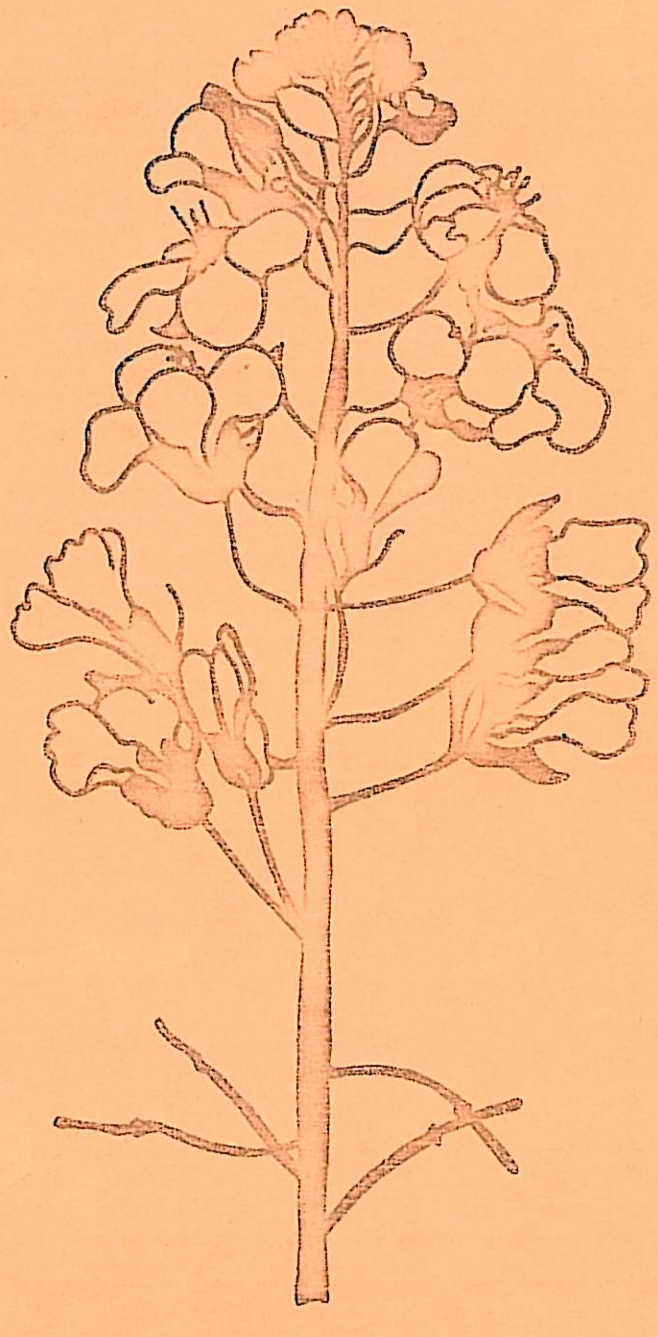
CRUCIFERAE NEWSLETTER No. 3



November 1978

EUCARPIA

Editorial

The previous edition of Cruciferae Newsletter appears to have been well received and since there has been a good response to the request for contributions to this one, the Newsletter appears to be well and truly launched. A continuing flow of contributions will ensure that it stays afloat.

The editors welcome the accounts of the ways in which cruciferous crops are grown and used, including the choice of varieties, and of local or national research programmes. In order to present a global picture of crucifers in agriculture readers are asked to assist by sending details of local work in areas not yet represented such as Eastern Europe, China, Taiwan and parts of South America. As the Newsletter may not reach these areas it would be helpful if readers would notify colleagues there of its existence and suggest that they might contribute to the next Newsletter.

The possibility of publishing an annual list of relevant papers is being considered. Readers may like to decide (and then inform the editors) whether this would be a useful service and if they could contribute. Little use is yet being made of the Newsletter as a place to publish requests for seed, appeals for information or suggestions for the exchange of pollen.

While the need for the Newsletter seems now to have been established its future can only be assured if funds are available to meet the costs of publication. At present we are fortunate in receiving financial support from the National Seed Development Organisation, Newton Hall, Newton, Cambridge, U.K. For this the editors wish to thank its Chairman, Mr M.G. Falcon. However this support is only guaranteed until the issue of the next edition and suggestions for financial support after 1979 would be welcome indeed. At present, copies are supplied free of charge (and postage paid) to those who have requested it in advance. For back numbers, which can be provided on request, there is a charge of £1 to cover the cost of photocopying.

Reminders for contributions to Newsletter No. 4 will be dispatched in August or September 1979 but to facilitate the preparation of typescripts notes on the format are included in this issue (see page 64). It is thus possible for you to send your contributions without waiting for the reminder. Please give due attention to instruction No. 3.

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First notice

"CRUCIFERAE 1979"

to be held in Wageningen on 2,3 and 4 October 1979

An Eucarpia Conference on the Breeding of Cruciferous Crops: Fodder- and Green manure crops, Oil crops, Vegetables*

Organized on the initiative of the Vegetable Section of Eucarpia

Organizing committee: Ir. J. Brewer (fa. Sluis en Groot) Ir. H. Ghijsen (fa. Barenbrug), Ir. N.P.A. van Marrewijk (RIVRO), Ir. Q.P. van der Meer (IVT), Ir. H. Toxopeus (SVP)

Executive committee: Ir. N.P.A. van Marrewijk
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Subject matter, general: Common themes in Cruciferous Crop Breeding

The organisers would like to attempt to get researchers on Cruciferous crops closer together, not just for interest's sake, but because of an increasing need to:

- put a stop to continuing genetic erosion
- get a grip on the problem of disease interaction
- obtain a clearer view on the possibilities of the transfer of economic characters from one species to another.

Rather than to invite participants to present papers in general, we propose that papers are submitted within the following subjects, these should be broadly interpreted.

* alphabetical order

Cruciferae 1979 continued

Subjects:

1. Nomenclature - Species concept - History of domestication of crops - Centres of diversity - Germplasm - Collections.

Our feeling is that we ought to be able to get a:

| Cruciferous crops gene bank organization | going

2. Diseases - Disease resistance - Screening methods.

As a result of rapidly growing areas of Oilrape and Fodder and Green manure crops in some major European countries the diseases problem is growing. Basically all Cruciferous crops are host to all known diseases of these crops. Should we not start off a

| Cruciferous crop pests and diseases Association | ?

3. Flowering induction and Mating system

4. Chemical compounds and routine analysis

Specialists will be invited, if available, to review or introduce a subject. Suggestions are welcome indeed.

Those who are not a member of Eucarpia should write to me for a copy of the first circular that will be sent to each member of Eucarpia sections: Fodder Crops, Oil Crops, Vegetables, by the middle of October.

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A BIOLOGICAL ASSESSMENT FOR CLUBROOT DISEASE OF CABBAGE IN BAGHDAD

KAMIL M.N. TAMIMI

Cabbage is an edible winter - vegetable crop. The seeds are usually grown during the first week of September in 1 x 2 - meter - blocks, which are left inside the green-house. Transference of all seedlings to an open field starts in the first week of November. The open field is divided into arrows, the distance between one arrow and the other is 70 - 80 cm, the distance between one seedling and the other is 60 - 80 cm. depending on the type of varieties. Heads reach their full size after 3 - 4 months of plantation; the average yield of cabbage, however, is 8 - 10 Tons/ Acre. The most common varieties are : -

1 - Copenhagen Market.
2 - Golden Acre.
3 - Latefly Raj.
4 - Bronz Week.
5 - A local variety.

