

SOME EXPERIENCES WITH THE BREEDING OF POINTED-HEADED CABBAGE

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ABSTRACT

1. A survey is given of research on pointed-headed cabbage carried out at the I.V.T. from 1947 to 1957. The aim has been to ascertain whether the production of hybrid seed will make it possible to increase the uniformity and cultural value. Three strains of pointed-headed cabbage were used.

2. It was found that the F_1 's from pair crosses between plants of the same strain were usually very uniform. By comparison it was possible to find out which parents gave on an average the earliest progenies. Crossing these early parents sometimes resulted in increased earliness.

3. By maintaining the two best parents vegetatively it is easy to maintain a certain selection level.

4. No decline in quality and yield occurred when an F_1 from a pair cross of two closely related parents was propagated for two generations without previous selection.

5. Indications were obtained that some hybrid vigour occurs in the F_1 -generation.

INTRODUCTION

In the Netherlands from 100 to 150 ha is annually cropped to pointed-headed cabbage. Sowing is done under glass in September; the young plants are pricked off into pots in the autumn, and planted outside early in spring.

Harvest begins in May, and the bulk of the crop is marketed in June, so it is the earliest white cabbage. In the Netherlands only strains of the variety Eersteling are now used for early production of pointed-headed cabbage; a few years ago also strains of the variety Sappemeerse were used. The productivity of these varieties is lower than that of the round-headed white varieties and amounts to about 20,000 kg per ha. As the round-headed varieties are later, however, early pointed-headed cabbage is still being grown, though on a limited scale.

From preliminary variety trials carried out in 1946-1947 it appeared that some strains of the above varieties were far below average in regard to earliness and uniformity. Therefore a start was made with the testing of some selection methods. The present article gives a survey of this work.

The investigations were initiated by Dr. J. SNEEP, taken over by Dr. J. R. JENSMA in 1953, and finished by the present author in the years 1955-1957.

MATERIAL AND METHODS

Three strains were used, two of which belonged to the variety Eersteling (fig. 2).

One of them, called *Vroegste van Allen* (Earliest of All), was medium early. Its productivity was too low in relation to its time of ripening. Its uniformity was only moderate. The uniformity of the other strain, called *Eerste van de Markt* (First of the Market), was slightly better. This strain also had a small head, but it was earlier. The third strain belonged to the variety *Sappemeerse* (fig. 3) and was somewhat later than *Eerste van de Markt*. It was fairly uniform. According to the breeder this strain is a hybrid derived from two parent plants that were maintained and propagated asexually.

The crosses made in 1948 were done by hand. As in this manner the amount of seed obtained from each cross is often insufficient, use was made in subsequent years of pollination cages to which small bee colonies or diseased bumble-bee queens were added to do the pollination (fig. 1). In this manner seed setting was usually good. A paper on this pollination method has already appeared (1).

