha* season, 1938–39.

DESIGN OF THE EXPERIMENT

Treatments.—Details of the three sets of factors investigated, *viz.*, seedling number per hill, ridging and spacing, are presented in Table 1. The design of the experiment was factorial, *i.e.*, it included all possible combinations of the three sets of factors.

TABLE 1.

Seedling Number	Ridging	Spacing
N_0 : 2 seedlings per hill	.. R_0 : planting on the flat	S_0 : close—3 ft. × 2 ft.
N_1 : 4 seedlings per hill	.. R_1 : planting on ridges ..	S_1 : wide—3 ft. × 3 ft.

System of replication.—An experiment with complete replication of the eight treatments within each block would have had an undesirably large block size and a consequently large error variance. The adoption in the present experiment of the process of partial confounding permitted the reduction of both block size and error variance. By sacrificing part of the information on the three first-order interactions and the one second-order interaction, it was possible to secure an increase in the accuracy of the direct effect comparisons (Fisher, 1936 and Yates, 1933 and 1937). The distribution of the eight treatments over the four pairs of blocks of four plots each, is illustrated in Table 2.

TABLE 2.

Interaction confounded	N × R × S		N × R		N × S		R × S	
Block	IA	IB	IIA	IIB	IIIA	IIIB	IVA	IVB
Treatments	$N_0 R_0 S_0$	$N_1 R_0 S_0$	$N_1 R_0 S_0$	$N_0 R_0 S_0$	$N_1 R_0 S_0$	$N_0 R_0 S_0$	$N_0 R_1 S_0$	$N_0 R_0 S_0$
	$N_1 R_1 S_0$	$N_0 R_1 S_0$	$N_0 R_1 S_0$	$N_0 R_0 S_1$	$N_0 R_0 S_1$	$N_0 R_1 S_0$	$N_0 R_0 S_1$	$N_1 R_0 S_0$
	$N_1 R_0 S_1$	$N_0 R_0 S_1$	$N_1 R_0 S_1$	$N_1 R_1 S_0$	$N_1 R_1 S_0$	$N_1 R_0 S_1$	$N_1 R_1 S_0$	$N_0 R_1 S_1$
	$N_0 R_1 S_1$	$N_1 R_1 S_1$	$N_0 R_1 S_1$	$N_1 R_1 S_1$	$N_0 R_1 S_1$	$N_1 R_1 S_1$	$N_1 R_0 S_1$	$N_1 R_1 S_1$

A separate interaction is confounded within each pair of blocks. The second-order interaction N × R × S is, for instance, confounded between the components of the first pair of blocks, which accordingly provide no information on this interaction. Complete information on the interaction N × R × S is, however, contributed by the other three pairs of blocks.

Size of plot.—Each plot was 1/42 acre and contained four rows of hills spaced 3 ft. between rows and either 2 ft. or 3 ft. within rows. In the collection of data, a strip 4½ ft. wide was rejected at each end of the plot. The nett area contributing data was hence 1/47 acre.

EXPERIMENTAL MATERIAL AND METHODS

The nursery.—Five cwt. of compost were spread over 570 sq. ft. (1/77 acre) of nursery bed and well mixed with the surface

soil in September, 1938. Seed of the variety Elephant's Trunk obtained from the Experiment Station, Jaffna, was sown in drills 3 in. apart.

Sowing Dates.	Quantities of seed sown.
September 16, 1938	8 oz.
,, 17, ,, ...	8 oz.
,, 28, ,, ...	1½ oz.

A certain amount of damping-off occurred in the nursery. The application of a 0·6 per cent. solution of potassium permanganate (1 oz. per gall.) at the rate of one quart per square foot of nursery bed appeared to check the disease. Seedlings corresponding to sowing dates September 16 and 17 were topped on November 3 ; the average height of the seedlings at the time was 7–9 in.

The field.—The experimental area had carried a crop of *Pennisetum typhoideum* Rich. during the *yala* season (March to July) 1938. The land was ploughed on October 3, 1938, and received an application of 11½ tons of compost per acre on October 11 and 12. The land was then disc-harrowed in two directions on October 13, and spike-harrowed on October 18. Plots set apart for ridge-planting were ridged with a ridging plough on November 5 and 6. Plots in which planting was to be on the flat were levelled on November 7. Seven-weeks-old seedlings were planted out in the field on November 7. It was found necessary to hand-water the area on November 15, as there had been no rain since the date of transplanting ; approximately one pint of water was applied per hill. Hand-watering was repeated on November 29 and December 9. The seedling stand was poor on account of the drought. Vacancies were supplied on November 17 and 18 and again on December 22. The unridged plots were weeded on December 1 and 2. The ridged plots appeared comparatively clean and were accordingly left unweeded. Flowering was first observed on December 6.

Incipient leaf-curl was effectively checked by spraying the plants on December 27 and 31, 1938, and on January 13 and 17, 1939, with lime-sulphur at a concentration of 1½ oz. per gallon. About 28 gallons of spray mixture were needed for the area.

Applications of sulphate of ammonia at the rate of 4 lb. per plot were made on January 3 and 4, 1939. The fertilizer was applied in pinches to the bases of the plants and forked in. The plots were harvested on January 1, February 2 and February 15.

METEOROLOGICAL DATA

Relevant rainfall records are presented in Table 3. Days of no rain are omitted.

TABLE 3.