To our knowledge, there is no available report in the literature concerning the incidence of clubroot of cabbage in the Republic of Iraq. The object of the present study, however, is the provision of a comprehensive understanding of the occurrence of the clubroot organism *Plasmodiophora brassicae* Wor. in the fields of Cruciferae.

MATERIALS AND METHODS

Baghdad, the Capital of Iraq, has a typical location in the middle of the country between the two main rivers, Tigris and Euphrates.

Five locations within Baghdad vicinity have been taken for this assessment. Five blocks within each station have been screened. Each block was containing fifty individual plants, and the inspection was undertaken for each of them. Each station was containing only one particular variety of cabbage; therefore the total plants which have been taken into consideration was 250 heads/Station. Each plant was inspected for the appearance of clubroot at maturation stage. The incidence of any disease was calculated, using the following equation.

$$\text{Percentage disease} = \frac{\text{Sum of diseased plants}}{\text{Sum of inspected plants}} \times 100$$

The causing agent of clubroot disease that we found was the *Plasmodiophora brassicae* ; the soft rot was *Erwinia carotovora*; the *Fusarium oxysporum* was the main response for

Cabbage - yellows; two species of insects Pieris rapae and P. brassicae were seen as the most common flies on cabbage. The identification of these agents have mostly been done in our laboratory.

RESULTS

Results for two successive years are shown in Table No. 1 and 2 respectively.

Table 1. The presence of clubroot and other diseases of cabbage in the year 1975-1976.

Station No.	Block No.	% of diseases in the field			
		Clubroot	Soft rot	Fusarium	Insects
I (Copenhagen)	1	Nil	2	Nil	2
	2	2	2	4	10
	3	2	4	2	12
	4	Nil	Nil	Nil	2
	5	Nil	Nil	Nil	2
II (Golden Acre)	1	2	2	2	2
	2	2	Nil	Nil	Nil
	3	Nil	2	Nil	10
	4	Nil	Nil	Nil	Nil
	5	Nil	4	8	8
III (late fly)	1	Nil	12	12	20
	2	4	8	8	20
	3	Nil	2	8	14
	4	Nil	4	4	18
	5	Nil	6	14	22
IV (Bronz weak)	1	6	20	6	28
	2	6	6	6	6
	3	6	Nil	4	18
	4	Nil	4	4	18
	5	Nil	12	20	28
V (Local type)	1	2	4	18	32
	2	8	8	6	18
	3	2	8	16	26
	4	2	2	16	26
	5	6	16	8	24

6. DISCUSSION

From the out look to the results of this survey; one could realize the following : -

1 - The first two varieties of cabbage (early ones) are generally more resistant than the other three varieties (late ones).

2 - There is a correlation between the presence of insects and the incidence of other parasitic diseases.

3 - There is a correlation between the presence and absence of clubroot, bacterial soft rot and Fusarial yellows of cabbage.

4 - Generally, the attack of insects as well as the parasitic diseases in 1976 was higher than in 1975 which might be due to some environmental factors such as the acidity of soil, the rainfall and plant nutrition.

5 - This primary investigation, however, will lead us to a further study to obtain a resistant variety to clubroot and bacterial soft rot diseases. Using certain methods such as the ionizing radiation and some chemicals.

Table 2. The presence of clubroot and other diseases of cabbage in the year 1976-1977.

Station No.	Block No.	% of disease in the field			
		Clubroot	Soft rot	Fusarium	Insects
I (Copenhagen)	1	4	2	6	16
	2	Nil	2	2	2
	3	Nil	Nil	12	6
	4	4	2	2	12
	5	2	2	Nil	Nil
II (Golden Acre)	1	2	Nil	Nil	4
	2	Nil	Nil	Nil	2
	3	Nil	2	2	4
	4	Nil	2	Nil	10
	5	Nil	Nil	4	Nil
III (Late fly)	1	8	16	16	28
	2	2	16	16	28
	3	2	12	18	26
	4	4	6	10	16
	5	Nil	2	6	10
IV (Bronz weak)	1	6	12	16	26
	2	8	8	8	26
	3	2	14	18	38
	4	10	10	18	26
	5	Nil	6	16	24
V (Local type)	1	2	12	12	12
	2	16	12	12	22
	3	14	18	16	36
	4	Nil	4	4	2
	5	8	18	22	32

THE INTRODUCTION OF RAPE SEED CULTIVATION IN SPAIN

By Eduardo Sobrino

Initial facts

The choice of rape seed as a new crop to be introduced in Spain, has been motivated by the existence of a deficit in the production of vegetable oils and feed, and stimulated by recent international achievements in rape seed breeding. Some favourable circumstances which can be particularly applied to the Iberian Peninsula are to be taken into account:-

1) The growth cycle of rape seed, when sown in autumn, is satisfactorily co-ordinated with the rainfall peaks of the Mediterranean climate.
2) The present crop rotation in the Spanish dry farming areas needs new species with different requirements than cereals, so that rape seed would be favourably received.
3) The tribe Brassiceae seems to have its origin in the Western Mediterranean area, as judged by the high specific and intraspecific diversity which is there exhibited. This suggests a minimum of adaptation problems.

Strategy for introduction

The introduction is being gradually carried out through the collaboration of a small number of companies and the Instituto de Investigaciones Agrarias.

Low erucic acid and/or low glucosinolate varieties from France, Germany, United Kingdom, Sweden and Canada are being used. Trials of the following experiments have been conducted or are being conducted:-

1) Comparison of different varieties in different Spanish areas.
2) Determination of optimum sowing dates.
3) Fertilizer application, weed control, harvest, and other agricultural problems.
4) Detection and control of pests and diseases.

The presence of different agro-ecological conditions are determining the choice of varieties for each Spanish region. In Castilla la Vieja and other cold areas, the normal winter varieties cultivated in Northern and Central Europe are being used. In Castilla la Nueva cultivated varieties are of either winter or spring type. In Andalucia and other hot regions spring varieties are favoured. Sowing is always in autumn. Although the international experience is certainly useful, the specific climatic and edaphic conditions of Spain strongly suggest that much work is still needed. Special interest is therefore given at present to the study of varieties and sowing dates. In the near future it will be necessary to produce new varieties for specific Spanish areas.

A stage of extensive cultivation has been developed in the past two years. Yields of more than 2000 kg/ha have often been obtained. It is expected that the Central Plateau and the Guadalquivir Valley will become important rape seed production areas in future.

IMPROVEMENT OF INDIAN CAULIFLOWER (BRASSICA OLERACEA L.) VAR. BOTRYTIS L).

S.S. Chatterjee & Vishnu Swarup

Among the Cruciferous vegetables grown in India, both cauliflower and cabbage are very important. These cover nearly 160,000 hectares with a production of about one million metric tonnes (Anon, 1976). However, contrary to other parts of the world, cauliflower is more important in India than cabbage. The major area (to the extent of nearly 50,000 hectares) under this crop is cultivated with heterogenous varieties of Indian cauliflower which are characteristically different from the temperate types. These are highly tolerant to high temperature, rainfall and humidity and also flower and produce seeds under tropical north Indian conditions (Swarup and Chatterjee, 1972).

