

## PROBLEMS IN THE DESIGN OF VARIETY TRIALS WITH SPRING CABBAGE

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### ABSTRACT

1. The differences in productivity between three strains of the spring cabbage Eersteling could be explained partly from a longer growing period and partly from a more rapid growth rate.
2. In commercial trials with spring cabbage only one spacing is needed to obtain a sufficiently reliable comparison of the various characters.
3. Commercial trials with spring cabbage arranged in a latin square with one plant per plot will usually give sufficient practical information on the measurable characters.

### INTRODUCTION

The trials with spring cabbage reported here have been made in an attempt to solve two problems in the design of variety trials with this crop.

The first problem presented itself when in comparative trials with strains of the variety Eersteling these strains were grown at the same spacing, while there were fairly large differences in size between the various strains. It was considered that strains planted at different spacings would probably not all behave in a similar way. Therefore the effect of 4 planting distances on 3 strains of different size was ascertained.

The second problem concerned the question whether it is possible to plant some variety trials on a smaller field by arranging them in latin squares with one plant per plot, instead of in a normal replicated block trial, as this will often reduce variations in the soil conditions within the trial.

The author is indebted to the mathematical section of the Institute for advice and computations.

### THE EFFECT OF DIFFERENT SPACINGS

#### *Trial design*

The distances chosen were  $40 \times 40$ ,  $50 \times 50$ ,  $55 \times 55$  and  $65 \times 65$  cm. The three strains of Eersteling were numbers 16 (with little spread), 11 (with medium spread) and 12 (with large spread) (fig. 1). The numbers of the strains correspond with those by which these strains were indicated in the commercial trials with spring cabbage in 1956 and 1957. By "spread" is meant the breadth of the plant measured across the head.

The trial was replicated twice using 48 to 52 plants per plot. Sowing was done in a



FIG. 1. THREE STRAINS OF THE SPRING CABBAGE EERSTELING WITH DIFFERENT SPREAD.

seedbed on 20 September 1956; the plants were overwintered under glass and planted in the open on March 22, 1957.

The gross and net weights of the heads were determined at the moment they were ripe for harvesting. The gross weight is taken to be the weight of the whole plant, i.e. the head and outer leaves together; the net weight is the weight of the head without the outer leaves.

### Results

The net weight converted to 1,000 kg per ha is entered in table 1. Between brackets are the relative yield figures, counting the yield from strain 12 as 100.

TABLE 1. NET YIELD IN 1,000 KG PER HA

Strain number	Spacings (cm)			
	40 × 40	50 × 50	55 × 55	65 × 65
16	40.4 (67)	26.6 (59)	19.8 (52)	16.9 (58)
11	43.4 (72)	34.0 (75)	30.1 (80)	21.4 (73)
12	60.0 (100)	45.2 (100)	37.7 (100)	29.2 (100)

It will be seen that for all strains the yield increases with closer spacings. At all four spacings the largest strain (number 12) is the most productive, while the relation between the yields of strains 12 and 11 remains of the same order (strain 11 produces 72–80 % of the yield of strain 12). At the three widest spacings the relation between the yields of strains 12 and 16 is also practically the same (yield of strain 16 is 52–59 % of that from strain 12). However, the 40 × 40 cm spacing places strain 16 in a relatively more advantageous position, since it now produces 67 % of the yield of strain 12. Consequently at closer spacings the strains with little spread are relatively more productive.

The greater productivity of a strain is accompanied by a longer growing period. Thus the date on which 50 % of the crop was harvested fell about 13 days later for

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strain 12 than for strain 16, and  $6\frac{1}{2}$  days later for strain 11 than for strain 16. The duration of the growing period in the field varied from 69 to 85 days.

However, the differences in productivity cannot be explained only from the growing period. There is also a difference in the average daily increase in weight. The average net increase in weight per day is expressed in kg per ha (table 2). Between brackets is given the relative increase in weight of the strains as compared with the increase in weight mentioned for the widest spacing.