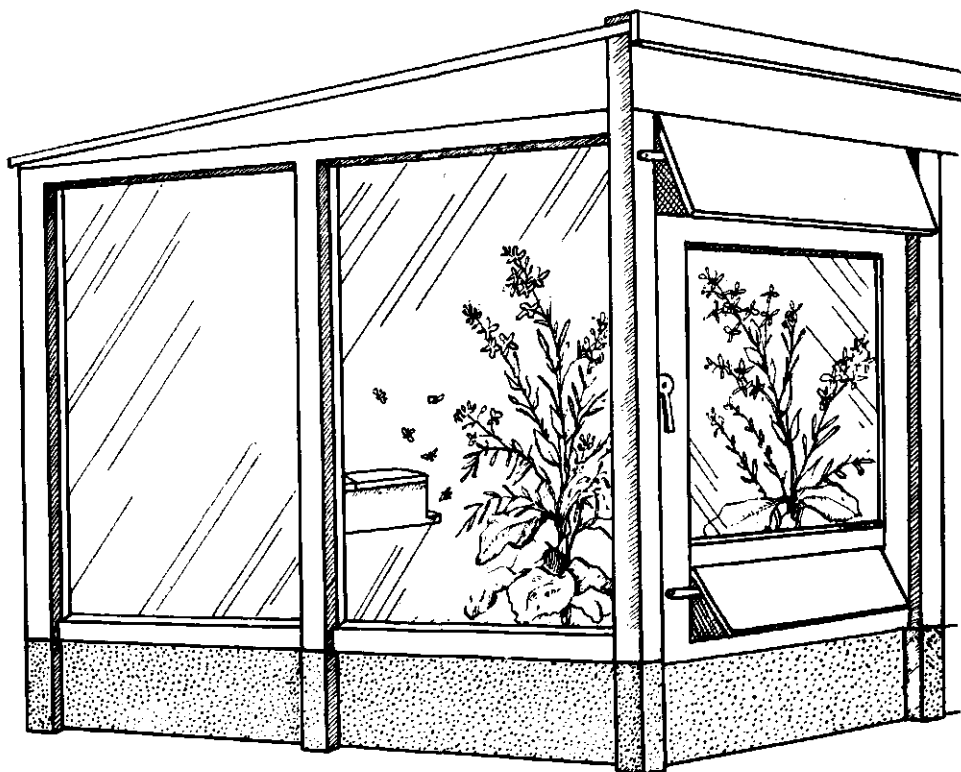


FIG. 1. POLLINATION CAGE

In some cases plants were also open-pollinated in the field, taking care to leave at least 500 m between them and other flowering cabbage plants; in many instances it was more than 1,000 m.

The resulting populations were tested on river clay at Elst in a normal spring production. The majority of the trials were not replicated, so that in many cases it was not possible to test differences found statistically. They were mostly judged by eye.

BREEDING OF POINTED-HEADED CABBAGE

Special attention was paid to uniformity and earliness. Uniformity is a measure of the suitability of a certain method, while earliness is of much importance to the grower. Moreover attention was sometimes given to productivity and rate of cracking. Notably the early strains are very subject to cracking. Hence they must be harvested as soon as possible, which may be a drawback if prices are low.

SELECTION IN VROEGSTE VAN ALLEN

Pair crosses

In 1947, 20 early plants of about the same type were selected. They were indicated by the letters A-U (the letter I is not used). With these, 43 crosses were made in 1948, which were compared in 1949.

As in 1948 the crosses were made by hand, the amount of available seed of various strains was only small and consequently the assessments in 1949 were not very reliable. The impression was obtained that the parent plants B and E produced on an average the earliest F_1 's. The uniformity of the F_1 's was generally good. A number of crosses, including the cross B \times E, were repeated in 1949. This was possible because the parent plants had been maintained vegetatively by means of shoot cuttings. By judging the progenies of the selected plants it is possible to find out which parent plants are genetically the best. This is a form of *parent selection*. By maintaining the two best parent plants vegetatively, in the present case B and E, crosses between them can always be made. In this manner a *hybrid variety* is obtained.

Propagation of the F_1 's

This method has the disadvantage that a great many cuttings of plants B and E have to be maintained for commercial seed production. Therefore it was investigated whether the F_1 seed could be propagated without losing its qualities. To this end a number of F_1 's were sown in July 1949 for seed production. In 1950 the resulting plants flowered without forming a head. Each cross flowered separately. With some of these F_1 's double crosses were also made and part of the seed derived from these crosses was sown in July 1950. In 1951 their progenies flowered separately. So in this propagation no selection work was done.

A comparison, in 1951 and 1952, of the F_1 's, F_2 's and F_3 's did not show great differences. Most strains were much uniform and also a little earlier than the original strain. Consequently an F_1 of a single cross between two closely related parents may in some cases be propagated for one or two generations without selection.

In 1952 the strains were rated on earliness and classed as "fairly early" and "medium early". Of the 9 strains that were "fairly early" 6 had both B and E as the original parent plant. Of the 18 "medium early" strains none had B or E as a parent. So the increased earliness of these parents was also retained when the crosses were propagated. The double crosses largely resembled the F_1 's that had been propagated separately.