Cauliflower was introduced in India in 1822 and by 1880 the adapted varieties inadvertantly selected by the growers were found to perform quite well in the early season and before the growing of imported late Snowball varieties (Swarup and Chatterjee, 1972). The Indian cauliflowers were later found to be successfully grown in South-east Asia (Rodrico et al 1935), Middle East (Feldner, 1956), Sri Lanka (Paul, 1933), Hawaii (Gilbert, 1953), Brazil (Camargo, 1956), Florida (Mortensen and Bullard, 1968), West Indies (Wood & Jones, 1936) and other tropical areas. The work done on this crop at the Indian Agricultural Research Institute, New Delhi (India) has established that the Cornish type of winter cauliflower contributed mainly to the development of the Indian types, though Roscoffs, Italians, Northerns, Erfurts etc. in later stages have also been responsible for a greater genetic diversity in this material. It has also been found to retain many useful genes of the Cornish type which has almost gone out of cultivation (Swarup and Chatterjee, 1972).

Improvement work in this heterogenous type was undertaken at the Indian Agricultural Research Institute since 1965 initially by adopting inbreeding which has resulted in the selection of several inbred lines having characteristically different maturity period, morphological and curd quality characters. Inbreeding has also resulted in the selection of an improved high yielding variety Pusa Deepali, resistant to high temperature conditions maturing in middle of October under north Indian conditions. The inbred lines have been utilized in heterosis breeding and synthetics as hybrid vigour has been found to be quite pronounced (Swarup and Chatterjee, 1974), unlike temperate Snowball groups (Haigh, 1960, 1962). In heterosis breeding programe, attempts have been made to select homozygous self-incompatible but cross-compatible lines, male-sterile lines and marker genes. Various heterotic combinations utilizing self-incompatible as well as male-sterile lines are under study. Presently in the absence of a convenient and economical method of hybrid seed-production, a synthetic variety has been released for cultivation.

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SYNTHESIS OF NEW RAPE /Brassica napus L./ GENOTYPES TO OBTAIN OIL AND FODDER FORMS.

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In 1976, the programme of synthesis of new genotypes of Brassica napus L. gained as a result of interspecific crosses between selected forms of B. campestris and B. oleracea species was started.

The practical aim of the work is to obtain B. napus oleiferous forms with favourable fatty acids and oil contents, of a high oilcake fodder value; also fodder rape forms with a high green mass productivity, high protein value and free of toxic compounds. Both forms are at the same time evaluated from the agricultural point of view.

Beside these practical aims, investigations of heredity, of incompatibility and compatibility systems, recognition of the genetical mechanism for recovering fertility in hybrids, and investigations of the pattern of inheritance of some desirable features in the obtained hybrids are being undertaken.

Sensitivity of selected B. napus forms to chemical EMS and NMH agents, as well as to physical, gamma ray mutagens is to be examined as well as frequency of point mutations after treatment and hereditary changes in oil acid composition in the obtained mutants.

Recognizing of the immunogenetic structure of rape --which also comes into the range of problems investigated-- should help to explain the nature of some genetical facts, mainly of the antygene polymorphism range and resistance of the plants against diseases.

For identification of amphidiploids gained on crossing we are using cytological methods; observations of the seed-coat morphology and an attempt at an immunochemical analysis were also carried out.

OIL CROP CULTIVATION IN SWEDEN IN 1978

Gösta Olsson

Both winter and summer types of rape (B. napus) as well as turnip rape (B. campestris) are cultivated in Sweden. White mustard is grown to a very limited extent and poppy and sun-flower are tested as potential new oil crops because of their better oil quality.

The acreages of different oil crops grown in Sweden in 1978, are presented in Table 1. The total acreage, comprising 145.000 ha, exceeds that of 1977 with 25.000 ha, but corresponds fairly well to the average for the past 5 years. Winter rape is grown mainly in southern Sweden, whereas turnip rape and the summer oil crops mainly are grown in northern Götaland and Svealand.

Table 1. Acreages and yields of oil crops in Sweden in 1978.

	Acreage ha	Seed yield kgs/ha 7.5 % water content	% Oil content of dry matter
Winter rape	45.200	2.600	46
Winter turnip rape	13.900	1.900	45
Summer rape	41.400	1.600	44
Summer turnip rape	44.100	1.400	41
White mustard	870	1.100	37
Total	145.470		

The winter rape suffered only slightly from winter damages, whereas 21 per cent of the winter turnip rape was completely destroyed, mainly because the fields were flooded. The germination and early development of the summer rape and the summer turnip rape suffered in many places from drought in April and May, which resulted in an uneven plant density. The further development during the summer was comparatively good, however, bad harvest conditions at the end of August and in the beginning of September have caused some losses. The harvest is not yet completely finished (September 15) and the yield figures for the summer forms are estimations only. As seen from Table 1 winter rape has yielded considerably more than the summer types of rape and turnip rape. The reason for the comparatively large acreage of the summer forms, in spite of their lower yield, is the inadequate winter hardiness of the winter rape within the main cultivation area of the summer types.

The following varieties have been the most commonly grown ones in 1978:

Winter rape: Svalöfs Brink; Winter turnip rape: Svalöfs Rapido III, Svalöfs Solo; Summer rape: Svalöfs Gulliver, Weibulls Olga; Summer turnip rape: CDA Span; White mustard: Svalöfs Trico.

Accepted varieties of winter rape, summer rape and summer turnip rape are only those with a low erucic acid content. This means that basic seed is not allowed to contain more than 1 % and commercial seed not more than 2 % of erucic acid. The erucic acid content in the harvested seed lot is usually somewhat higher because of voluntary seeds from earlier growings of older varieties with high erucic acid contents. The average erucic acid content of the 1978 winter rape yield is 3.5 % and that of summer rape and summer turnip rape below 3 %. The farmers' price for the oil seed is adjusted with regard to purity and content of water, oil, chlorophyll and erucic acid.

BREEDING FOR PIERIS RAPAE, TRICHOPLUSIA NI RESISTANCE IN CABBAGE AND CAULIFLOWER

M. H. Dickson
NYSAES Geneva, New York USA

The cabbage worm Pieris rapae is usually a problem in New York State while in some years the cabbage looper Trichoplusia ni and the diamond back moth Plutella maculipennis are also problems. Until recently chemicals have provided good control. However, new chemicals are not being made available so readily and some of these pests are developing resistance to the available chemicals.

Dr. C. Eckenrode and I have been trying to breed for resistance to these pests in cabbage and cauliflower. We have screened most of the United States' cabbage, broccoli and cauliflower Plant Introductions for resistance and PI 234599, a glossy leaved late cauliflower from Australia, has been highly tolerant to all three pests. In Australia it is resistant to the diamond back but not to the cabbage worm.

We tried screening in the greenhouse with high pest populations of the cabbage worm and looper but found that the greenhouse environment influenced resistance compared to field response. We then tried testing in the field using large cages and high pest populations. Response varied from season to season but also with location in the cage. We now feel that field screening is best with every third row being a susceptible cultivar. In years of light natural infestation it may be necessary to inoculate the check row. We have found that if the field or plot only contains lines with some tolerance and no very susceptible lines then the overall level of infestation is reduced resulting in reduced selection pressure.

