FINAL REPORT

REDUCTION OF GENETIC VULNERABILITY AND IMPROVEMENT OF DISEASE RESISTANCE, GERMINATION, AND SEEDLING VIGOR IN SUGARBEET

J-MOA/USDA-5 /PG-Po-335/

PL-ARS-92

Institute of Plant Breeding and Acclimatization
Departament in Bydgoszcz
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This Report includes the results of the comprehensive investigations on interspecific hybrids /vulgaris-corolliflora, vulgaris-maritima and vulgaris-procumbens/, germination and seedling vigor in sugarbeet carried out under PL-ARS-92 Project at the Institute for Plant Breeding and Acclimatization, Department at Bydgoszcz.

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Z.Szota, Professor, Principal Investigator, 25 %
L.Dalke, Assist. Professor, Plant Breeder, 25 %
B.Jassem, Assist. Professor, Embryologist, 25 %
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M.Szota, Ph.D., Cytologist, 25 % /onwards 1981/
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Mrs. T.Burduk, M.A.,	100 %	-	1/6/1980 - 31/12/83
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Mrs. M.Wilcz,	100 %	-	1/12/81 - 31/5/82

This Report covers the research performed in 1983 and also the results previously presented in Yearly Reports 1980-1982. The Report forms a whole, but it is divided into separate sections, making it possible for the reader

to get acquainted with any of the items of his special interest.

No graduate degrees were received during the life of the research project.

No publications appeared so far, but there are some in preparation. The list of these publications is enclosed at the end of the Report.

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II. SUMMARY

Objective 1.

An attempt was made at fixing the male sterility occurring in interspecific hybrids of sugarbeet x B.corolliflora in generations B_3-B_5. In the investigated material, 22 male sterile tetra-, tri, and aneuploid plants were found. The examination of meiosis revealed considerable disturbances in the development of microspores.

The crossing of male sterile plants with sugarbeet O type plants did not fix the male sterility in the progeny. The sterility occurring in these hybrids was caused by periodical disturbances in pollen fertility, characteristic for remote interspecific hybrids.

The investigations comprised also the progeny of a male sterile plant which was found in the ecotype from northern France, B.maritima. The O type line of the sugarbeet proved to be necessary to reproduce the male sterility in the progenies. The examination of meiosis revealed that reduction divisions proceed regularly with small aberrations up to the tetrad stage, and then degeneration of pollen grains was observed. The anatomical examinations of anthers showed that the cause of the formation of sterile pollen are the distrubances in the development of tapetum.

The results from the investigations indicate that the male sterility in these hybrids was caused by the presence of S cytoplasm and to its reproduction O types are needed. The male sterile hybrid material may be recognized as a new CMS source because of combining the sterile plasm of the wild species with sugarbeet genom. The male sterile hybrids showed a considerable degree of tolerance to yellows virus /BYV/ under natural infection.

Great variabilityof morphological characteristic and incomplete transmission of sterility to the progeny deserves futher attention.

Objective 2.

In 1980-1983, the investigations on vulgaris-procumbens hybrids, courtesly provided by Dr.McFarlane, were continued. Since 1974, over 18.000 hybrid plants have been checked. Selection was carried out in four successive generations of trisomics. The resistant plants were most frequently with 19 chromosomes.

The selected plants were multiplied in isolated family groups or pair-crossed. The seeds were collected individually from each plant and their progeny was tested again. The share of resistant plants increased slowly.

In the last three years of the investigations, two thirds of trisomic progenies accounted for 20-30 % resistant plants. A small number of diploid plants was partially resistant to beet nematodes; in their progeny no resistant

plants were found, or only a small percentage. In the progeny of 6 diploid resistant plants tested in 1983, the percentage of resistant plants varied from 1,5 to 7.0. Meiosis of these plants showed slight disturbances.

Objective 3.

A. In 1983, the investigations were continued on the evaluation of the quality of seed material with particular consideration of the field emergence and the possibility of its improvement and prognostication by laboratory methods both with respect to monogerm hybrid varieties /series A/ and other hybrids obtained at the top cross tests /series B/. The high correlation between germination capacity /GC/ and field emergence /FE/, and a very high modifying influence of environmental conditions on FE, expressed by a considerable differentiation of relative emergence /RE/ for the particular experimental locality, has been confirmed. The influence of varietal factors and the quality of seeds on RE is negligible, but in this respect a slight superiority of diploid seeds as against triploid ones has been established. The usebility of Akeson and Widner's test /PSCT/ for prognosticating field emergence has been confirmed. In addition to quantitative data /GC,FE,RE,PSCT/, attention has been paid to germination speed /GC after 4 days : GC after 14 days „germination speed index"/ and increase of germ weight

/ mass of 100 germs/. The possibility of improving the germination capacity of hybrid seeds by selection of proper parental components has been confirmed.

B. The investigations in 1980/83 were performed on seeds of the monogerm variety PN-Mono 1. To stimulate the germination or/and growth of seedlings, the seeds were conditioned by active soaking in lye solution in a multicomponent mineral preparation: the preparation was used in the form of spray or dust.

At the field experiment seeds were sown at a distance of 18 cm. Manuring and cultivation practices were performed according to principles applied generally in sugarbeet cultivation. A considerable increase in enzymatic activity and in the growth of seedling mass in variants with seeds treated with lye and multicomponent mineral solution have been observed. The seed leaching operation did not affected significantly the field emergence, plant population, yield and technological value of roots. These characteristics have been, however, significantly improved by seed spraying or dusting with mineral mixture. Leaching followed by spraying or dusting gave best results.

III. INTRODUCTION

Objective 1. Search for a new source of male sterility.

The hybrid varieties of sugarbeet cultivated now are based on one source of sterile cytoplasm isolated by Owen from the US-1 variety. Thus, finding a new different source of male sterility would be very desirable since it would reduce the genetic vulnerability and enrich breeding materials.

Contrary to other species of cultivated plants /corn, alfalfa, tomato and others/, no distinct cytoplasm causing sterility in sugarbeet has been found so far. Male sterile cytoplasmic plants have been discovered only in some wild species of Vulgaris section of the genus Beta /Oldemeyer, 1957; Coe and Stewart, 1977/.

Among the interspecific hybrids of the sugarbeet with the B.corolliflora species, we found male sterile plants in generations F_1, B_1 and B_2. In generation B_3, most plants had fertile pollen. Male sterile plants, however, continued to occur. Particular attention has been given in the investigations to these sterile plants, because this characteristic, besides disturbances in fertility occurring in interspecific hybrids, could have been caused by mutation of cytoplasm, genes or both these factors.

In investigations, the attempt was made to fix the male sterility in interspecific hybrids of the sugarbeet with B.corolliflora species and to determine this character.

The progeny of the male sterile plant found among the B.maritima ecotype, originating from northern France has also been included into the program.

Objective 2. Selection for resistance against nematodes.

The selection of nematode resistant forms of beets in populations of cultivated varieties has not given any satisfying results so far. A selection based on a lower reproduction of nematode cysts may lead to favoring plants of weaker, slower growth, and of smaller root mass. The quantity of cysts produced on roots undergoes considerable variability under the influence of many environmental and microclimatic factors /Curtis, 1970; Whitney and Doney,1973/.

As Heijbroek's investigations have shown /1977/, the partial resistance to nematodes found in a B.maritima biotype, was increasing as an effect of selection, but only in a limited range. After the second backcross with sugarbeet, it disappeared. The inheritance of this resistance was of recessive character.

By applying mass selection for shape and root mass, plants were selected which faded less on the field heavily infested with nematodes. These plants produced heavier roots. They reproduced, however, the same amount of nematodes /Heijbroek, 1977; Heijbroek, McFarlane and Doney, 1977/. Attemps at finding biochemical selection criteria in sugarbeets failed/ Finkner and Swink, 1959/.

The discovery in the genus Beta 3 viny species resistant to nematodes attracted the attention to this

type of resistance. Already in the forties, first crosses between sugarbeet and B.patellaris were made. A detailed review of the subject was presented by Coons /1975/. The main obstacle in transferring the resistance from wild species to cultivated beets was sterility and poor viability of the hybrids. In addition, cytological disturbances at meiosis discouraged many recheachers to continue the work.

H.Savitsky and Price /1965/ investigated the resistance pattern of vulgaris-patellaris hybrids. They stated a dominant character of the resistance. By backcrossing F_1 vulgaris-procumbens hybrids with sugarbeet Savitsky /1975,1978/ obtained 4 resistant trisomics with an addition of B.procumbens chromosome. This chromosome carried the resistance to nematodes. In the progeny of trisomics, 3 diploid resistant plants have been found, which suggested the incorporation of a fragment of wild beet chromosome into the sugarbeet chromosome. These resistant plants transferred resistance to subsequent generations. The transmission rate of resistance increased with selection. Working on these hybrids Savitsky /1980/, Yu /1981/, McFarlane et al. /in press/ succeeded in obtaining homozygous plants with 100 % transmission rate of resistance to the progeny.

The subject of our work was trisomics courtesly supplied by Dr.McFarlane for investigations and selection.

Objective 3. Methods of identifying, isolating and selecting genotypes with rapid germination, emergence and seedling vigour particularly at low temperatures.

A. Investigations having in view the evaluation of the vigor of sugarbeet seeds were initiated in 1980. They also comprised an attempt at evaluating /possible/ heritability of this characteristic, and at the same time the possibility of its improving by breeding methods. In 1980-1982, several methods of evaluating the vigor of sugarbeet seeds were checked, namely : cold-test /4,6 and 8.0°C/, pot test /in sand/, Derlitzky and Hiltner's test in grit /the latter was modified and performed on two levels of a relative humidity of the grit, 40 and 60 %/, and since 1982, the so-called Packed-Sand Cool Test of Akeson and Widner 1980 /PSCT/. A parallel evaluation of field emergence was carried on at experiments with 4 replications x 100 seeds at three localities /series B/ and at six localities /series A/.

In 1982, additional extensive comparative investigations on pelleted seeds of different origin were carried out, also comprising the evaluation of emergence speed and increase of seedling mass under glasshouse conditions /Jassem, 1983/. So far, the results may be recapitulated as follows: none of the tested methods of laboratory vigor evaluation does not offer results distinctly better correlated with the field emergence than the standard method of evaluating the laboratory germination capacity /GC/.

The correlation /GC:FE/ is very high of the order of 0.8-0.9, significant at P = 0.01.

Similar results, though at the same time considerably in agreement with those of the field emergence, provides Hiltner's test at sub-optimum humidity of the grit /40%/ and PSCT. The investigations on the heritability of the vigor of seeds did not provide positive results, but the doubtless influence of parental components on the germination capacity of hybrid seeds was established.

A one-row cassette drill for investigating field emergence was developed, as well as a device for evaluating the resistance of pelleted seeds to crushing, and so called Forberg's mill was adapted for evaluation the resistance of pelleted seeds to rubbing.