SELECTION IN EERSTE VAN DE MARKT

Pair crosses

A number of plants were selected in 1948 and paired in 1949. They were judged in 1950 and it was found that there were hardly any differences between the F_1 's, in con-

trast with the F_1 's of Vroegste van Allen. The cause probably had to be sought in the fact that most plants of Eerste van de Markt were early. From this strain early plants were selected, i.e. those of the current type. The chance of these being genetically closely related was much larger than for the plants of Vroegste van Allen. This strain was less uniform and later, and the plants selected from it deviated from the normal type in that they were earlier.

The uniformity of the F_1 's was generally good. This is also evidenced by the fact that in 1950 there were only 2-3 days between the date on which 25 % of the heads were ripe for harvesting and the date on which this percentage was 75 %.

The propagation of the F_1 's

In 1950 and 1951 the F_1 's were propagated twice, without selection. The F_1 's and their progenies always flowered separately. In 1951 and 1953 the F_1 's and F_2 's were also propagated after previous selection in 1950 and 1952, respectively. In 1951 the F_1 's were compared with the F_2 's propagated without selection. The average results of three plots of 4 crosses each are shown in table 1.

TABLE 1. YIELD, EARLINESS AND RATE OF CRACKING IN F_1 AND F_2 OF EERSTE VAN DE MARKT

Cross	Net weight per head in kg		50% harvesting date (days in June)		Number of days from 50% harvesting date to date on which 50% of the heads were cracked	
	F_1	F_2	F_1	F_2	F_1	F_2
1	1.11	1.07	11.3	13.8	3.4	4.0
2	0.97	0.96	12.6	12.5	3.0	3.0
3	1.14	0.99	11.5	12.3	3.0	3.7
4	1.06	0.93	12.0	14.0	4.0	6.5

In three of the four crosses the F_2 's yielded a little less than the F_1 's, while they were also somewhat later and cracked less rapidly. The differences, however, were small.

From the trials made in 1951 and subsequent years significant differences between propagation with and without previous selection were not shown.

In 1953 seed of some F_1 's from Eerste van de Markt was distributed to private seed firms.

SELECTION IN SAPPEMEERSE

F_1 's were propagated twice, viz. in 1951 and 1953, after previous selection. In both years the seed of the plants was harvested collectively (positive mass-selection). In the trials made in 1952 and subsequent years differences between the various generations were generally not large. That they could not be neglected, however, appeared in 1955 when somewhat more extensive observations were made. These data are given in table 2.

It will be seen that the F_2 and F_3 are more uniform and earlier than the F_1 , among which in some cases an appreciable amount of contamination (probably with kale) as well as a number of round-headed plants occurred.

BREEDING OF POINTED-HEADED CABBAGE

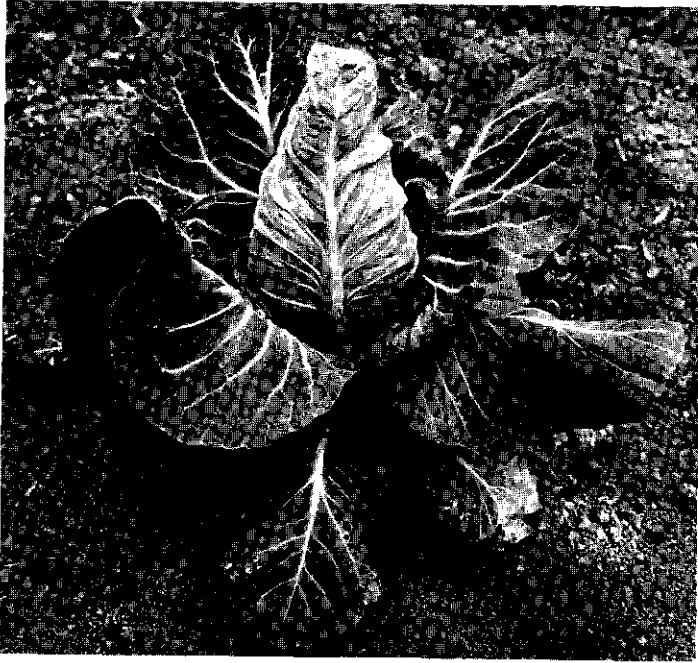


FIG. 2. A PLANT OF THE VARIETY EERSTELING



FIG. 3. A PLANT OF THE VARIETY SAPPEMERSE

BREEDING OF POINTED-HEADED CABBAGE

TABLE 2. UNIFORMITY AND EARLINESS OF SAPPEMEERSE

Generation	Uniformity	Percentage harvestingripe on	
		16/6	20/6
F ₁	moderate	10	40
F ₂	rather good	30	65
F ₃	rather good	40	90