Screening is also influenced by light intensity and nitrogen. High N or low light reduce resistance. This has made greenhouse screening in the winter difficult except with the use of high intensity mercury vapour lights providing 4-60,000 lux.

Seed of PI 234599 is available from me or from the U. S. Plant Introduction Service, Beltsville, Maryland.

There are some other late cauliflowers with some tolerance, such as PI 204771 and some variation in cabbage lines. However, after extensive screening of some cabbage selections with intermediate levels of tolerance we feel, after the summer of 1978 which had very high pest population, that only the highest sources of resistance will provide adequate protection. There appears to be some association with the glossy character and resistance but susceptible glossy plants will segregate in the F_2. It has been quite difficult to select non glossy plants with resistance as superior as that of the glossy cauliflower parent. However, progress is being made to develop both cauliflower and cabbage with high levels of tolerance and selections with minimal damage were obtained in a year of high pest populations and where the check rows were very uniformly damaged.

PRODUCTION OF *BRASSICA CAMPESTRIS* HAPLOIDS VIA ANTHER CULTURE

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One of the major objectives of our research is to develop reliable procedures for the production of large numbers of *Brassica* haploids for use in breeding programs. Anther culture has been selected as the best method of achieving this objective. The results of our earlier work has been summarized in Cruciferae Newsletter No. 2 (page 33).

Recently, studies have been initiated to increase the frequency of microspore-derived plants in turnip rape (*Brassica campestris*). Studies with *Brassica napus* (Keller and Armstrong, 1978) had shown that elevated anther culture temperature treatments dramatically stimulated embryogenesis. The optimum treatment involved culture at 30°C for 14 days followed by a transfer to 25°C. Tests with *B. campestris* showed that this treatment did not increase the yield of embryos over that achieved by continuous culture at 25°C. However, it was found that a higher temperature treatment (35°C) for a shorter period (1—3 days) prior to transfer to 25°C significantly increased the frequency of anthers producing embryos. The degree of stimulation was not as great as that achieved with elevated temperature treatments in *B. napus*.

More than 300 anther-derived *B. campestris* plants were regenerated. A large number of plants with small, sterile flowers were observed amongst the anther-derived regenerates. These were cytologically evaluated and were found to be haploid (2n=x=10). In a population derived from F_1 (Torch×R500) anthers, more than 70% of the plants were haploid. The fact that haploids were detected in the present study but not in a previous study (Keller *et al*. 1975) in which the anthers received no elevated temperature treatments might indicate that culture temperature treatments influence the frequency of haploid embryos produced. Similar results were obtained with *B. napus* where haploids were obtained from experiments involving the use of high culture temperature treatments (Keller and Armstrong, 1978) but not in studies in which the anthers were cultured only at 25°C (Keller and Armstrong, 1977).

References:

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14. Estimation and Selection of Dry Matter Content in Swedes.

S. Gowers and D. Barclay.

In an experiment to compare methods of drying core samples of swedes, three oven temperatures (60°C, 80°C and 100°C) were compared with freeze-drying. Four cultivars were used and the cores were reweighed at 24, 48 and 72 hours. It was found that

a) For two cultivars the cores dried at 100°C were heavier at 48 hours than at 24 hours.

b) Drying at 60°C gave results which were not significantly different from freeze-drying. At 80°C some results were significantly lower (p 0.05) and others were not. At 100°C the results were significantly lower, in the range 1% to 1.7% in dry matter percentage (D.M.%).

c) There was a significant interaction between cultivars and drying temperatures (p 0.05).

As the core samples were reweighed at each drying time, the increases recorded were not due to sampling variation. This result remains unexplained, as weighings made since over a period of 8 days showed no changes in weight whilst quite large changes in relative humidity occurred.

If freeze-drying gives the correct results, using 100°C would lead to an underestimation of the value of the swede crop. The method of core sampling could also affect the true value, as Dyson (1977) considers cores can underestimate the D.M.% by up to 1%. As core samples dried at 100°C are used in most trials, e.g. U.K. National List trials, these two factors combined could lead to estimates of D.M. yield of swedes being 20 - 25% lower than their true value.

The interaction factor will lead to the under-estimates of D.M.% being greater for some cultivars than for others. This could give ranking differences between different drying regimes both for D.M.% and dry matter yield. Although of importance for evaluating cultivars, this factor is especially important in breeding, particularly when selecting for high D.M.%.

Work aimed at high D.M.% in swedes has been concentrated on inbreeding with selection from high D.M.% cultivars. Although in general there is a negative correlation between D.M.% and fresh weight yield, it was not significant in five of the ten cultivars examined at the start of the programme. From the first generation of selection one line from Bangholm Wilby was outstanding. In trial in 1977 it had a D.M.% of 14% and was equal to the best commercial varieties for dry matter yield. Second generation selections are now in trial. However, as these selections were made from core samples dried at 80°C, further selections have been made from the Bangholm Wilby line using freeze-drying. D.M.% of individual plants ranged from 13% to 17%, and selections were made on deviations from the regression of D.M.% on fresh weight of bulb.

This approach should give the quickest response for increase in D.M.% It is hoped, however, that further increases can be made by introducing new variation, either by introgression or by resynthesising <u>napus</u> using high D.M.% turnips.

Reference

Dyson, P.W., 1977. see Reith, J.W.S., In: Brassica Fodder Crops Conference, Pentlandfield, 1977.

CRUCIFERAE FOR FORAGE AND GREEN MANURING IN THE SOUTHERN PARTS OF GERMANY

Helmut Scheller

Cruciferae for forage and green manuring in the southern parts of Germany are used nearly exclusivly for catch-crops growing. About 10 % of the fields are culrivated with catch-crop plants. By far the summer catch-crop growing (seed-time in August, harvest-time in October) predominates. Only a small part about 10 %, is used for winter growing (seed-time in September, harvest time from April to June).

In catch-crop growing cruciferae takes about 60 % of the fields, the rest is taken by legumes, grasses, sunflowers etc. Nearly 2/3 of them are used as forage, the rest for green manuring. The importance of cruciferae in catch-crop growing in creased during the last years. The average quota of catch-crop growing from 1970 to 1975 was distinctly under 50 %, today it amounts to 60 % (see above). Spring rape occupies the largest part of the fields (more than 60 %), followed by turnip, winter rape, white mustard and oil radish.

The Bavarian State Institute for Plant Breeding and Soils examined the yield of the called species at five different locations in Bavaria in summer catch-crop growing from 1972 to 1975. The average yield over the range of these four seasons amounted to 32 dt/ha DM. The yield fluctuates very much from season to season and location to location.

(The average yield over a range of four seasons: locations of humid summer season with an average rainfall of more than 420 mm from April to September yielded 41 dt/ha DM; locations of dry summer season with an average rainfall of less than 380 mm from April to September yielded 25 dt/ha DM).

Especially at locations of dry summer season the rainfall in August is very important for the level of yield.

White mustard had always the highest yield at all experimental locations. At locations of humid summer season the rank in yield turned out as follows: oil radish, turnip, spring rape, winter rape; at locations of dry summer season: oil radish, spring rape, winter rape, turnip.