B. One of the most important problems requiring a quick solution by planting to a stand, is improving the energy and laboratory germination capacity of seeds, field emergence and plant vigor.

The most frequently occurring causes reducing germination capacity of seeds are, apart from defects of the embryo, the specific growth inhibitors. Their partial extraction from seeds can essentially enhance their germination /Massart, 1956; Roubaix, 1960; Trzebiński, 1976/. The field emergence, population and yield of roots is influenced not only by soil and weather conditions, agrotechnical practices, and genetic properties of seeds, but in a notable degree also by technical and chemical operations

applied at the time of preparing seed material /Gutmański, 1972; Byszewski and Chrobak, 1974; Ziółek, 1976/.

The most critical period of beet growth is the phase of germination and emergence. At this period, providing the plants with minor-and macroelements essentially determines the field emergence and growth dynamics of seedlings. Localization of an adequate amount and assortment of nutrients at optimum concentration on the seed pericarp or in its proximity exerts an essential influence on emergence and dynamics of the initial plant growth.

These assumptions confirm, to a great extent, the investigations with sugarbeet /Schweigart, 1956; Kwiatoń, 1959; Muchin, 1974; Gutmański, 1976/, as well as with other plant species /Grzywnowicz-Gazda, 1976; Szukalski, 1979/. In Poland so far, these investigations were dealt with only fragmentarily and pertained mainly to the single mineral components.

IV. MATERIAL AND METHODS

Objective 1.

The subject of investigations were interspecific tetrapoid hybrids of sugarbeet with the wild species of B.corolliflora 4x, generation B_3-B_5, originating from various series of back-crossing with the di- and tetraploidal sugarbeet. The progeny of the male sterile plant, found among the ecotype B.maritima in northern France, was also investigated. The male sterile plants were crossed in

isolators with type O plants of the sugarbeet, and subsequently, the sterility of the pollen in the progeny of this crossings was investigated.

To accelarate the cycle of reproduction, the plants were vernalized in a glasshouse in winter. In spring, 250-374 hybrid plants and progenies originating from crossings with type O plants were transplanted into the field.

The number of chromosomes for each plant was determined on squash preparations stained with orcein. During flowering, a phenotypic and cytological evaluation of pollen sterility was carried out. The pollen fertility was made in Belling's solution. From male sterile plants, anthers were taken from the main flowerstalk to check meiosis. The material was fixed in Cornoy's fixer and stained with 2% orcein. Meiosis was observed on squash preparations.

From several male sterile plants of B.maritima crossed twice and three times with sugarbeet O type line, material for anatomical investigations was taken. The investigations were carried out on paraffin preparations stained by Heidenhaim's iron hematoxilin.

Five progenies of male sterile hybrids with B.maritima after crossing three times with sugarbeet O plants, were checked for content of yellows /BYV/ under conditions of natural infection. The virus titre was determined by drop precipitation method with specific antiserum toward beet yellows virus. The plant material consisted of 30

plants, out of each progeny. The control combination was the male sterile line of the sugarbeet growing in the same field.

Objective 2.

The material for investigations consisted of vulgaris-procumbens trisomics isolated by H.Sawitsky which we have received through Dr McFarlane. Since 1974, we selected from this material resistant trisomics and some resistant or partially resistant diploids. In testing for resistance to sugarbeet nematodes the technique suggested by Sheperd was applied /1958/.

The seeds were sown in wooden boxes filled with steamed compost. The seedlings at cotyledon stage were singly transplanted into pots of 7-8 cm diameter. The soil consisted of compost mixed with sand at a ratio 3:1.

The plants were infected with nematode larvae at 2-4 leaf stage. The cultures of larvae were carried on in a thermostat at 25°C or at room temperature. Freshly hatched larvae were used for inoculation. At the first testing, 2000 larvae were used to infest one plant, placing them in the pot with medical syringe.

After 5 weeks, observations on the external surface of the lump, after taking the plant out of the pot, were performed. The plants without white nematode females on the roots /sometimes single ones/ were screened for repeated testing. Directly after observation, these plants were carefully transplanted to larger pots of 10-12 cm diameter.

After two weeks, the plants were inoculated for the second time with 2000 larvae per plant. About one month later, observations were made on the external surface of the roots. On plants without visible females, nematode reproduction was checked on the whole root system. For this reason, the plant was taken out of the pot; the roots were rinsed to remove the remainders of soil on sives with a stream of water. The plant was immediately transplanted into fresh sterilized soil. From the pot, in which a given plant grew, 1-2 samples of 100 g of dried soil were taken, or the whole content of the pot was analysed by flotation method for the presence of nematode cysts. If no cysts were found or only a small number of them-up to 10 cysts, such a plant was recognized as resistant.

During the selection of plants for resistance, the number of chromosomes was checked. Squash preparations stained with orcein were used for this purpose. From resistant or partialy resistant plants anthers were taken for meiosis investigations.

Meiosis was observed on squash preparations stained with orcein. Pollen viability was determined in Belling's solution.

Resistant plants were crossed in pairs or groups, spatially isolated. Seeds were collected on an individual base.

Objective 3.

A. In 1983, we concentrated our investigations on monogerm varieties and several hybrids, which made it possible to evaluate the influence of parental components on the qualitative characteristics of the hybrid seeds and, with respect to method, on PSCT test and Hiltner's test, which although rather troublesome, provide results highly in agreement with the field emergence. Thus, the investigations were carried out in two series :

a. All the monogerm varieties participating in the official variety tests were examined, some seed samples were pelleted. Two varieties were reproduced both in Poland and abroad. In Bydgoszcz, the laboratory determination of germination capacity and of the mass of 1000 seeds and 7-days old germs /with additional analyses of ungerminated seeds/ as well as Hiltner's test and PSCT were carried out. In view of the difficulties in collecting the data on time prior to the reporting period 1982, last year's results of varietal experiments have been placed in the report for the present year. The field test was carried out at 6 localities, each experiment with 4 replications x 100 seeds /SOO Chrząstowo, Głogowa and Głębokie, ZD-HAR Kończewice- - Nawra, SHR Polanowice and IHAR Sandomierz/.
At Chrząstowo, Głębokie, Polanowice and Nawra, sowing the seeds has been performed with a one-row drill developed by us.

b. 33 monogerm hybrids originated from crossing 3 CMS lines with 11 pollinators, 8-2x and 3-4x, from the program of breeding cooperation between Poland and German Democratic Rep.-/harvested in 1982 at Polanowice/ were tested. Seed samples of all the hybrids were tested by standard method for laboratory germination capacity /GC/, investigated at PSCT test /methodical details of the test-see Report 1982 /and the field emergence was determined at 3 experiments, localised at ZDHAR Kończewice, IHAR Sandomierz, and SHR Polanowice. At all these localities, temperature and precipitation readings were taken, which are compiled in Table 10.

B. The investigations have been carried out on the monogerm variety PN-Mono 1. To stimulate the process of germination and seedling growth the seeds were subjected to chemical treatment. Active /mechanical/ soaking of seeds on a horizontal laboratory shaker in lye solution was performed, subsequently the seeds were washed in running water, and again actively soaked in multicomponent mineral preparation, and then dried to 10% of water content. The seeds prepared in this way constituted the initial material for investigations in 1980 and 1981. In 1982 and 1983, a modification in the preparation of seed material followed. Instead of active soaking the seeds in mineral solutions, the mineral preparation was applied dry or in the form of spray mixed with fungicide Oxafun T. Variants without preliminary leaching, but treated with preparations in the

form of spray or dust were made. The following elements were included into the composition of the mineral preparations: nitrogen, phosphorus, potassium, sodium, chlorin, calcium, magnesium, sulphur, iron, magnese, zinc, boron, copper, molibdenum, chromium and nickel.

The activity of proteolithic enzymes of seeds and germs was investigated after Anson /Angel, 1969/, amylolithic after Bielozersky, and rybonucleases after Anfinsen /quoted Kulka, 1971/.

Field experiments were carried out at the Experimental Station of the Institute. The experimental design were randomised blocks with 4 replications. The soil of experimental field was of pseudo-podsoil light dusty clay with pH in H_2O = 6.6. The content of potassium and phosphorus was good; the content of magnesium and minor elements /Mn, Zn, B and Cu/, was average. The forecrop was wheat. Mineral fertilization was as follows : 120 kg of N, 108 kg of P_2O_5, and 160 kg K_2O per ha, and organic manuring 30 t/ha. Cultivation practices were performed according to common rules in sugarbeet production. The seeds were planted 18 cm apart. The plot area for harvesting was 12.0 m^2.

The field emergence, seedling mass at the four-leaf stage and plant population at harvest was determined after Gutmański /Gutmański, 1982/. At the end of vegetation period, the mass of leaves and roots and their technological qualities were determined.

V. RESULTS

Objective 1.

The interspecific hybrids of the sugarbeet with B.corolliflora from B_3-B_5 generations consisted of plants of a different chromosome number. There were plants with full di-, tri- and tetraploid genoms and aneuploids.

Within the three years, during which the hybrid progenies were evaluated, 22 male sterile plants were found. Among them, there were 8 tetraploids, 8 triploids and 6 aneuploids with the chromosome number of 30,32,34 and 38.

After crossing with O line type, 7 plants set seed. The remaining ones were also female sterile. Apart from cytological disturbances, weather conditions at flowering time also affected seed setting. This is particularly true of 1980, in which, at flowering time, heavy and frequent rainfalls occurred.

The investigations of the microsporogenesis of male sterile plants revealed notable disturbances in the development of microspores. In a part of male sterile plants / in spite of taking flower buds at different stages of development/ no PMC with divisions could be observed.

The content of anthers was made up of gelatinous substance which, after fixing, did not stain and had the shape of clods. This kind of disturbances occurred in tetra-as well as tri-and aneuploids. In the remaining male

sterile plants, at meiosis at M_I, the conjugation of chromosomes into 1,2 quadrivalents, trivalents, bivalents and 1-4 univalents could be observed. As a rule, at A_I and A_{II}, chromosomes separated more regularly in tetraploids than in tri- and aneuploid forms. The univalents were scattered beyond the metaphase plate. Laggards, single and double bridges were seen.

As the result of these disturbances, tetrads with nuclei of different sizes with additional micropollen, were formed. In some male sterile hybrids, asynchronous divisions took place. Among cells in the stage of tetrads, groups of cells at A_I stage occurred consequently distinctly lagging. This phenomenon occurred to the end of meiosis. A detailed description of disturbances at meiosis in the particular male sterile plants was made in the Yearly Reports of 1981 and 1982.