TABLE 2. AVERAGE NET INCREASE IN WEIGHT PER DAY IN KG PER HA

Strain	Spacings			
	40 × 40	50 × 50	55 × 55	65 × 65
16	553 (229)	380 (158)	287 (119)	241 (100)
11	536 (188)	436 (153)	401 (141)	285 (100)
12	706 (203)	538 (155)	461 (132)	348 (100)

At the three widest spacings the higher productivity (table 1) is accompanied by a larger increase in the net weight per day. Only at 40 × 40 cm the daily increase of strain 11 is somewhat smaller than that of strain 16. That strain 11 at this close spacing nevertheless yielded about equally high as strain 16 is, therefore, only attributable to the longer growing period.

We have calculated that about 11 % of the greater productivity of strain 12 compared with that of strain 16 is due to the longer growing period – the period between planting and harvesting –; for strain 11 about 5 %. Hence the differences in productivity are largely associated with the growth rate.

From the relative increase in weight it appears that as the spread of a strain becomes less the check in growth sustained by each individual plant at closer spacings also becomes less. However, the difference between strains 11 and 12 at the two closest spacings is only slight. This may be partly due to the fact that the difference in spread between these two strains is not very large either.

The effect of spacing on the individual plant also appears from table 3, showing the gross and net weight per plant, the spread and the 50 % harvesting date. The 50 % harvesting date is the date on which 50 % of the total crop is harvested.

TABLE 3. THE AVERAGE GROSS AND NET WEIGHT OF THE PLANT, THE SPREAD AND THE EARLINESS

Spacing	Gross weight per plant in kg			Net weight per plant in kg			Spread in cm			50 % harvesting date days in June		
	16	11	12	16	11	12	16	11	12	16	11	12
40 × 40	0.86	0.95	1.26	0.65	0.70	0.96	39	40	41	3	11	15
50 × 50	0.91	1.20	1.51	0.67	0.85	1.13	43	49	51	0	8	14
55 × 55	0.86	1.39	1.60	0.62	0.94	1.18	41	48	52	-1	5	12
65 × 65	0.99	1.24	1.70	0.72	0.91	1.24	45	47	48	0	5	14

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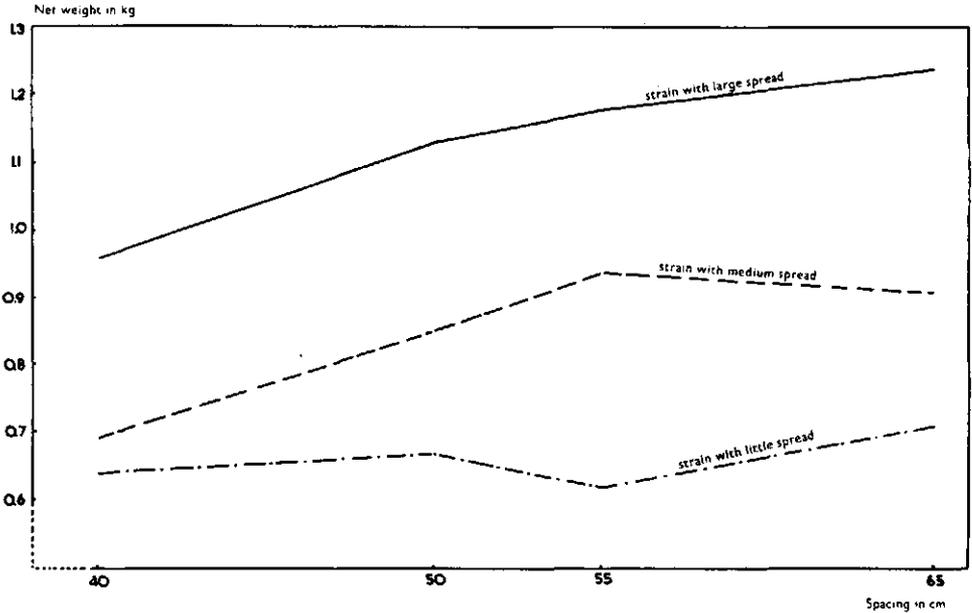


FIG. 2. NET YIELD PER PLANT OF THREE STRAINS OF EERSTELING FROM 4 SPACINGS

At closer spacings the growth of the plant is clearly checked (fig. 2). This is reflected in a smaller head, and slower growth – the head matures later.