After using cruciferae for green manuring an average increase of yield of the next main crop until 11 % over a range of four years could be stated. At that cruciferae was as good during the preceding crop action as legumes, for example.

SPECIES CROSSES AND STERILITY IN BRASSICA AND RAPHANUS

Sven Ellerström
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The amphidiploid hybrid Raphanobrassica (2n=36 rrcc) was produced at Svalöv in 1969 from crosses between autotetraploids of fodder radish, Raphanus sativus L. (2n=18 rr) used as pistillate parents, and marrow stem kale, Brassica oleracea var. acephala L. (2n=18 cc). The original crosses yielded a comparatively high frequency of hybrid seeds, 0,2 per pollinated flower. No hybrids were obtained from the reciprocal cross. Seed setting was extremely bad in the first generation hybrids, only 0,1 seeds per pollinated flower. Repeated fertility selection has improved seed setting quite considerably in later generations (Ellerström and Zagorsheva, 1977). Seed setting is, however, still far from adequate for an economic seed production.

Similar results have been obtained by McNaughton (1973, and personal communication) from his material of Raphanobrassica, that was produced in 1968.

Meiosis is rather regular and the few disturbances found can in no way account for the bad fertility (McNaughton, 1973; Iwasa and Ellerström, unpublished). Embryological studies have demonstrated the main causes for the sterility to be failure of fertilization and embryo abortion (Ellerström and Zagorsheva, 1977). These disturbances are to some extent environmentally influenced but also genetically determined, since selection results in improved fertility.

It is interesting to compare these findings with data obtained from other crosses between and within Raphanus and Brassica. In 1970 crosses were performed on the tetraploid level between Raphanus sativus L. and different subspecies of Brassica campestris L. (aa, 20). When chinensis, nipposinica, pekinensis and perviridis were used both as pistillate and pollen parents in crosses with fodder radish the average number of hybrids obtained varied between 0,01 and 0,02 seeds per pollinated flower, thus a much lower frequency than that, obtained from the earlier mentioned crosses. Crosses were also made in both directions between ssp. narinosa and fodder radish. When the Brassica species was used as pistillate parent the number of hybrid seeds obtained was 0,02, thus the same as for the other campestris crosses mentioned. However, when the Raphanus species was used as pistillate parent the number of hybrid seeds obtained was 0,2 per crosses flower, thus 10 times more frequent than in the reciprocal cross. After the crosses were made it was found that the Brassica plants used were not tetraploid, as anticipated, but diploid. The hybrid seeds obtained were therefore all triploid.

All the amphidiploid hybrid plants exhibited an extremely low fertility in spite of repeated efforts to improve this.

In fact, it is extremely difficult to maintain the hybrid population since the plants do also show signs of disturbed vigour. This is in strong contrast to the earlier mentioned Raphanobrassica amphidiploids.

Crosses have also been performed between autotetraploid material of marrow stem kale and the earlier mentioned subspecies of Brassica campestris, the lastmentioned ones as pistillate parents. The crosses with ssp. pekinensis did not yield any hybrid seeds, whereas the crosses with chinensis, nipposinica and perviridis yielded hybrid seeds but less than 0,01 per pollinated flower. The diploid narinosa material was also erroneously used in these crosses with tetraploid marrow stem kale. This cross yielded a large number of triploid hybrid seeds, 0,4 per crossed flower. The amphidiploid hybrid material retained full fertility after two - three generations and the plants are very vigorous. The combination Brassica oleracea var. capitata with B. campestris ssp. chinensis has also been realized, but only with oleracea as pistillate parent. Thus the species used in these crosses and the resulting hybrids, exhibit a variety of sterility reactions in different cross-combinations. These may be caused by difficulties for the genomes to cooperate in a hybrid, by some genomes not being able to work perfect in a foreign cytoplasm, by different factors obstructing pollen germination and fertilization in the style of a foreign species or in disturbances caused by the environment.

The aim of our future studies is to carefully survey the causes for these disturbances and to find ways of overcoming them in order to facilitate the use of such species crosses in the breeding work.

BREEDING RESEARCH ON COLE CROPS AT THE IVT.

Q.P. van der Meer, Institute for Horticultural Plant Breeding (IVT), Wageningen, The Netherlands.

The breeding research on cole crops was taken over (from N.P.A. van Marrewijk) by the author in 1977. He is also in charge of leek and onions.
At the moment, in cole crops, work is done on the following two subjects:
- Introduction into autumn cauliflower of male sterility from cabbage and broccoli. This material was kindly supplied by Pearson, Bannerot and Dickson.
- Improving of the Chinese cabbage crop for growing under glass and in the open. Special attention is paid to screening for resistance to tipburn and bolting. At the same time there is a need for a better keeping quality.

Perhaps in the near future time will be devoted to research on breeding for resistance in white cabbage.

HIGH DRY MATTER CABBAGE

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In 1924 Lamprecht reported on the differences in dry matter of cabbage 7.5%, savoy cabbage 10.5%, brussel sprouts 13% and kale 18%. In 1967 the New York Sauer Kraut industry was having problems of excess brine during kraut fermentation and it occurred to me that if we could increase the dry matter of cabbage this should result in reduced brine production and increased pack out in the kraut factories.

Dry matter fluctuates from season to season and during the past ten years in Upstate New York the standard varieties King Cole and Round Up have varied from 6.1 - 7.9% and 6.4 and 8.1% respectively. Once a cabbage reaches maturity the solids content does not change inspite of rain or dry weather. We have also observed that generally in a wet year the solids are higher than in a dry season, the opposite of what might at first be expected.

Crosses were made to kale, brussels sprouts and savoy cabbage. The early selections were poor type cabbages, but Dr Stamer was able to show a good correlation between dry matter and brine drain weight. It was also observed that the high solids selections froze at lower temperatures than standard cabbage cultivars. The use of kale and brussels sprouts resulted in some very strong smelling pseudo cabbages resulting in very strong and off flavored krauts. However, with selection the kale smell was removed and inbred G571 developed which is high in solids (+2½%- 3%) was developed. Some other inbreds G314, G326, G328 and G364 (+2% - 2.5%) were developed from crosses with savoy cabbage and this is apparent in their semi-savoyed leaf type. The first hybrids were late and this was to be expected if yields comparable to standard varieties was to be obtained as 25-30% increase in dry matter could only be obtained by a great increase in photosynthetic efficiency or a longer growing season. However, strong selection pressure for earlier inbreds had resulted in selections of G364 which are earlier and also of inbred G305 which is considerably earlier but not quite as high in dry matter as the other selections.

In 1974 a one ton sample of high solids cabbage was commercially processed and resulted in a 49% increase in pack out over the standard using Round up. In 1975, 50 tons of G314X364 and G364X328 hybrid high dry matter cabbage was processed by Silver Floss of Phelps, New York, and the packout was increased 20% and the brine production reduced by 25%.

Inbreds mentioned have been released to interested seedsmen. They had not been selected carefully for incompatibility at the time of their release in 1975 and this has entailed work by individual seedsmen to select their own subselections of these inbreds. Since then some of the inbreds have been further refined and stabilized for incompatibility especially in 364 and small quantities of thse inbreds are available to cabbage breeders and seedsmen. The released lines are yellows resistant.