The evaluation of male sterile hybrid progenies with B.corolliflora after crossing with O type plants was as follows. Only in one progeny of a male sterile tetraploid plant, segregation into fertile and sterile plants could be found. However, a part of the plants of the same progeny, after crossing with a normal sugarbeet plants, also segregated into male sterile and fertile plants. Thus, it was not male sterility, the expression of which depended exclusively on O line genotype. The repeated crossings of male sterile segregants with O line type provided progenies with fertile and semisterile plants. In the remaining 6

investigated progenies of male sterile plants, those with fertile and semi-sterile pollen shedding from the anthers, were detected. None of the investigated male sterile plants fully transmitted this characteristic to progenies, after crossing with O type plants.

The second group of the investigated male sterile hybrids were the diploid progenies of the male sterile plant of the ecòtype B.maritima, crossed three times with sugarbeet O type plants. After the first crossing with O type plants, sterile plants with white anthers and semi-sterile ones, were found in the progeny.

The sterile plants were crossed again with O type plants. The subsequent evaluation of sterility revealed white sterile plants of this generation. Seed setting in isolators was good. A considerable amount of seeds was obtained, which made it possible to evaluate the degree of sterility of progenies of the single plants on a large material. In this generation, additional test crossings were performed to elucidate the character of male sterility. Several male sterile plants were crossed with normal fertile plants /not possessing the genotype of O line/ In 1983, the hybrid progenies were evaluated, after crossing three times with O type plants /280 plants/ and progenies from the test crossings /90 plants/.

The phenotypic and microscopic evaluation of the pollen sterility after three backcrossings with sugarbeet O type plants revealed that male sterility was not

fully transmitted to the progeny. The occurrence of semi-sterile plants, amounting to 2-27% among the particular progenies, was established. The fertility of the pollen of semi-sterile plants varied from 13-52%. This result was rather unexpected, since the mother plants from the previous generations were male sterile with white non-dehiscing anthers.

The evaluation of progenies from test crossings with fertile plants showed segregation into fertile, semi-sterile and sterile ones, in a ratio of 8:6:3. Such a result points to a complex heredity of this trait in these hybrids. At the same time, it rather excludes monogenic character of inheritance of male sterility. It turned out that the genotype of O line with two recessive genes for male sterility is necessary to express sterility of pollen.

The progenies of CMS plants with B.maritima, crossed three times with sugarbeet O type plants, exhibit a hybrid character with regard to such morphological characteristics as the shape of the root, leaves and leaf rossette /Figures 1,2/. In part of the progenies, a red coloring of the leaf base, stalks and pericarps were observed. The material obtained is characterized by a wide range of variability. The fruits are mostly monogerm or bigerm.

Five progenies of male sterile hybrids with a predominance of morphological characteristics of the

sugarbeet were tested for the presence of yellows virus. In all the investigated progenies, no presence of the virus in the leaf juice in a number of dilutions, up to that of 1:64, was found. The control combination was CMS line of the sugarbeet from the same field, still showed the presence of the yellows virus /BYV/ in a dilution of 1:32.

The investigations of meiosis were carried out in male sterile plants of B.maritima and in hybrids obtained after backcrossing these plants with sugarbeet O type.

In all the investigated plants, a regular meiosis was observed, at diakinesis and M_I, the chromosomes formed, as a rule, 9 bivalents; sometimes 8 bivalents and 2 univalents were noticed. At A_I and A_{II} the chromosomes passed per nine to the poles. Sporadically, single bridges and 1 lagging chromosome occurred. The tetrads contained 4 nuclei of the same size. In this stage, in 5 plants a sporadic occurrence of dyads /Figure 3/could be observed. They formed by fusing of chromosomes grouped at the neighbouring poles. Monads occurred sporadically /Figure 4/.Sterile pollen was differentiated in shape. There were plants with mis-shaped pollen /Figure 5/and those of which the pollen grains were large with visible pores, but with a thin exine. In only a small number of individuals, micropollen occurred.

The anatomical investigations of the male sterile anthers of hybrid plants, after twofold or threefold

crossing with sugarbeet O type plants, showed the same deviations from the normal development of anthers, consisting, like in the CMS sugarbeet, in disturbances of the lining layer /compare also Artschwager, 1974/.
In each of the investigated plants, three kinds of disturbances could be observed:
1. precociously degenerating tapetum, most often observed / in 76 % of the investigated flowers/.
2. the cellular tapetum strongly vacuolized /5%/.
3. plasmodial tapetum /19%/.

The atrophy of the tapetum cells of the first of the referred to types took place, sometimes already at prophase stages of microsporogenesis /Figure 6/. The tapetum of the second type showed normal development, up to the tetrad stage, then the cells of the lining layer enlarged and underwent strong vacuolization /Figure 7/. Periplasmodia in the third type did not form until the end of the reduction division /Figure 8/.

Objective 2.

The seeds of vulgaris-procumbens trisomics, received in 1973, were used for the reported investigations. From among 1084 plants tested for resistance, 113 resistant plants had been selected, which amounted to 10%. The great majority of them were trisomics, carrying one chromosome of B.procumbens. Chromosome counts made on over 800 plants revealed about 20% trisomics. About 24% of them showed high resistance to nematodes.

In 1976-79, on a small scale, investigations were continued on these hybrids and resistance to nematodes of the selected plants was tested.

In a group of 60 plants, 11 trisomics and four partially resistant diploid plants were selected. In the progeny of diploids, a low percentage of resistant plants was found. In two progenies of trisomics, however, a greater percentage of resistant plants was stated, in one of them 20%, in the other 32%. /Table 1/. In both progenies 21 highly resistant plants were selected, also trisomics which were planted in an isolated nursery. Seeds set 18 plants.

In another group of progenies of resistant plants, pair-crossed in F_2 generation, only two of nine progenies had a high percentage of resistant plants, amounting to 26,8% and 40.5% /Table 2/. On these plants, the chromosome number was checked. These plants were pair-crossed. In one progeny, No.72,12 pairs of trisomics and one pair od disomics were arranged. Seeds were obtained from 22 plants. From family No.73, 12 pairs were established; seeds were collected from eight plants. In this family, two diploid plants, partially resistant to nematodes, were selected. Seeds were obtained only from one plant.

The collected seeds were used for tests in 1979-1980. 18 progenies, comprising 2098 plants, were tested. The results are given in Table 3. In four progenies, no resistant plants were found. In the remaining progenies, the lowest portion of resistant plants was 1%, the highest 29%.

The majority of plants shot flowerstalks in the first year. The plants were isolated in groups by progenies, seeds were collected individually. Some plants showed a high degree of pollen sterility and set little seed.

The results of testing 32 progenies of resistant plants, multiplied in 3 groups, are compiled in Table 4. Most of the resistant plants were selected in group 3, which was made up of both resistant trisomics and resistant of partially resistant diploid plants. From among 11 progenies, numbering 707 plants, 161 were selected, which accounts for 22.8%. In one progeny, No.16, one diploid resistant plant was found, which had sterile pollen and in spite of being outcrossed with sugarbeet, did not set any seed.

The successive generation of this series in F_2 was tested in 1980/81. From group No.1, one trisomic progeny was tested. Among 41 plants, no resistant plant was isolated. From group 2, five progenies of diploid plants were tested; in three progenies, no resistant plants were stated; in two progenies, one resistant plant per progeny was found. In group 3,12 progenies were tested, in which 3 progenies were susceptible and in the remaining 9 progenies the share of resistant plants averaged 19,7%, and varied from 11,5% to 31,3% /Table 5/.

In Table 6, the results of testing 33 progenies, comprising 2.499 plants in generation F_3, are compiled. The parental plants were pair-crossed under the isolator.

14 progenies had resistant plants, varying from 11-20%, 9 progenies from 21 to 30%; in 5 progenies, the percent of resistant plants varied from 31 to 40%. In 22 of the investigated progenies, 46 plants had no nematode cysts, despite a double infection with larvae. The majority of these plants were trisomics and shot flowerstalks in the first year of growing. In one progeny, one resistant plant was found.

In 1981, successive tests with 110 progenies from 29 families were carried out, the number of plants being 2.743. The results, given in Table 7, show that two thirds of the investigated families accounted for more than 20% of resistant plants; more of them were identified in two families - 40% and 54%.

In 1981-82, the resistant generation of trisomics in generation F_3 was tested, which were selected in family No. 61-62 in 1980. In 1981, eight progenies were tested, and in 1982 eleven / six of them for the second time/. Within that family, more than hitherto, diploid resistant plants and partially resistant ones were discovered. In Table 8, the results of both tests, related to family No. 61-62, are given together with the results of testing four other families in generation F_4.

In family No. 61-62, most investigated progenies, 8 out of 13, had resistant plants, varying from 21 to 40%. In 1982, seeds from 30 diploid resistant plants and from 10 trisomics were collected in this family. Of 25 plants, seeds were taken from 16 plants. In 1982, in 24 resistant

or partially resistant diploid plants, meiosis was studied. Meiosis was quite regular. In diakinesis and M_I chromosomes paired in bivalents. At A_I and A_{II} single bridges and laggards were sporadically observed. The forming tetrads contained nuclei of the same size, and only a few of them had additional micronuclei. The pollen was regular with a small admixture of micropollen /see Second Yearly Report, Table 6, page 55/.

In 1983, six diploid progenies, numbering 1920 plants, were tested /Table 9/. The percentage of resistant plants in four progenies amounted 1.47% to 3.1%. In one progeny it was higher and amounted to 5.73%, while two plants were completely free from nematodes. The highest percentage of resistant plants was stated in the progeny of a diploid plant, No.1313, which was selected in 1981 from family 23/46. After first testing, 57% of the plants from its progeny did not exibit the presence of cysts on the roots outside the soil lump. After the second infection with 3000 larvae per plant, the percentage of resistant plants diminished to 7.3% and three plants did not develop any cysts. Within 50 resistant plants, selected in 1983,25 are diploids.

Objective 3.

A. The results of the experiments carried out are compiled in Tables 10-15. Table 10 presents the data concerning soil and weather conditions at localities, where the field tests were lacated, together with the summary.

Table 11 shows the results of series A for 1982 and constitues a supplement to the Report for the last year. Table 12 shows the results of same series for 1983. In view of the particular importance of the relative emergence /RE/, in Table 13, the comparative data were compiled concerning RE for 2x and 3x varieties for the period 1976--1983 /Table 13a/ and for natural and pelleted seed for the period 1982-1983 /Table 13b/.

Tables 14 and 15 concern series B. The former comprises the results for the particular tested hybrids, and the latter, the data compiled separately for progenies of the particular CMS lines /a/ and the particular pollinators /b/.

In Tables 11,12 and 15 apart from the data presented in the previous Report, the new parameter, suggested by us, has also been stated, namely, "germination speed index" /GSI=GE:GC/ and in Table 15 also "the laboratory vigor index" /PSCT-21 d: PSCT-28d/. The most significant correlation coefficients have been calculated and stated in the lower part of the Tables, and for series B, also the regression coefficients. In series A /Table 12/, the mass of 100 germs on the seventh day of GC, has been shown.