Date	Rainfall in.	Date	Rainfall in.	Date	Rainfall in.
1938		1938		1938	
Sept. 16	·18	13	·02	17	·25
17	·55	14	·01	19	·13
18	·03	23	·42	20	·16
19	·28	27	·82	21	2·13
22	·94	28	·41	22	·06
23	1·33	31	·68	23	1·08
25	·24	Nov. 1	1·03	24	·42
26	·16	2	1·53	25	·25
27	1·13	3	·35	26	·21
28	·81	5	·49	27	·29
29	·66	6	·25	28	·10
30	·42	10	·01		
Oct. 1	·16	16	·35	1939.	
2	·03	17	2·57	Jan. 8	·09
3	·04	18	1·34	9	2·98
4	·26	19	·04	10	2·34
5	·22	21	·02	11	·01
7	·04	26	·06	12	·05
8	·48	Dec. 4	·10	17	·49
9	·62	7	·05	18	·76
10	·24	13	·19	19	·02
11	·01	15	·29	Feb. 15	·02
		16	·06		

RESULTS

Records of the vacancies provided estimates of the effects of various factors on the stand of transplanted seedlings. An analysis of variance of these records is presented in Table 4.

TABLE 4

Analysis of Variance of Numbers of Vacancies.

	D. F.	Sum of Squares	Variance
Blocks	7	47,667·75	6,809·7
Direct effects	3	217,382·3	72,460·8
Interactions	4	28,045·9	7,011·5
Error	17	59,476·55	3,498·6
Total	31	352,572·5	

The value of F for total treatments greatly exceeds the one per cent. point; the treatment effects are hence highly significant. The standard errors for the estimates of direct effects and interactions are $\sqrt{32 \times 3498 \cdot 6}$ and $\sqrt{24 \times 3498 \cdot 6}$ respectively.

Fisher's t test indicated that the effects of ridging and of seedling number per hill were significant at the one per cent. level. The various interactions and the effect of spacing were not significant. The results are presented in Tables 5 and 6.

TABLE 5

Numbers of Vacancies

(8/47 acre)

	Flat-planting	Ridge-planting	Means
Two seedlings per hill	313	483	398
Four seedlings per hill	961	2,074	1,517·5
Means	637	1,278·5	957·75

TABLE 6

Numbers of Vacancies

(8/47 acre)

	Flat-planting	Ridge-planting	Means
Close spacing	681	1,507	1,094
Wide spacing	593	1,050	821·5
Means	637	1,278·5	957·75

Yields in the experimental season were poor on account of the continued drought. It was not possible to take more than three pickings off the area. The total yields have been subjected to an analysis of variance in Table 7.

TABLE 7

Analysis of Variance of Yields

	D. F.	Sum of Squares	Variance	
Blocks	7	12,732·875	1,818·98	
Direct effects	3	40,433·75	13,477·92	
Interactions	4	7,270·5	1,817·6	
Error	17	15,237·75	896·34	
Total	31	75,674·875		

The value of F for total treatments greatly exceeds the one per cent. point and hence indicates significance. The standard errors for estimates of main effects and interactions are $\sqrt{32 \times 896 \cdot 34}$ and $\sqrt{24 \times 896 \cdot 34}$. The application of Fisher's t test showed that effects of spacing and of seedling number per hill were significant at the one per cent. level. The various interactions and the effect of ridging were not significant. The results are presented in Tables 8 and 9.

TABLE 8

Yields in cwt. per acre

	Flat-planting	Ridge-planting	Means
Two seedlings per hill	3·13	3·29	3·21
Four seedlings per hill	4·03	4·17	4·10
Means	3·58	3·73	3·66

TABLE 9

Yields in cwt. per acre

	Flat-planting	Ridge-planting	Means
Close spacing	4·35	4·60	4·47
Wide spacing	2·82	2·86	2·84
Means	3·58	3·73	3·66

DISCUSSION

Abnormal weather prevailed during the period of the experiment the results of which are accordingly of rather limited application. Monthly precipitation was well below the average for previous years, and the crop which was almost completely rain-fed was subjected to a protracted period of drought. The average yield over the experimental area was only 3·7 cwt. per acre.

In the statistical analysis of the records of vacancies, the significance of the effect of seedling number per hill is of little interest. A significantly better stand was obtained with flat-planting than with ridge-planting. The number of vacancies on the ridges was over double that on the flat. The increase in casualties consequent on ridging was estimated at 3,769 per acre. The poor stand associated with ridging was probably due to the occurrence, after transplanting, of a prolonged dry spell, during which plants on ridges, on account of their greater root exposure, would have experienced severer drought conditions than plants on the flat. Ridging did not produce a significant increase in yield and did not exhibit any incidental advantages that might have justified the extra expenditure incurred.

The effects of spacing and of seedling number per hill on yield were both significant and considerable. The closer spacing and the higher seedling number per hill produced increases in yield of 1·63 cwt. and 0·89 cwt. per acre respectively. The poor shoot and root growth consequent on the prevailing drought explains this association of increased yields with increase in plant number per unit area. It is probable that the repetition of this experiment in a wet season would reveal a significant interaction of season with spacing and with seedling number per hill.

SUMMARY

An experiment designed to determine the effects of spacing, ridging and seedling number per hill on the yield of chillies was laid down at the Experiment Station, Peradeniya, during the *maha* season, 1938-39.

The stand of transplanted seedlings on the flat was significantly superior to that on the ridges.

Significantly higher yields were obtained with the closer spacing (3 ft. by 2 ft.) and with the higher seedling number (four per hill), *i.e.*, increase in plant number per unit area was accompanied by increase in yield.

ACKNOWLEDGMENT

The writers gratefully acknowledge their indebtedness to Mr. C. N. E. J. de Mel, Principal, Farm School, Peradeniya, for his co-operation, and to Mr. M. W. Jayasuriya, Experiment Station, Peradeniya, for his assistance and for his careful supervision of the field operations.

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