Dry matter is obtained by drying 200gm samples in an oven at 80C. If high dry matter inbreds +2% over the standard are crossed with low dry matter inbreds the F_1 is only slightly higher than the lower parent.

However, some seedsmen are finding some of their own inbreds are quite high when tested, although never selected for high dry matter.

We are now trying to develop male sterile inbreds using the radish cytoplasm, and incorporate black rot resistance into these new lines.

M. H. Dickson and J. R. Stamer, 1975. G314, 323, 326, 328 and 364 High Solids Cabbage Inbreds. Hort Science 10:534.

VEGETATIVE GROWTH IN DIPLOID AND TETRAPLOID HYBRIDS

OF BRASSICA CAMPESTRIS

B. Dörries and W.Odenbach

Eight varieties of Brassica campestris belonging to the subspecies chinensis,pekinensis, narinosa and nipposinica were crossed with winter turnip rape,summer turnip rape and one variety of B.campestris ssp.rapifera. All crosses were made in both directions in two sets, at the diploid and the tetraploid level. The F_1-generations and the cross parents were tested in two years.

In both years the east asian varieties yielded morethan the adapted european campestris forms. In general this is true for green yield and dry matter yield in both sets, the diploids and the tetraploids. Comparing the cross parents the diploids yielded more than the tetraploids with some exceptions.

To some extend we could observe reciprocal differences.
No F_1-generation was superior to the best of our cross parents.
The highest dry matter yielded a combination between ssp.nipposinica (2x) X ssp.rapifera (2x) followed by ssp.pekinensis var.cylindrica (2x) X Lembkes Rübsen. Var. cylindrica showed the highest green yield and Lembkes Rübsen was the top variety in dry matter content.
29 of the diploid F_1-combinations and 26 of the tetraploid ones reached the best variety.

Heterosis was observed in a smaller scale than we exspected after crossing campestris types of such different origin.

Brassica research in South Island, New Zealand

By T.N. Barry

Brassica crops are normally grown in the South Island of New Zealand either as a winter feed for ewes, or for fattening lambs during autumn. In all instances the crop is grazed in situ. Dry matter production trials carried out at Invermay have shown that kale is the superior yielder under our conditions.

A programme of nutritional evaluation of kale with young sheep commenced in 1977. Results to date show that despite the high apparent digestibility of 82-87% and high total N content (2.0 - 2.5% DM), liveweight gains under grazing were low at 100 - 150g/day. Heinz body anaemia developed very rapidly, and even after 12 weeks of grazing approx. 30% of the red cells showed Heinz bodies; up to 8% of the haemoglobin was converted to methaemoglobin due to incomplete reduction of nitrate in the rumen. The SMCO content of the young kale (6000kgDM/ha) was 0.7 - 0.9% DM, and nitrate levels are currently being measured.

A feature of the results was that animal growth rates did not increase as the amount of crop DM on offer was increased to very high levels, in contrast to what is normally found in New Zealand for young sheep grazing ryegrass/clover pasture or lucerne. Also, at each level of herbage allowance, animal growth rates were approx. 50g/day less during the first six weeks, when the anaemia was most severe, than were obtained in subsequent periods.

Our results suggest that toxic substances present in the NPN* fraction of kale, such as SMCO and nitrate, could well be having a depressing effect on animal performance. Detailed nutritional experiments are being set up under controlled indoor feeding to study SMCO metabolism in sheep, and how dimethyl disulphide production might be regulated.

*NPN (non-protein nitrogen)

Storage of field samples due for laboratory analysis

By M.J. Allison and R. Borzucki

There is a lack of information concerning the procedures to be followed when sampling field plots of brassicas for a subsequent analysis of quality factors. For example, the concentration of thiocyanate, a goitrogenic factor, decreases during storage at ambient temperatures, and some loss may occur while samples are being transferred from field to laboratory. In such cases it is necessary to define the optimum storage conditions. As a similar argument may apply to the haemolytic factor S-methyl cysteine sulphoxide (SMCO) different methods of storing harvested samples, due for SMCO analysis, were investigated.

It has been established that SMCO concentrations are high in the actively growing parts of brassica plants, and reach the highest concentrations in the inflorescence. Flowering heads of kale were therefore chosen as samples to be stored under different conditions. The method used to determine SMCO was essentially that developed by Whittle (1) and recovery of SMCO is expressed as a percentage of the total extracted from a sample that was freeze dried one hour after harvest (treatment a).

	Sample	Storage condition	Recovery %
a	Flowering heads of Maris Kestrel	1 hour at ambient - freeze dried	100
b	"	1 hour at ambient - 24 hours at -10°C - freeze dried	100
c	"	7 hours at ambient - 24 hours at -10°C - freeze dried	100
d	"	24 hours at ambient - freeze dried	90

The results indicate that loss of SMCO is avoided if samples are stored at -10°C, or freeze dried within seven hours of harvest.

Reference

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A SURVEY OF THE GLUCOSINOLATE CONTENT OF RUTABAGA (*BRASSICA NAPOBRASSICA* MILL.) AND TURNIP (*B. RAPA* L.)

W.J. MULLIN

During the last few years there has been considerable Canadian research interest in the production and use of rapeseed protein for human consumption. To assess the impact of any additional glucosinolates in the diet via rapeseed products, efforts to measure the average daily intake of glucosinolates from cruciferous vegetable crops in the diets of Canadians were attempted, (Mullin and Sahasrabudhe 1978). Certain crops showed high glucosinolate content, particularly progoitorin the toxic effects of which cannot be reduced by dietry iodine. In the Canadian diet it was estimated that cabbage (*B. oleracea* var. capitata, L.), and rutabaga contributed 38.6% and 19.3% respectively to the total consumption of cruciferous vegetables, (Benns et al. 1978). VanEtten et al. (1976) published detailed analysis of 22 cultivars of cabbage. Due to the high goitrin content of rutabaga a similar programme has been undertaken at the Food Research Institute, Agriculture Canada. Several cultivars of turnip were also analysed as earlier work has shown high levels of goitrin.

Nine cultivars of rutabaga were grown at the Central Experimental Farm, Ottawa, from seed obtained from Canadian, United States and Danish sources. A further 13 cultivars of rutabaga and 21 cultivars of turnip were grown at the Agriculture Station, St. John's, Newfoundland with seed from the Plant Gene Resource collection Ottawa, originating from the USSR and Wester European countries (Holland, Belgium).

The edible portion of the roots were prepared for detailed glucosinolate analysis. The indications so far show the goitrin, can range from 12 to 124 ppm fresh weight in rutabaga and from 9 to 95 ppm fresh weight in turnip. Other individual glucosinolates have been measured from their hydrolysis products, and show considerable differences between cultivars. In an extension of this study the glucosinolate content of the seeds of a selection of the cultivars is being measured to see if there is any correlation between the seed and root content.

Growing consumer interest into the nutritional value of foods leaves one to suggest that plant breeders should take note of this concern. Progress has been made in continually improving disease resistance, growing, and storage features. More attention should be paid to nutritional quality in terms of vitamin, protein and fibre content and particularly to any potential toxins. Breeding low progoitrin containing cruciferous crops would be of benefit to the consumer.