B. In the investigations carried out in 1980, a proportional relationship between the enzymatic activity of ribonicleases, proteolhitic and amylolithic enzymes, and the increase rate of germ mass in comparision with the increase of germs under control was observed. A notable increase of activity of the investigated enzymes, as to the variant comprising soaking in lye, was observed, and likewise, a further increase in activity of the investigated enzymes, on the average

by 25% in terms of 100 germs when the seeds were treated with lye, and then, with the mineral preparation /Table 16/.

These encouraging results obtained in lab were varified in field experiments. Planting to a stand of 18 cm made it possible to accurately record the field emergence and other characteristics. The results are presented in Table 17. It was found that seed soaking in water and lye did not affect essentially the emergence capacity, seedling mass, yield of roots, and their quality. Leaching of seeds in lye solution, following their soaking in the mineral preparation, improved traits mentioned above.

In the experiments in 1981, the variant with leaching the seeds in lye solution was abandoned and a new variant with non- leached seeds, but treated with mineral preparation, was introduced. The results are presented in Table 18. All the variants compared have markedely improved field emergence, yield and its quality. The variant with non-leached seeds, but treated with the mineral preparation, produced the best results. The field emergence was increased by 17%, yield of roots by 7,6 t/ha, that of leaves by 6,6 t/ha, and that of white sugar by 1,46 t/ha as against control.

In the investigations carried out in 1982/83 attention was paid to the technique of using preparations on technical scale. The variant with soaking seeds in mineral

preparations was given up by introducing variants consisting in spraying seeds with a preparation, suspended in water, and dry-conditioning, with a mixture of the preparation with a fungicide. The results obtained at the laboratory and field experiment are presented in Tables 19 and 20.

In the laboratory tests in both years, clear-cut differences appeared between the combinations. The best effects have been obtained with variants, in which preliminary leaching of seeds, prior to applying the mineral preparation, was performed and with variants /combinations/, in which only the preparation was used. The effects were manifested by improvement of germination energy and germ length as compared with control. The considerable differences observed in the laboratory between leached and non-leached seeds were not so clear under field conditions and differed significantly only in the mass of seedlings at four-leaf stage.

All the preparations used and methods of their application in relation to the control, as may be seen in Tables 19 and 20, markedly improved field emergence, seedling mass at four-leaf stage, plant population, root yield, and sugar yield. The best effects have been obtained in combinations with seed leaching followed by spraying them with the mineral preparation.

VI. DISCUSSION

Objective 1.

As a result of 4 years of investigations on the male sterile forms occurring in interspecific hybrids of the sugarbeet with B.corolliflora in generations B_3-B_5, it was found that the sterility of the pollen was caused by cytogenetic disturbances, characteristic for remote interspecific hybrids. The remote relationship of the crossed species caused considerable and differentiated disturbances in reduction division, mainly male gametes.

The different number of chromosomes caused both by the little degree of homology of chromosomes of both species and ploidy level of sugarbeet plants, used in back-crossing, additionally affected the irregularity of meiosis, pollen fertility and seed setting.

The crossing of male sterile plants with sugarbeet O type line did not lead to fixing the pollen sterility in the progeny. All the investigated progenies, after single or twofold crossing with O type plants, had pollen completely or partially fertile. The male sterility in these hybrids was consequently, not caused by the presence of sterile S plasm. It should be reckoned to periodical disturbances of pollen fertility in remote interspecific hybrids. It was not possible to find, as in the case of interspecific hybrids of the Nicotiana genus /Berbeć, 1974/ a plant of mutated cytoplasm.

Different results were obtained in the progeny of the male sterile plant found among the ecotype B.maritima from northern France. As a result of backcrossing with sugarbeet O type plants, male sterile hybrids were obtained which did not show disturbances in fertility. The genotype of O line of the sugarbeet reproduced male sterility in successive generations.

The segregation in F_1, after crossings of CMS plants with the fertile sugarbeet plants /not carrying genes of sterility/ indicate that the sterility is not of monogenic character. The results obtained made it possible to state that cytoplasmic-genic male sterility occurs in these hybrids. This conclusion confirms the cytological investigations of meiosis and pollen and anatomical investigations of the anthers. Genetic background of sterile pollen formation is similar to that in sugarbeet. The hybrids under study exhibited regular microsporogenesis and its sopradic disturbances occurred in the final stage of meiosis. Sporadical occurrence of monads and dyads resulted from a hybrid nature of these plants. The process of meiosis did not affect the sterility of the hybrids. The development of microspores was arrested after PMC release. Pollen grains were sterile, in some plants they were deformed with a thin exine. Pollen degeneration was aaused, as it was found, by disturbances in the debelopment of anthers, mainly of the lining layer /tapetum/, which disintegrated and could not fulfill the trophic functions. Similar phenomena could be observed in male sterile forms of sugarbeet /Artschwager, 1947; Hosokawa and Takeda, 1954;

Oto and Matsumura, 1960; Zajkowska, 1970; Zajkowska and Żużałowa, 1971/.

The hybrids /B.maritima CMS form x sugarbeet O type/ segregated in two generations into sterile and semi-sterile plants. Such a result is not in agreement with the genetic interpretation of inheriting this pattern presented by Owen. The occurrence of semi-sterile plants may have been caused by O type line, which did not transmit 100% of sterility to the progeny. The action of modifier genes can not be ruled out. Such genes may exist in interspecific hybrids. Incomplete transmission of male sterility was found by Coe and Stewart /1977/ in hybrids which resulted from crossing sterile plants of B.maritima from England with sugarbeet O type plants. Gilbert MC Colum /1981/ has found semi-sterile plants in hybrids of male sterile radish /Raphanus sativus/ with Brassica oleracea. These semi-sterile segregants were designated as "restorers". No explanation of the causes of formation of semi-sterile plants has been offered so far.

The cytoplasmic male sterile hybrids obtained by us may be recognized as a new source of male sterility in spite of the fact that the degeneration of pollen proceeds similarly to that of the sugarbeet. The different character of this source of male sterility is determined by the mutated cytoplasm of the wild species of B.maritima combined with a genom of the sugarbeet. It should

be also emphasized that the hybrids have some tolerance to yellows virus /BYV/. It is considered that futher work on these hybrids would be desirable.

Objective 2.

The first successful transmission of resistance to nematodes from the wild species of B.procumbens to cultivated beets was carried out by H.Savitsky /1973,1975/. Speckman and de Bock /1982/, and recently Heijbroek et al. /1983/ reported transmitting a chromosome B.patellaris or B.procumbens to the sugarbeet. The chromosome of wild species was transmitted to successive progenies with an average frequency of 12% /Savitsky, 1975/. Nakamura /1976/ found a higher frequency of transmitting resistance in progenies of two lines of trisomics, on the average 20% of resistant plants.

Nakamura and Tsuchiya /1982/ studied the behavior of B.procumbens chromosome at meiosis. They established that the mean freguency of microspores with an additional chromosome accounted for 41.7%. The percentage was too high to rate the plants resistant to nematodes at tests of trisomic progenies.

In the inital material of trisomics received from the USA in 1973, we found 20% trisomics, of which merely 24% were resistant to nematodes. During the last three years of investigations, most of our trisomic progenies, resulted from interpollination, transmitted resistance to about 20-30% of plants. Sporadically, the transmission

of resistance was higher about 40%.

At meiosis of trisomics, Savitsky /1975/ found trivalent associations between chromosomes of B.procumbens and sugarbeet chromosomes. Nakamura /1975/ and Nakamura and Tsuchiya /1982/ confirmed the occurrence of trivalents in pachytene, supporting thus the hypothesis of the possibility of crossing-over. They established the occurrence of trivalents with a frequency of 1,7% at diakinesis and 1,2% at metaphase.

Savitsky /1976,1978/, in the progeny of resistant trisomics, managed to select three resistant diploid plants with a fragment of B.procumbens. These plants were isolated from 14.000 plants checked. The forth resistant diploid plant, within the same material, was discovered by Yu /1978/. The finding of resistant diploid plants pointed to the conjugation of sugarbeet chromosomes with these of B.procumbens.

The frequency of occurrence of resistant diploid plants in the progeny of trisomics, according to Nakamura /1976/, was low, from 0 to 4,4%. Likewise, we have only sporadically found resistant diploids in the progeny of trisomics. In the last two years, in one trisomic family, No. 61-62, more resistant diploids-up to 10%,were found.

After a single selection in 6 interpollinated diploid plants, transmission of resistance to the progeny amounted to 1,5% and 7%.

Meiosis of resistant diploid plants showed small irregularities /see photos 1-6, Third Yearly Report/. The disturbances reported by H.Savitsky /1978/ at meiosis in resistant diploid plants were brought about by loss of the terminal fragment of the translocated chromosome. The loss of the segment, originating from chromosome B.procumbens, was observed in part of PMC in 12 out of 15 investigated plants. I other PMC, meiosis was regular and the resulting gametes transmitted resistance. Disturbances of this type were not observed in the diploid plants studied by us, and similarly, Yu /1978/ did not observe them in diploid resistant plants selected from Savitsky's trisomics.

Nakamura and Tsuchiya /1977/, and Yu /1978/ assume, that disturbances at meiosis in resistant diploid plants are related to the heteromorphic conjugation of chromosomes, formation of paracentric inversion, which, at subsequent stages of meiosis, lead to the formation of bridges, lagging chromosomes, acentric fragments. As a result of these disturbances, defective gametes in about 25% are produced.

In the material investigated by us, although such disturbances were not observed, some plants were resistant and this trait was transmitted to the progeny in a small degree. This might indicate that the translocation of a small segment of the chromosome of B.procumens took place.

H.Savitsky /1976,1978,1980/ reported that the rate of resistance from diploid plants to the progeny was transmitted in different proportions, both by female /24%/ and male gametes /12%/. Selection carried on in the direction of obtaining a higher transmission rate of resistance was successful. Some diploid lines were obtained which transmitted this trait to the progeny to 100% /H.Savitksy, 1978,1980,1981; McFarlane et al. in press/. Homozygotic diploid lines, established in respect to resistance, crossed with susceptible sugar-beet, transmitted resistance to the progeny in a high rate, even to 100%. The increase of the transmission rate was achieved by selection within a vast hybrid material and multiplication of selected plants, in closely related groups, pair-crossed or self-pollinated.

It may seem that the prospects of breeding resistant varieties, based on the bybrids in question, are very near. The nature of the resistance of these hybrids is based, however, on the reaction of oversensitivity, which requires to consider sceptically this resistance source /Heijbroek et al., 1982/. The attractiveness of root excretions of these hybrids is similar to that of susceptible sugarbeets. Nematode larvae, after penetrating into roots, damage them, cause the formation of necrosis around nematodes. This reaction does not allow a full development of nematodes; it is also harmful to

plants, causing poorer growth and a decrease in crops /McFarlane et al., in press/. Speckan and de Bock /1982/ and Heijbroek et al. /1982/ reported the production of new trisomics, vulgaris-patellaris and vulgaris-procumbens, with chromosome of resistance. These new hybrids may constitute a different genetic material, although the nature of resistance may be similar.