### *Discussion*

In variety trials it is necessary to choose such spacings as mask the principal characters of a strain as little as possible. We have seen that the relation between strains 11 and 12 regarding the net weight of the head was about the same at all four spacings. At the three widest spacings the relation between strains 16 and 12 was also about the same; at  $40 \times 40$  cm this relation changed somewhat in favour of strain 16. So at different spacings the productivity relation between the various strains is not always alike, although it does not change to such an extent that it becomes necessary to test the varieties at more than one spacing. Using a spacing of at least  $50 \times 50$  cm it seems likely that a reliable comparison of the strains with a medium to fairly large spread can be obtained. Relatively, the strains with little spread are then judged somewhat too unfavourable, since at closer spacings their growth is retarded less than that of strains with a large spread, so that they become more productive.

### LATIN SQUARE

In 1957 the results from a block trial of 21 strains in two replications with 33 plants per plot, were compared with those from a latin square with the same 21 strains, but using only one plant per plot. In these experiments the latin square gave a saving in space of 68%. In both trials a  $55 \times 55$  cm spacing was used. The results are shown in table 4.

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TABLE 4. STANDARD DEVIATIONS, COEFFICIENTS OF VARIATION AND LEVELS OF SIGNIFICANCE

	Net weight per plant (g)		Gross weight per plant (g)		Net/gross × 100	
	Trial in two replications	Latin square	Trial in two replications	Latin square	Trial in two replications	Latin square
Characteristics . . . . .	964	921	1,372	1,416	70.5	66.7
Standard deviation p. plot per plant	61	} 243	89	} 381	2.3	} 7.5
	350		514		13.3	
Coefficient of variation per plot per plant	6.3	} 26.3	6.5	} 26.9	3.3	} 11.4
	36.3		37.5		18.8	
Levels of significance . .	13-22	15-25	18-33	24-39	4.8-8.8	4.7-8.1

The averages do not differ much. In the trial in two replications the standard deviations of the plots are considerably smaller than in the latin square, as would be expected. In the former trial the standard deviation per plot equals  $\sqrt{33}$  times the standard deviation per plant, while in the latin square it equals the standard deviation per plant. It is of importance that the standard deviation per plant is smaller in the latin square and consequently also the coefficient of variation per plant, for the latter is equal to the quotient of the standard deviation and the average times 100. This may be partly due to the smaller growing area occupied by a latin square arranged in this manner. Any fluctuations in the soil conditions are then smaller.

The latin square has a smaller coefficient of variation than a block trial in two replications. Hence the latin square makes it possible to demonstrate a difference with a smaller number of plants than that required for the block trial. In our case the confidence limits at the 5 per cent level are about the same for the latin square with 21 plants per strain as for the trial in two replications with 66 plants per strain.

*Discussion*

In judging commercial trials with spring cabbage one is concerned with measurable characters. It seems justified to arrange such trials, at least the simple yield trials, in latin squares using one plant per plot. For eye judgement it will also be necessary to plant a normal block with 30 to 50 plants per plot.

The latin square has the disadvantage that its lay-out, especially in the beginning when one has not yet much experience with it, will take a little more time. Moreover its application will only be possible if the number of varieties to be tested is not too small, while the advantage of the saving in growing area becomes smaller as the number of varieties to be tested increases.

SAMENVATTING

*Proeftechnische aspecten bij rassenproeven met spitskool*

1. Het verschil in productiviteit tussen drie selecties van het spitskoolras Eersteling is deels het gevolg van een langere groeiperiode en deels van een snellere groei.

2. Bij praktijkproeven met spitskool is bij één plantafstand een voldoende betrouwbare vergelijking van de verschillende eigenschappen mogelijk.
3. Praktijkproeven met spitskool opgezet als latijns vierkant met één plant per veldje zullen voor praktijkdoeleinden meestal wel voldoende gegevens verschaffen over de meetbare eigenschappen van de selecties.

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