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BRASSICA ANAEMIA FACTOR: R. H. Smith

The forage brassicas have considerable potential as convenient, nutritious home-produced feeds for sheep and cattle. When, however, ruminant animals are fed mainly or exclusively on a variety of brassica crops they may develop a severe haemolytic anaemia. The characteristic early sign of the disease, seen after 1-3 weeks feeding, is the appearance of refractile granules - Heinz bodies - in the red blood cells. This is followed by a fall in the blood haemoglobin level from the normal 11 g/100 ml to 8 g or lower. An obvious clinical sign of brassica poisoning in cattle is the haemoglobinuria (redwater) which may be seen in acutely poisoned animals. Other possibly earlier signs of the disease include loss of appetite, jaundice, increase in pulse rate, fall in milk production and, possibly, growth stasis.

In sheep, brassicas were responsible for 14% of all poisonings in the period 1975-7 and 31% of the diagnoses made under code 440 at VI centres involved the Cruciferae - mostly brassicas (1). On dairy farms where kale supplied on average about one-third of the dry matter intake 6.4% of cows developed an overt anaemia but one-third had appreciable Heinz body counts (2). In most kale-fed dairy herds the disease is kept under control because animals are seldom fed on kale alone. Classes of stock that are most at risk are sheep and cattle fed almost entirely on brassica fodder crops.

S-methylcysteine sulphoxide (SMCO) which may account for as much as 2% or more of the dry matter of a variety of brassicas, was implicated as the major primary cause of this Heinz body anaemia (3,4). It occurs as the free amino acid and probably serves as a mobile metabolizable store of organic S which can be readily converted to the essential S-amino acids required for protein synthesis. SMCO itself is probably not toxic, but when ingested by the animal is converted by certain rumen bacteria to dimethyl disulphide, a reactive compound, which leads to the changes in the haemoglobin molecule associated with Heinz body formation and anaemia (4). Suppressing this bacterial action is not at present a practical possibility. We are thus faced with the alternatives of restricting the intake of forage brassicas or of selecting for varieties of low SMCO content. In a small diallele cross SMCO has been found to be a heritable character (5).

The SMCO content of kale and other forage brassicas increased as the plants matured and secondary growth began. Particularly high contents are associated with buds (Brussels sprouts) and flowering structures (kale, cauliflower, broccoli) and animals offered these structures are greatly at risk (6). Roots (swede) may also contain levels of SMCO, approaching or exceeding those found in the shoots, and both structures may cause severe anaemia if fed exclusively.

As a rough guide to the safe feeding of brassicas to cattle and sheep, it seems that daily intakes of 150-200 mg SMCO kg^{-1} liveweight are required for an acute haemolytic response whereas intakes of about 100 mg kg^{-1} give sub-acute low grade anaemias. The practical implications of these sub-acute conditions in relation to possible impairment of growth efficiency call for an early examination (7).

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FACTORS INFLUENCING CONTENT OF NATURAL GOITROGENS IN CRUCIFEROUS VEGETABLES

Calvin Chong and B. Bible*

Plants of the Cruciferae family contain a range of glucosinolates (thioglucosides) which yield certain hydrolytic derivatives known to be toxic. The consumption of cruciferous plants has long been related to goitre development (enlargement of the thyroid gland) in both humans and animals. In view of the importance of cruciferous vegetables in our diet, there is need for more knowledge on the amounts of these natural toxic substances and factors affecting their accumulation in cruciferous crops.

Our studies since 1969 have indicated wide variation in the content of glucosinolates and their derivatives in different types of cruciferous vegetable crops and in their cultivars as exemplified by data for thiocyanate ion (SCN^-) derivative in Table 1. These data, together with other evidence, indicate genetic control of thiocyanates in these vegetables, which means that these toxins can be eliminated or considerably reduced by plant breeding as has been demonstrated in the case of rapeseed.

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Table 1. Thiocyanate ion (SCN^-) content in cruciferous vegetables

Crop	Number of varieties examined	Mean SCN^- content of edible part ≠
Radish	14	140
Kale	1	175
Rutabaga	5	250
Turnip	11	275
Cabbage (1974)	14	295
Cabbage (1975)	14	595
Broccoli	6	830
Cauliflower	10	1030
Brussels sprouts	7	2160

≠ Expressed as mg potassium thiocyanate per gram dry weight in tissue.

Environmental conditions during the growing season also influence toxin build-up as shown by the large differences in SCN^- content between cabbage cultivars grown in 1974 compared with the same cultivars grown in 1975 (Table 1). Other studies indicated variations in toxin content associated with factors such as soil type, date of planting, temperature, rainfall, irrigation frequency, sulfur nutrition, and concentration of nutrient media.

Results revealed that accumulation or synthesis of these substances may be associated with differential plant growth and development, and with location and morphological origin of plant tissues such as young floral and vegetation tissues, in which content of glucosinolate derivatives are very high. Presently, continuing studies are investigating variation of goitrin (5-vinyloxazolidinethione), SCN^- and other hydrolytic derivatives of rutabagas (strongly goitrogenic) and turnips during growth and development in the field and during storage of the edible roots. More recent studies with application of growth regulators such as alar, gibberellic acid, benzyladenine, kinetin, 2-4,D, and Ethrel indicate that some of these growth regulators influence toxin levels in cruciferous vegetables.

Results acquired on how these glucosinolate derivatives are synthesized, accumulated, or metabolized in cruciferous plants should be of value to plant breeders, nutrionists, and toxologists and ultimately should aid in the culture and marketing of toxin-free or low-toxin vegetables for the general public.

BREEDING FOR RESISTANCE TO VERTICILLIUM DAHLIAE IN RAPE AND TURNIP RAPE

R. Jönsson

Verticillium dahliae every year brings about considerable losses in yield in rape fields in the southern part of Sweden. The parasite causes a premature ripening of the host with characteristic, light brown streaks starting often at one side of the stalk only.

During the period 1973-77 the frequence of attacked plants in varieties and breeding lines has been determined before ripening in heavily infested fields. In these tests Norde surpassed other Swedish winter rape varieties in resistance to V. dahliae. Also to Phoma lingam this variety showed a good resistance. Because of a high erucic acid content in the oil Norde is no longer permitted for cultivation in Sweden but is used in the breeding work. Brink from the cross (Norde x Sinus) is more resistant to V. dahliae than Sinus. The winter turnip rape varieties Rapido III, Solo and Sylvi showed a poor resistance to V. dahliae.

Tests with breeding lines of winter rape has pointed out considerable differences in resistance with most significant correlation between years ($r = 0.59 - 0.69$). In material with low erucic acid content very good resistance has been found i.a. in NPZ Rapora, NPZ 17674, WW 766 and in many lines from the cross /(Panter x From Lembkes) x Sinus/. Varieties with considerably improved resistance compared to Brink and Magnus are now tested in official trials. Good resistance exists also among lines with low glucosinolate content in the meal.

A greenhouse method with infection of seedlings and determination of the frequency of attacked plants after about 8 weeks has been tested. This method gives a lower reliability than the field test partly because many plants show symtoms at later stages of plant development and partly because of the lower number of plants that can be tested. In greenhouse tests with summer rape the variety Gulle, with high erucic acid content, has shown good resistance to V. dahliae but a considerable variation exists also among lines with improved oil and meal quality.