Objective 3.

A. The results obtained in 1983 constitute an essential supplement to the data earlier reported. There is no doubt that field emergence /FE/ significantly influences the final stand of plants / above all, when sowing was made at greater distances/, and at the same time the yield and quality of beet-roots. The results of our experiments, confirmed by other authors, show that field emergence /FE/ largely depends on germination capacity /GC/, which is expressed, as a rule, by a high correlation coefficient, significant for P = 0.01 /Tables 11,12 and 14/. At the same time, however, FE is strongly modified by soil conditions, comprising a large complex of biotic factors /damping-off fungi/ and abiotic/physical and chemical properties, humidity, temperature and cultivation practices/.

As can be seen from Table 10, in 1983, FE was high at Głębokie and relatively low at Polanowice /for series A 67,9% and 37%, respectively/, in 1982, the FE at Polanowice

was the highest, although the experiments were carried out in the same field, which proves a considerably modifying influence of weather factors /humidity and temperature/.

Thus, from the point of view of breeding and seed production, the greatest emphasis should be put on obtaining the highest GC, whereas the maximum approximation of FE to GC is, in the highest degree, dependent on factors generally defined as agro-ecological.

Although the correlation relationship FE:GC is very high, yet the analysis of long-term data, concerning the relative emergence /RE=FE:GC/, makes it possible to assume that to some extent, it is dependant, among others, on the degree of ploidy /Table 13a/; the result favor the diploid seeds as compared with triploid ones. Pelleting, at least in relation to the kind of pill used in this country, seems to lower not only GC, but also, though to a rather low degree, the RE /Table 13b/. The main influence on RE, however undoubtedly point to soil conditions, which under this year's conditions, modified it for series A within the limits of 0.47 /SHR/Polanowice/ to 0.86 /SOO Głębokie/.

Nevertheless, we do not give up continuing investigations on the methods of laboratory prognostication of FE, assuming that, in some instances, GC may not be a sufficient criterion of quality, as is shown, among others

by the results of Akeson and Widner's investigations /1981/ on sugarbeet seeds of different size. In the reporting year, we concentrated on Akeson and Widner's test /PSCT/. The agreement of PSCT results with FE, expressed by the correlation coefficient, is not better than for GC, but the mean values are closer / on the level of FE for favorable conditions, e.g. IHAR Sandomierz/, and the regression coefficient, PSCT:FE, is higher than GC:FE.

As our long-term investigations on GC, FE and RE have shown, as well as auxilliary vigor test, such as Hiltner's test /HT/ or PSCT, they all do not constitute a sufficient criterion of evaluation of the seed material value. The speed of germination and emergence /estimated, among others, by Pieper's test/, and the initial increase in germ and seedling mass are of essential importance. On account of this, we introduced two new additional parameters, conventionaly defined as "germination speed index" /GS = GE:GC/, and the analogous "laboratory emergence speed index" based on the results of PSCT /LESI=PSCT-21d : PSCT-28d/. The similarly calculated field emergence speed index /= FE-7d : FE-28d /showed minimum differentiation for the particular objects /0.87-0.91, $\bar{x}$ = 0.89/, may be on account of the very considerable modifying influence of the soil conditions and it was omitted.

As can be seen from data in Tables 11 and 12 /series A/ and 15 /series B/, the particular varieties

differ in a high degree with respect to the germination speed index /GSI/. The germination speed index is also influenced by pelleting, at least in respect to the pelleting material used for the tested PN Mono cultivars, but this observation cannot be generalized, because some pelleted seeds germinate very quickly /Jassem, 1983/, which is indicative of major significance of the quality of pellets and conditioning. A distinct influence of favorable conditions of seed production in the south of Europe became evident: seeds of PN $Mono_4$ and $Amnomono_1$ cultivars reproduced in France and Yugoslavia, respectively, germinated faster than those reproduced from the same basic seed in Poland. And curiously enough, the GSI exibited a high correlation with RE, which, if confirmed in futher investigations, might be an essential contribution to the laboratory evaluation of seed material.

Taking advantage of the data obtained in the investigations of series B /Table 14/, we performed an evaluation of the influence of the parental components on the properties of hybrid seed /Table 15/. The data obtained confirm, once more, our earlier observation /Jassem, 1976, 1982/ concerning the possibility of perfectioning seed material of monogerm hybrid varieties through selection of suitable parental components. From among three investigated CMS lines, the best results provided line 81103, and from among pollinators, the majority of diploidal

components from SHR Chodów and Polanowice, while pollinators from SHR Więcławice supplied worse results in this respect. In extreme cases, which may be ascribed to "specific combination value in respect to germination capacity" /Jassem,1980/, GC of the particular diploidal hybrids varied from 55 to 81% / on the average 70.8% /, and the triploidal ones from 53% to 72% /average 60.2%/. The triploidal hybrid seeds showed not only lower GC, but also lower germination speed /GSI/.

B. The investigations show that the extraction of phenolic acids by means of lye solution improves seed germination. The increase of germination capacity is accompanied by a distinct increase of germ mass, which suggests that phenolic acids also inhibit their growth. It was also shown that paralelly with improvement of seed germination, from which phenolic acids had been removed, the proportion of decaying germs increased. These observations suggest that phenolic acids, and probaly their derivatives as well, are of significance as a factor protecting germs against pathogenic micro-organisms.

At the experiment performed, in order to explain the action of seed soaking, an analysis of biochemical changes in the seed, determing in the germ growth, has been carried out. In investigations of this type, it is particularly easy to perceive changes in the activity of different enzymes. An increased enzymatic activity and a germ growth, in combination with seed soaking in lye, has been observed. Faster growth of the germ increases

the nutrient requirements of the developing plant per unit of time. Supplying nutrient components to the pericarp of the seed causes a futher increase in enzymatic activity and a increase in germ mass. The positive results obtained with seeds soaked in lye at the laboratory did not yield satisfactory effects under field conditions. The results are in good agreement with those of other authors. The available reports, dealing with the problem of stimulating germination of the sugarbeet seeds, did not elucidate this problem, since usually different substances, comprising several or mostly single mineral components, had been investigated. These experiments provided varied and ambiguous results, especially under field conditions.

Thus, the results of investigations, presented here, make some progress in this respect. We succeded in developing multicomponent mineral preparations and methods of their application, virtually improving the germination energy of seeds, field emergence, vigor and plant population. These are the factors which condition to a notable degree the success of sowing seeds at greater distances.

VII. CONCLUSIONS

Objective 1.

1. The male sterility observed in some interspecific vulgaris-corolliflora hybrids in B_3-B_4 generations was caused by the lack of meiotic divisions and notable disturbances in the development of mocrpspores. No progenies, which would transmit pollen male sterility after crossing with sugarbeet O type line, were received. The male sterility of these hybrids was not conditioned by S plasm, but rather with periodical disturbances in pollen viability occurring in remote interspecific hybrids.

2. The male sterility in maritima-vulgaris hybrids is caused by both cytoplasm and genes. The line genotype of the sugarbeet transferred pollen sterility to successive generations.

3. The male sterile hybrids with B.maritima constitute a new source of CMS. Sterile S plasm was incorporated into these hybrids with sugarbeet genom.

Objective 2.

1. The plants resistant to beet nematodes were most freguently trisomics.

2. A small number of diploid resistant plants to nematodes transmitted resistance at a low percentage /from 1.5 to 7.0%/.

3. The prospects of utilizing vulgaris-procumbens resistant disomics are not big, if there are at all, due to the nature of resistance i.e.oversensitivity of the damaged tissues by larvae.

Objective 3.

A. The results of experiments carried out in 1983 made it possible to formulate conclusions confirming or supplementing conclusions presented in previous Yearly Reports.

1. Field emergence capacity /FE/ is dependent, above all, on germination capacity /GC/ and the conditions of the soil habitat, the variability of which is expressed by the value of the emergence index /relative emergence/. A little modifying influence on RE may also be exerted by the degree of seed ploidy /2x>3x/ and method of processing the seed material /conditioning,pelleting/. The speed and germination capacity are, in addition, modified by conditions of field seed-production. Akeson and Widner's test /packed - sand - cool test, PSCT/, confirmed its suitibility for prognostcating FE.

2. Besides GC and FE, i.e.parameters defining numerically the number of germinated and emerged seeds, a vital parameter is the speed of development of germs and seedlings. A new parameter was suggested conventionally defined by us as "germination speed index" /GSI = GC-4d : GC-14d/ and inclusion into seed evaluation the weight of 100 germs.

3. Heritability of a set of characteristics conditioning the quality of seeds, if it exists at all, has not been established /see Report 1982/, but frequently the occurrence of „a general and specific combining ability" concerning germination capacity may be found, thus it may be possible to improve this trait by a proper selection of parental components / CMS lines and pollinators/.

B. 1. The soaking of seeds in lye solution increases enzymatic activity and germ growth.

2. By supplying nutrient components to the pericarp of leached seeds, a futher increase in enzymatic activity and germ growth is achieved.

3. Leaching and soaking seeds in water does not influence significantly the improvement of field emergence, yield of roots and their quality.

4. The application of the complex of microcomponent mineral preparations on the pericarp of the seeds in the form of spray or dust mixed with a fungicide improves the germination energy, field emergence, seedling growth, plant population, root yield and their quality. Leaching followed by spraying or dusting with mineral preparation gaved best results.

5. Leaching and treating the sugarbeet seeds with mineral components conditions to a notable degree the success of sowing beet seeds at greater distances.

List of papers prepared for publication.

1. Dalke, L., Szota, M. Attempt to utilize cytoplasmic male sterility of B.maritima in sugarbeet breeding program.
2. Jassem, M., Burduk, T. 1981. Laboratoryjna i polowa ocena nasion buraków cukrowych. /Laboratory and field evaluation of sugarbeet seed/. Ref. : Seminar IHAR-HBC, 1981.
3. Jassem, M. 1981. Untersuchungen zur Ausnutzung verschiedener Methoden der Laborsaatgutprüfung zur Voraussage der Feldaufgang.Ref.Rada Hod.PRL-NRD,Kleinwanzleben, NRD,14.07.1981.
4. Jassem,M.1982.Influence of Parental Components on Hybrid Seed Qualities in Sugarbeet.IIRB Breeding and Genetics Study Group Meeting,Zaragossa. 7-8.09.1982.
5. Jassem,M.1983. Einschätzen des pillirten Zuckerrübensaatgutes veschiedener Herkunft. Ref. Rada Hod. PRL- NRD, Chodów,19.07,1983.
6. Pawelska,K.,Szota,M. Investigations into the resistance of vulgaris- procumbens hybrids against sugarbeet nematode / Heterodera schachtii Schm./.