DISCUSSION

The variability inherent in naturally cross-pollinated plants can be considerably reduced by the production of hybrid varieties. These are obtained by breeding inbred lines, subjecting them to test crosses, and using the two best for the production of hybrid seed. The two inbred lines are always propagated sexually. Various Japanese cabbage varieties are obtained in this manner.

Using the method discussed in this paper, test crosses between the selected plants are made immediately. Since the selected plants can be maintained vegetatively, the best F₁'s can always be reproduced again. Thus it is possible to maintain a certain selection level.

The present experiments have clearly shown that crosses between phenotypically identical cabbages, selected from a population, may yield a sufficiently uniform F₁ of high cultural value. It is not likely, however, that in this manner much heterosis will occur, as the parents are genetically too closely related. Yet the data in table 1 seem to indicate that the F₂ is somewhat less vigorous than the F₁. This might point to some hybrid vigour in the F₁. The differences, however, are small. Attempts might be made to increase hybrid vigour by using parents that are genetically more different. An F₁ thus obtained will presumably be less uniform and more difficult to propagate sexually while retaining its favourable characters. This is a drawback, as the production of F₁ seed from parents maintained and propagated vegetatively can only be carried out on a limited scale. Therefore in large-scale seed production the F₁ seed should also be suitable for sexual propagation. In the above crosses the F₁'s could be propagated without materially affecting their quality.

Summarizing we may say that the production of F₁ varieties by pairing the selected plants immediately, without previously selfing them for a number of generations, will lead to rapid results. However, the necessity of maintaining the parent plants vegetatively is a disadvantage and a weak point. Owing to diseases or insufficient care the parents may become lost. Moreover, it will be more difficult to obtain so much F₁ seed as with the previously mentioned method, as the large-scale vegetative propagation of the parent plants requires more labour than the generative maintenance of the inbred lines. It is therefore of importance that the F₁'s can be propagated once or twice sexually without losing too much of their quality. This is only possible if both parents have almost the same genetical constitution, as otherwise there will be too much segregation in the F₂ and F₃. Consequently it will be difficult to breed a heterosis variety in this way.

The procedure discussed in this paper may also prove useful for the selection of inbred lines. The combining ability of the parent plants might give an indication of the combining ability of the inbred lines which may be derived from them by selfing.

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SAMENVATTING

Enige ervaringen met het kweken van spitskool

1. Een overzicht wordt gegeven van het onderzoek met spitskool dat in de jaren 1947 tot 1957 bij het I.V.T. plaats vond. De opzet was na te gaan of de produktie van hybridezaad mogelijkheden biedt de uniformiteit en de gebruikswaarde op te voeren. Er is gewerkt in een drietal spitskoolselecties.

2. Het bleek dat de F_1 's van paarsgewijze kruisingen tussen planten uit dezelfde selectie doorgaans zeer uniform waren. Door deze met elkaar te vergelijken, bleek het mogelijk na te gaan welke kruisingsouders gemiddeld de vroegste nakomelingen gaven. Door deze vroege kruisingsouders daarna weer met elkaar te kruisen, kon soms enige vervroeging worden verkregen.

3. Door vegetatieve instandhouding van de 2 beste kruisingsouders kan een eenmaal bereikt selectie-niveau gemakkelijk gehandhaafd worden.

4. Vermeerdering van een door paarsgewijze kruising verkregen F_1 van nauw verwante ouders gedurende twee generaties in stultenteelt bleek geen beduidende achteruitgang in kwaliteit en opbrengst te veroorzaken.

5. Aanwijzingen werden verkregen dat in de F_1 enige heterosis optreedt.

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