Table 1.

Results of testing resistance to beet nematodes in the progenies of diploid and trisomics in F_2 generation.

Number of mother plants	Number of chromosoms	Number of tested plants	Number of resistant plants	Percent of resistant plants
1	18	116	2	1.7
2	18	213	1	0.5
3	18	89	2	2.2
4	18	174	4	2.3
5	18	101	6	5.9
6	18	117	4	3.4
61	19	45	10	20.2
62	19	86	28	32.6

Table 2.

Results of testing resistance to nematodes in the progenies of trisomics pair-crossed in F_2 generation.

Progeny No.	Number of tested plants	Number of resistant plants	In %
8	1	-	-
20	9	-	-
21	111	1	0.9
22	2	-	-
23	39	-	-
49	2	-	-
72	121	49	40.5
73	108	29	26.8
327	51	7	13.7

Table 3.

Results of testing resistance to nematodes in trisomic progenies of F 3 generation.

Family No.	Number of progenies	Number of tested plants	Number of resistant plants	In %
21	59	81	-	-
21	60	229	-	-
72	9	192	-	-
72	6	80	6	7
72	10	119	12	10
72	5	35	5	14
72	48	109	20	18
72	43	173	31	18
72	37	125	24	19
72	47	232	47	20
72	38	177	40	22
72	44	41	10	24
72	15	170	41	24
73	66	33	-	-
73	91	178	3	1.7
73	17	27	7	26
73	21	24	7	29
trisomic x sugar beet	16	73	1	1.4
Total	626	2098	254	

Table 4.

Results of testing resistance to nematodes in the progenies of resistant plants F 1 generation multiplied in groups.

Groups	Number of tested progenies	Number of tested plants	Number of resistant plants	In %
I. with 19 chromosomes	8	84	25	29.7
II. with 18 chromosomes	13	1142	17	1.5
III. with 18 or 19 chromosomes	11	707	161	22.8

Table 5.

Results of testing resistance to beet nematodes in progenies multiplied in groups, after twofold selections / F_2 /.

Items	Number of progenies	Number of tested plants	Percent of resistant plants
I. Progeny of trisomic plants	1	41	no resistant plants
II. Progenies of diploid partly resistant plants	3	114	no resistant plants
	2	159	progenies of resistant plants sharing from 1 to 1,8%
III. Progenies of trisomic and diploid plants	3	60	no resistant plant
	6	618	progenies of resistant plants sharing from 11 to 20%
	2	276	progenies of resistant plants sharing from 21 to 30%
	1	83	progenies of resistant plants above 30% /31,5%/

Table 6.

The results of testing resistance to nematodes in 33 progenies of two families /72 and 73/ in F_3 generation.

Items	Number of progenies	Number of tested plants
Progenies without resistant plants	2	5
Progenies of resistant plants sharing from 1 - 10%	2	139
Progenies of resistant plants sharing from 11-20%	14	1063
Progenies of resistant plants sharing from 21-30%	9	742
Progenies of resistant plants sharing from 31-40%	5	548
Progenies of resistant plants sharing from 41-50%	1	2
Total	33	2.499

Table 7.

Results of testing resistance to nematodes in 110 progenies from 29 families in 4 generation.

Family No.	Number of progenies	Number of plants tested	In %
2/3	13	197	31
2/8	2	64	15
2/9	1	94	32
2/10	5	82	5
2/11	1	17	17
2/12	2	134	22
4/8	1	10	40
5/10	2	29	45
8/15	2	55	27
9/17	2	19	16
9/18	1	19	16
19/38	6	142	26
21/41	3	44	38
23/46	2	35	28
24/47	3	44	20
29/58	2	29	38
12/23	5	201	28
12/24	2	15	33
20/39	4	138	19
20/40	7	274	23
22/43	15	522	22
73/15	3	39	31
73/20	4	107	27
5/78	5	178	31
3/24	1	10	10
25/19	7	114	30
25/66	4	78	22
26/68	2	29	10
26/151	3	24	25
Total	110	2743	

Table 8.

Results of testing resistance to beet nematodes in F_3 and F_4 generations.

Family No		Progenies							
		No resistant plants	Percent of resistant plants ranging from - to					Total number of progenies	Number of tested plants
			1-10%	11-20%	21-30%	31-40%	41-50%		
61/62	Number of progenies	-	-	3	5	3	2	13	
	Number of plants	-	-	154	170	327	129		780
38/80	Number of progenies	1	2	7	12	6	2	30	
	Number of plants	9	103	568	1091	487	51		2309
43/80	Number of progenies	-	-	1	1	-	-	2	
	Number of plants	-	-	63	10	-	-		73
47/80	Number of progenies	2	1	1	3	-	1	8	
	Number of plants	9	21	9	259	-	17		315
48/80	Number of progenies	-	-	1	-	-	-	1	
	Number of plants	-	-	14	-	-	-		14

Table 9.

Results of testing resistance to beet nematodes in the progenies of diploid plants - 1983.

Number of mother plant	Number of tested plants	Percent of resistant plants after single infection with larvae.	Percent of resistant plants after twofold infection with larvae.
9	209	24	2.9
45	136	6	1.47
85	149	27	5.37
154	184	18	2.7
156	159	18	3.1
1313	110	57	7.3

Table 10.
Main soil properties, weather conditions, and field emergence.

No.of local.	Locality	Soil type	Soil class	Planting date	Beginn. of emergence
1	Polanowice	black turf soil	II	2.05	13.05
2	Nawra	brown soil	IIIa	5.05	15.05
3	Sandomierz	black humic soil	II	4.05	19.05
4	Chrząstowo	brown soil	IIIa	29.04	11.05
5	Głębokie	black turf soil	IIIa	21.04	6.05
6	Głogowa	brown soil	IIIa	23.04	5.05

contd.

No.of local	Mean air temperature °C				Precipitation - mm			
	1	2	3	4	1	2	3	4
1	3.4	3.3	7.9	7.4	7.8	11.8	12.7	3.7
2	- 1.9	3.8	5.7	8.0	5.1	31.6	5.2	5.2
3	7.2	6.9	12.1	10.5	34.1	22.0	0.2	9.8
4	9.2	11.7	17.7	16.3	9.5	15.6	2.9	39.7
5	7.8	15.1	12.1	19.0	6.2	5.4	12.5	12.9
6	7.0	13.8	12.0	17.2	2.1	11.6	31.9	

Mean temperatures and total precipitation cover four decades /1....4/, beginning of first decade prior to sowing date, loc. 1,2,3- at ground surface, loc.4,5,6- at 2 m hight

contd.

No.of local	Mean field emergence			
	Series A		Series B	
	7 days	28 days	7 days	28 days
1	32.5	37.6	38.9	44.5
2	33.6	42.0	31.5	41.2
3	47.6	49.4	60.7	61.5
4	45.5	51.3	-	-
5	62.9	67.9	-	-
6	62.2	52.9	-	-

Table 11.

Official variety trials; germination capacity and field emergence.

Series A, 1982

No.	Cultivar	Germination capacity - %			Field emergence - %		
		4d.	14d.	2:3	7d.	28d.	Rel./6:3/
	1	2	3	4	5	6	7
1	PN Mono 1	59	93	0.63	64.8	57.4	0.62
2	PN Mono 1 /ot./	5	82	0.06	41.5	45.3	0.55
3	PN Mono 3	63	89	0.71	59.5	63.5	0.71
4	PN Mono 3 /ot./	49	87	0.56	53.0	55.8	0.64
5	PN Mono 4	38	84	0.45	46.3	49.1	0.58
6	PN Mono 4 /ot./	0	81	0.00	39.6	41.4	0.51
7	Annomono 1	47	84	0.56	53.8	55.7	0.66
8	WIA 3	17	81	0.21	52.5	54.3	0.67
9	SAA 281	16	72	0.22	37.2	40.0	0.56
10	PS Mono 3	57	87	0.66	58.6	61.0	0.70
11	AL Trimono	48	86	0.56	54.8	56.8	0.66
12	Bulion	24	96	0.25	62.6	65.2	0.68
13	10126	23	77	0.30	50.3	53.8	0.70
14	10143	20	86	0.23	56.3	59.4	0.69
	$\bar{x}$	33.3	84.6	0.39	52.2	54.9	0.64

Correlation coefficients :

GC - 4d : FE - 7d = 0.6942^{xxxx}

GC - 4d : FE -28d = 0.6399^{xxx}

GC -14d : FE - 7d = 0.8380^{xxxx}

GC -14d : FE -28d = 0.7791^{xxxx}

Table 12.

Ici 1 variety trials germination capacity, vigor and field emergence. Series A., 1983.

No.	Cultivar	GC - %		Vigor				FE - %		Rel. emergence
		4d.	14d.	2:3	Weight of 100 germs/g	HT 40%	PSCT	7d.	28d.	
	1	2	3	4	5	6	7	8	9	10
1	PN Mono 1	52	93	0.56	3.01	81	76	56.4	59.5	0.64
2	PN Mono 1 /pel./	32	84	0.38	1.77	68	14	45.8	49.2	0.59
3	PN Mono 3	59	84	0.70	2.85	73	30	43.2	48.5	0.58
4	PN Mono 4	52	93	0.56	3.39	88	64	50.8	53.8	0.58
5	PN Mono 4 /pel./	14	82	0.17	1.56	73	6	46.9	48.2	0.59
6	PN Mono 4 reproduced in France	66	89	0.74	3.69	81	70	55.8	56.5	0.63
7	Annomono 1	45	87	0.52	3.44	92	66	53.2	55.3	0.64
8	PS Mono 3	23	76	0.30	2.28	73	38	43.2	47.2	0.62
9	WIA 181	53	80	0.66	3.14	79	58	50.1	52.6	0.66
10	SAA 281	43	73	0.59	3.41	65	30	43.4	47.3	0.65
11	SAA 382	47	79	0.59	3.86	77	28	45.2	47.4	0.60
12	CHA 181	51	83	0.61	3.05	85	44	47.3	50.2	0.60
13	CHA 482	14	41	0.34	2.53	32	26	27.4	31.1	0.76
14	Kawepura	86	93	0.92	3.29	88	58	48.0	51.3	0.55
15	10126	35	70	0.50	2.69	72	36	47.0	48.6	0.69
16	10143	36	70	0.51	3.38	66	46	45.8	48.5	0.69
17	11109	48	76	0.63	3.12	71	52	54.1	55.5	0.73
18	Annomono 1 reproduced in Yugoslavia	66	76	0.87	3.10	74	56	49.2	52.9	0.70

Correlation coefficient

GC - 4d : FE - 7d 0.5965^{xxxx} GC-14d : FE - 7d 0.8367^{xxxx} HT-40%: FE-28d = 0.8426^{xxxx}

GC - 4d : FE- 28d 0.5885^{xxx} GC-14d : FE -28d 0.8430^{xxxx} PSCT : FE-28d = 0.6751^{xxxx}

Table 13a. Official variety trials - relative emergence of 2x and 3x seeds /unpelleted/.

	'76	'77	'78	'79	'80	'81	'82	'83	$\bar{x}$ /exd. '77/
PN Mono 1	0.39	0.44	0.52	0.50	0.70	0.61	0.62	0.64	0.57
PN Mono 3	0.38	-	0.61	0.51	0.69	0.63	0.71	0.58	0.59
PN Mono 5	0.48	0.44	-	-	-	-	-	-	-
x̄ 2x	0.42	0.44	0.57	0.51	0.70	0.62	0.67	0.61	0.58
PN Mono 2	0.45	0.46	0.45	0.36	0.65	-	-	-	-
PN Mono 4	0.42	0.48	0.50	0.42	0.67	0.58	0.58	0.58	0.54
x̄ 3x	0.44	0.47	0.48	0.39	0.66	0.58	0.58	0.58	0.54

Table 13b. Official variety trials - relative emergence of pelleted and unpelleted seeds.

Year	PN Mono 1		PN Mono 3		PN Mono 4	
	Unpelleted	Pelleted	Unpelleted	Pelleted	Unpelleted	Pelleted
982	0.62	0.55	0.71	0.64	0.58	0.51
983	0.64	0.59	0.58	-	0.58	0.59
x̄	0.63	0.57	-	-	0.58	0.55

Table 14.

Germination capacity and emergence in packed-sand cool test and in the field.

Series B., 1983 2x and 3x hybrids

No.	Desi-gna-tion	Parental component		GC-%		PSCT-%		FE-%	
		CMS	Polin.	4d.	14d.	21d.	28d.	7d.	28d.
	1	2	3	4	5	6	7	8	9
1	12101	81101	Wi-CPN	16	78	35.5	55.0	39.5	46.5
2	12102	102		15	56	44.5	67.5	40.6	49.1
3	12103	103	2x	16	65	62.5	72.0	48.5	55.3
4	12105	101		18	76	40.5	50.0	42.6	47.1
5	12106	102	Wi-CK4	14	55	43.5	63.0	41.4	48.9
6	12107	103	2x	17	71	37.0	60.0	44.3	48.3
7	12109	101		31	64	42.0	58.5	46.0	50.9
8	12110	102	Wi-CK14	41	76	47.5	67.0	41.9	47.4
9	12111	103	2x	36	81	47.5	66.5	47.0	54.1
10	12113	101		59	72	54.5	69.0	44.7	50.5
11	12114	102	Ch N	28	56	51.0	67.0	46.4	52.0
12	12115	103	2x	41	77	50.5	61.5	47.3	54.6
13	12117	101		34	72	44.0	64.5	50.5	55.2
14	12118	102	Ch CN	51	65	60.0	71.5	44.8	50.7
15	12119	103	2x	62	77	44.0	58.0	48.0	53.7
16	12121	101		64	77	43.0	61.5	45.2	52.7
17	12122	102	Ch CI	42	66	42.5	61.5	46.0	52.4
18	12123	103	2x	61	77	65.0	76.5	49.3	54.8
19	12125	101		58	73	38.5	57.0	47.6	52.9
20	12126	102	Ch CII	50	74	56.0	65.5	44.5	51.3
21	12127	103	2x	59	71	31.0	50.5	51.6	53.7
22	12129	101		65	79	52.5	65.0	44.9	50.2
23	12130	102	Po RR	42	66	42.5	59.5	45.5	50.4
24	12131	103	2x	62	76	39.0	61.0	47.8	55.9
25	12201	101		16	54	32.0	48.5	38.8	44.0
26	12202	102	Wi PCK	10	66	44.5	56.5	36.9	40.5
27	12203	103	4x	10	63	37.5	53.0	36.7	41.0
28	12205	101		15	48	43.5	53.5	33.5	39.8
29	12206	102	Ch N	17	72	27.0	46.0	33.8	38.1
30	12207	103	4x	28	69	50.5	67.5	49.5	54.4
31	12213	101		12	55	30.5	47.5	36.5	43.7
32	12214	102	Ch C	12	62	45.0	54.5	37.2	42.5
33	12215	103	4x	11	53	59.0	72.5	44.0	48.7
		$\bar{x}$		33.7	65.6	45.0	61.0	44.7	49.4

	Correlation coefficient	Regresion coefficient
GC - 4d : FE	0.4459^{xxx}	0.2481
GC- 14d : FE	0.6535^{xxxx}	0.1659
PSCT-21d :FE	0.4534^{xxx}	0.3919
PSCT-28d :FE	0.6124^{xxxx}	0.2449

Table 15.

Germination capacity and emergence in packed - sand coll test and in the field. Series B, 1983. 2x and 3x hybrids.

a/ progeny of individual CMS lines

No.	CMS line / Pollinator	GC - % 4d.	GC - % 14d.	2:3	PSCT % 21d.	PSCT % 28d.	5:6	FE 7d.	FE 28d.	Rel. emergence / 9 : 3/
	1	2	3	4	5	6	7	8	9	10
1	81101	35.3	68.0	0.52	41.3	57.3	0.72	42.7	48.5	0.71
2	81102	29.3	64.9	0.45	45.8	61.8	0.74	41.7	47.6	0.73
3	81103	36.6	70.9	0.52	47.6	63.5	0.75	46.7	52.2	0.74
	b/ progeny of individual pollinators									
1	Wi-CPN-2x	15.7	66.3	0.24	47.5	64.8	0.73	42.9	50.2	0.76
2	Wi-CK-4-2x	16.3	67.3	0.24	40.3	57.7	0.70	42.8	48.1	0.71
3	Wi-CK-14-2x	36.0	73.7	0.49	45.7	64.0	0.71	45.0	50.8	0.69
4	Ch N-2x	42.7	68.3	0.63	52.0	65.8	0.79	46.1	52.4	0.77
5	Ch CN-2x	49.0	71.3	0.69	49.3	64.7	0.76	47.8	53.2	0.75
6	Ch CN-2x	55.7	73.3	0.76	50.2	56.5	0.75	46.8	53.3	0.73
7	Ch CII -2x	55.7	72.7	0.77	41.8	57.7	0.72	47.9	52.6	0.72
8	Po R+R+-2x	56.3	73.7	0.76	44.7	61.8	0.72	46.1	52.2	0.71
	$\bar{x}$	40.9	70.8	0.57	46.4	62.9	0.74	45.7	51.6	0.73
9	Wi PCK-4x	12.0	61.0	0.20	38.0	52.7	0.72	37.5	41.8	0.69
0	Ch N - 4x	20.0	63.0	0.32	40.3	55.7	0.72	38.9	44.1	0.70
1	Ch C - 4x	11.7	56.7	0.21	44.8	58.2	0.77	39.2	45.0	0.79
	$\bar{x}$ 3x	14.6	60.2	0.24	41.0	55.5	0.74	38.5	43.6	0.73

orrelation coefficient

1/ 4 : 10 = - 0.188 2/ 7 : 10 = 0.8300

Table 8.

Seeding value and enzymatic activity in germs /5 days, 20°C/ of sugarbeet seeds soaked in solutions of different chemical compounds / Bydgoszcz, 1980/.

Variants	Time of germination 5 days, 20°C		Lab. germ. capacity	Activity											
				Ribonucleases				Preteolithic				Amylolithic			
				Per 1g of dry mass		Per 100 germs		Per 1g of dry mass		Per 100 germs		Per 1g of dry mass		Per 100 germs	
	Av. length of germs in cm.	Increase of dry matter in germs in %		In units of activity x/	In %	In units of activity	In %	In units of activity	In %	In units of activity	In %	In mg of glucose	In %	In mg of glucose	In %
Control	2.94	18.75	85	13.4	100.0	2349	100.0	1044	100.0	178.8	100.0	61.3	100.0	10.5	100.0
Seeds soaked in lye	4.54	35.78	88	15.7	116.9	3264	138.9	1198	114.8	233.9	130.8	94.5	154.3	18.4	175.9
Seeds soaked in lye and multicomponent mineral solution	5.07	47.98	87	17.3	128.5	3912	160.5	1287	123.2	279.2	156.2	98.0	159.9	20.9	198.9

x/ Unit of activity equals to the amount of enzyme which increases the extinction by 0.01.

Table 17.

Influence of soaking sugarbeet seeds in different chemical solutions on yield and technological value of roots - 1980.

Variants	Field emergence capacity	Mass of 100 seedlings at singling in g	Yield t/ha			Sugar content %	mval/100 g of pulp		
			Roots	Tops	Sugar		K	Na	$N - NH_2$
Control	64.1	99.9	35.9	47.4	4.50	14.63	4.76	1,29	1.65
Seeds soaked in water	67.5	101.4	36.3	48.7	4.55	14.76	4.76	1.29	1.82
Seeds soaked in lye	67.1	102.4	37.2	49.4	4.65	14.83	4.71	1.29	1.83
Seeds leached + 0.7% multicomponent mineral solution-D4	72.9	116.9	40.5	50.8	5.30	15.21	4.62	0.92	1.89
Seeds leached + 0.7% multicomponent mineral solution-D11	75.7	134.1	41.6	55.5	5.45	15.38	4.48	0.86	1.91
LSD p= 0.05	3.5	6.0	2.1	3.8	0.39	0.26	0.22	0.19	0.20

Table 10.

The influence of seed conditioning on the yield of technological value of sugar beets - 1981.

Variants	Field emergence capacity		Mass of 100 plants at 6-8 leaf stage in kg	Yield t/ha			Sugar content in %	mval/100g of pulp		
	After 16 days	After 30 days		Roots	Tops	Sugar		K	Na	$N-NH_2$
Control	43	64	29.2	41.2	52.6	6.23	15.60	4.42	0.41	2.94
Seeds soaked in water	54	68	29.5	44.5	55.7	6.82	15.82	4.38	0.42	3.09
Seeds leached + multicomponent mineral solution-D 11	59	76	30.5	46.5	56.2	7.20	15.90	4.22	0.40	3.26
Seeds leached + multicomponent mineral solution-D 19	61	79	34.2	48.2	58.7	7.49	16.02	4.18	0.38	3.31
Mineral preparation D 19 mixed with fungicide, applied dry	63	81	35.5	48.9	59.2	7.69	16.21	4.12	0.38	3.34
LSD p= 0.05	5.4	4.5	3.7	1.9	3.6	0.27	0.15	0.15	0.09	0.09

Table 62.

Influence of seeds conditioning on root yield and its technological quality - 1982.

Variants	Germination energy after 5 days in %		Laboratory emergence capacity in %	Field emergence in %	Increase of seedling mass in 4 leaf stage in %	Plant population th/ha	Yield t/ha		
	Av.length of germs in cm	No.ef germs above 1,5 cm long					Roots	Tops	Sugar
Control	4.03	69	86	53	100.0	48.0	56.2	35.8	9.40
Spray of seeds with D 19 + fungicide used dry	4.52	78	92	68	114.8	68.1	62.5	37.9	10.30
Preparation D 19 mixed with fungicide, used dry	4.49	78	91	68	115.2	67.8	62.7	37.3	10.33
Seeds leached + seeds spray with D 19 + fungicide used dry	7.36	88	92	71	125.9	73.1	66.3	38.2	10.99
Seeds leached + D 19 mixed with fungicide, used dry	7.53	89	93	71	120.4	72.7	65.5	40.4	10.93
Seeds leached + spray with preparation D 25 + fungicide, used dry	7.42	91	93	73	126.8	75.4	63.5	39.6	10.49
Seeds leached + preparation D 25 mixed with fungicide, used dry	8.15	91	93	73	122.4	74.6	63.8	37.5	10.62
LSD p= 0.05	-	-	-	2.5	-	3.1	3.9	5.3	0.36

Table 20.

Influence of seeds conditioning on root yield and its technological quality - 1983.

Variants	Germination energy after 4 days in %		Laboratory emergence capacity in %	Field emergence in %	Increase of seedling mass in 4 leaf stage in %	Plant population th/ha	Yield t/ha		
	Av.length of germs in cm	No.of germs above 1,5 cm long					Roots	Tops	Sugar
Control	2.09	37	88	34	100.0	49.9	46.1	24.4	5.91
Spray of seeds with D 19 + fungicide used dry	2.35	44	92	63	115.8	70.2	52.6	27.4	7.49
Preparation D 19 mixed with fungicide, used dry	2.38	44	92	62	112.6	69.4	50.6	27.4	7.32
Seeds leached + seeds spray with D 19 + fungicide used dry	2.95	69	92	65	124.2	72.3	53.2	27.4	7.78
Seeds leached + D 19 mixed with fungicide, used dry	3.02	71	92	67	123.5	73.0	53.6	31.5	7.75
Seeds leached + spray with preparation D 25 + fungicide, used dry	2.96	69	92	62	120.3	72.6	50.6	30.2	7.12
Seeds leached + preparation D 25 mixed with fungicide, used dry	3.05	70	92	64	123.3	73.1	48.5	29.6	6.95
LSD p = 0.05	0.16	3.4	-	6.2	-	6.4	4.2	4.3	0.67

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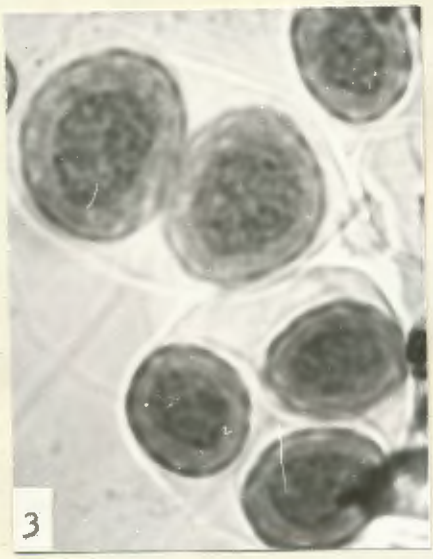
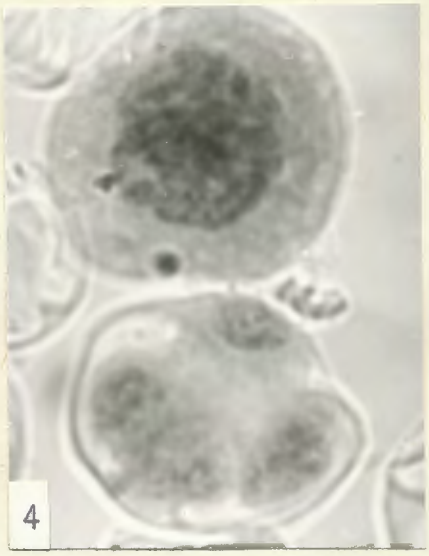
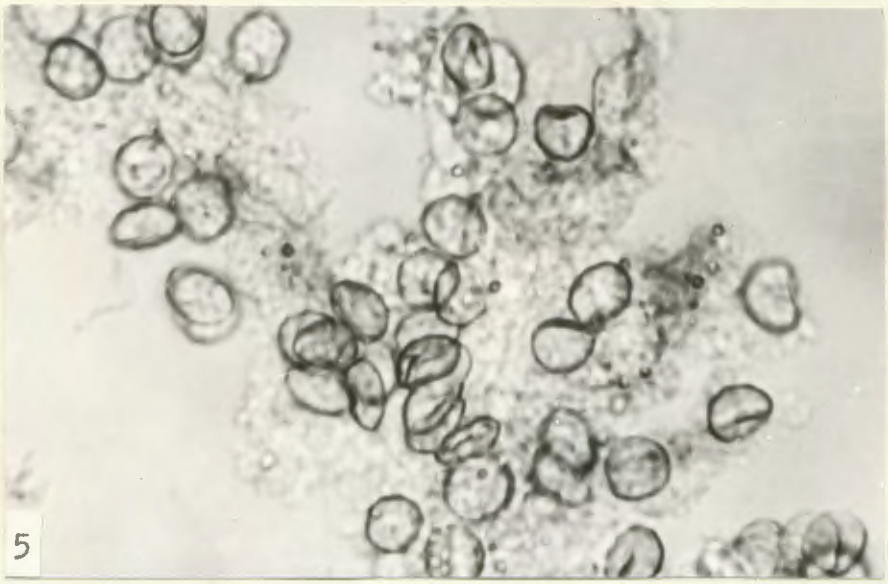
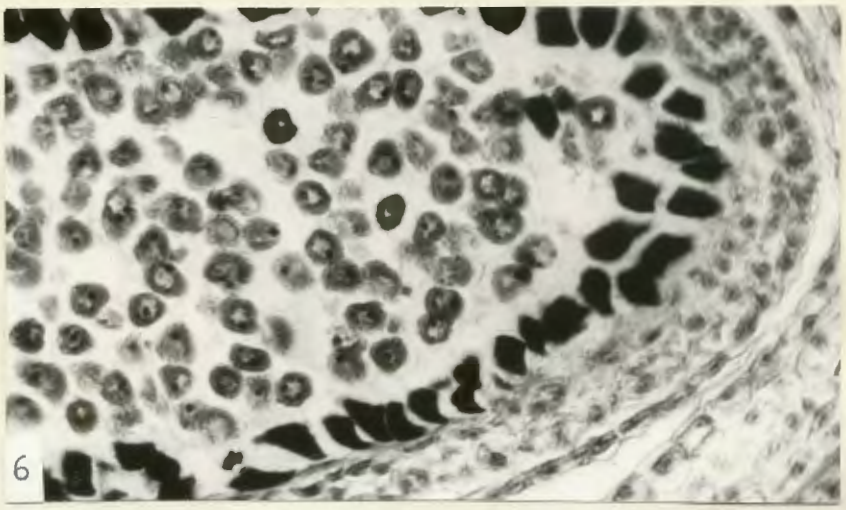
Fig.1. Leaves of male sterile B.maritima x sugar beet O line hybrids /right/ and one of B.maritima /left/
Fig.2. The roots of male sterile B.maritima x sugar beet O line hybrids /

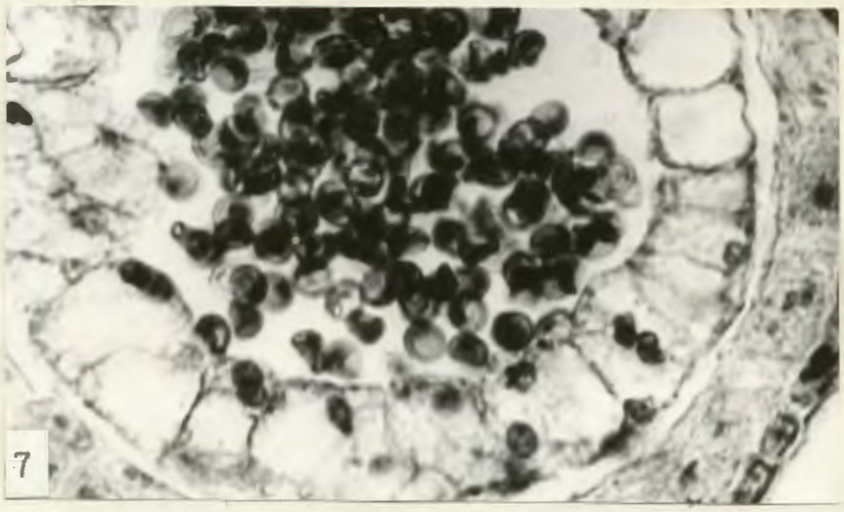


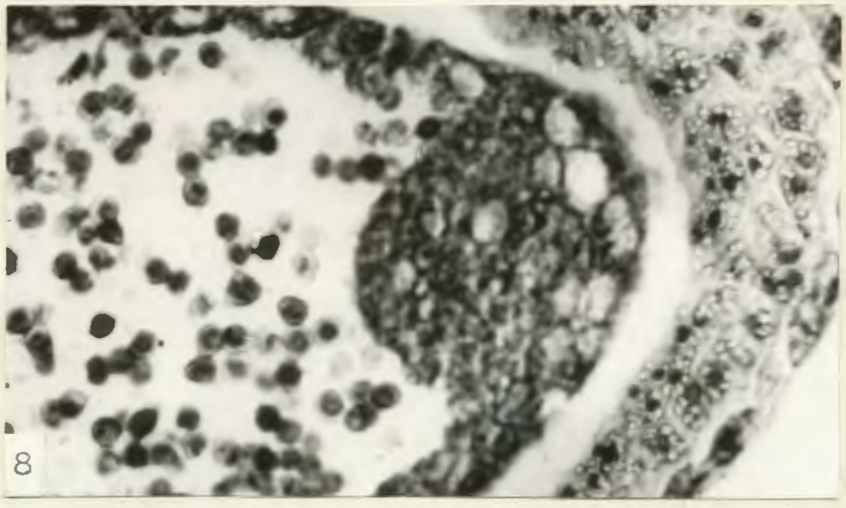




Meiosis of CMS B.maritima x sugar beet O line hybrids
Fig.3. Dyad
Fig.4. Monad
Fig.5. Deformed and sterile pollen







The anthers of CMS B.maritima x sugar beet O line
Fig.6. Prematuraly degenerating tapetum
Fig.7. Cellular tapetum with oversized vacuoles
Fig.8. Plasmodial tapetum