INHERITANCE AND LINKAGE STUDIES RELATED TO RESISTANCE IN BRASSICA CAMPESTRIS L. TO PLASMODIOPHORA BRASSICAE WOR. RACE 6

R. V. James, P. H. Williams and D. P. Maxwell

The identity of a sample of *Plasmodiophora brassicae* Wor., the causal agent of clubroot, collected at Bear Creek, Wisconsin, was confirmed as race 6 using the Williams differential set. The same sample was classified as race 16/02/30 using the European Clubroot Differential host series.

The genetics of resistance in *Brassica campestris* L. to *P. brassicae* race 6 and possible linkage of genes for resistance to clubroot, and phenotypic marker genes were investigated. Two *B. campestris* members of the European Clubroot Differential host series and a commercial cultivar served as sources of genes controlling resistance to *P. brassicae* race 6. The resistant reaction in the commercial cultivar was due to a single dominant gene, designated *Pb1*. The resistant reaction of the two *B. campestris* members of the European Clubroot Differential host series to *P. brassicae* race 6 was due to more than one independent dominant gene in each case. A series of backcrosses was conducted to produce and identify plants containing single genes controlling clubroot resistance. The two single dominant genes identified from this material were designated *Pb2* and *Pb3*. Rapidly flowering stocks homozygous for each of the three genes were produced. Allele tests between stocks containing each of the genes indicated that they were three different genes at three loci.

Tests were conducted to determine if linkage existed between *Pb1*, *Pb2* or *Pb3* and six marker genes controlling phenotypic variants in *B. campestris*. Five of these traits, (cream corolla (*cr*), narrow sepals (*nsep*), puckered leaf (*pkl*), apetalous (*pl*) and rosette (*ro*)), were controlled by single recessive genes. Resistance to *Albugo candida* race 2 was controlled by a single dominant gene. No evidence for close linkage was found among the gene pairs tested. Data from two gene pairs, *Pb3* and *pkl*; and *Pb2* and *ro*, indicated the possibility of loose linkage, with recombination fractions of 0.45 and 0.46, respectively.

SOME PRELIMINARY INVESTIGATIONS INTO LIGHT LEAF SPOT (PYRENOPEZIZA BRASSICAE)

T. D. Johnston

Light leaf spot disease developed quite extensively on a number of swede (B. napus) varieties and selections in the main Brassica breeding glasshouse at the Welsh Plant Breeding Station during the late winter and early spring of 1978. In B. oleracea its attack was virtually limited to one marrow stem kale plant and to some F1 hybrids of MSK with an annual form of the species from Asia. The forage rape breeding material was little affected in comparison with the swedes.

Various aspects of investigation into the disease have been pursued; some are summarised below.

1. Spore germination in aqueous suspension
Germination was extremely limited in distilled water suspension, but was markedly stimulated by the addition of a little juice extracted from kale or swede leaves.

2. Development of the pathogen on detached leaf segments
The use of segments cut from young to fully grown leaves supported profuse pustule development when kept on moist filter paper in petri dishes in a North facing laboratory window.

3. Variations in host response to inoculation
The response varied between either profuse sporulation on otherwise apparently unaffected segments and necrotic spotting without sporulation. Intermediate reactions involving moderate sporulation and some necrosis also occurred. There appeared also to be small differences (2 - 3 days) in duration of the latent period (days from inoculation to first sporulation).

4. Spore suspension dilution tests
Tests have indicated that a spore load of about 10^5/ml brushed onto segments, using a small amount of wetting agent to achieve good spread on the otherwise water-repellent upper leaf surface, gave earlier and more dense pustule development than either substantially higher or lower concentrations.

5. In situ leaf inoculation
Inoculation of leaves on plants in the glasshouse, by brush application of spore suspension plus wetting agent, effectively revealed variations in host susceptibility, especially if the leaf was enclosed in a loosely fastened cellophane bag for a few days after inoculation in order to maintain high humidity.

6. *Cross inoculation investigations*
Inoculum from either *B. oleracea* or *B. napus* has proved equally pathogenic on susceptible genotypes of either species, indicating the absence of species-specific racial differentiation of the samples of the pathogen used in the investigations.

Studies have not so far indicated any linkage of genes governing reaction to *Pyrenopeziza* with reaction to powdery mildew (*Erysiphe cruciferarum*). The disease is generally of minor importance in the forage brassica crops and it is not at present proposed to emphasise selection for resistance in the breeding programme.

CHEMOTAXONOMIC STUDIES IN THE GENUS *BRASSICA*

F.W. Collins

As part of a broader biosystematic study, an in-depth investigation is being undertaken to determine the inter- and infra-specific variation in certain classes of secondary metabolites in *Brassica*. Included in this study are (a) anthocyanin glycosides, (b) all other flavonoid derivatives, and (c) glucosinolates and related compounds. Particular emphasis will be placed on structural elucidation of the naturally-occurring forms, their in-plant distribution (temporal and organ-specific) and their biosynthetic interrelations. From the data, an indication of the biosynthetic capabilities and diversity with respect to each class of compounds can be derived and used to evaluate biogenetic variation amongst and between the taxa. When correlated with cytological, physiological and morphological data obtained from the same plants a clearer picture may emerge, which more truly reflects natural affinities within *Brassica*.

To date, over 200 cultivars, mainly of *B. napus* but including several *B. campestris* and *B. oleracea* types, have been sampled for roots, leaves, flowers, siliques and seeds, and biochemical analyses are in progress. Preliminary results for *B. napus* suggest that flavonoids will offer a rich source of biosynthetic characters. For example, over 70 different flavonoid glycosides have been observed in mature leaves of a single cultivar of *B. napus* L. var. *napobrassica* (L.) Reichb. In view of the amphidiploid origin of *B. napus*, it will be interesting to see the extent (if any) to which this high biogenetic diversity reflects an additive effect resulting from the combination of divergent ancestral complements.

The author would welcome seed material for inclusion in this study. Of particular interest are "wild" and cultivated representatives of *B. perviridis* Bailey, *B. tournefortii* Grouan *B. narinosa* Bailey, *B. parachinensis* Bailey, and *B. napella* Makim. A complete list of cultivars and material already represented will be forwarded upon request.

CELL AND TISSUE CULTURES OF HAPLOID BRASSICA NAPUS FOR INDUCING AND SELECTING RESISTANCE TO PATHOGENS[1]

M. D. Sacristán

The possibility of using tissue culture technology with the aim to produce novel disease resistant plants is being tested with haploid rape cultures against two fungal parasites: Plasmodiophora brassicae and Phoma lingam.

In the case of the obligate endoparasite Plasmodiophora brassicae a previous condition for the use of an in vitro system is that the tissue cultures could be directly infected with the parasite. The first successfull infection in vitro occurred by using "stem embryo cultures" (Thomas et al. 1976) of haploidrape (Sacristán and Hoffmann, in preparation). The parasite developed and completed its life-cycle in the cultured cells.

The imperfet fungus Phoma lingam can grow and sporulate on rape callus and tissue cultures. From previously mutagenized cell suspension cultures which had been plated on agar medium containing a top-layer with pycnidiospores it was possible to isolate few cell colonies which did not show signs of attack as the mycelium had covered most part of the culture. Attempts to regenerate these possible resistamt cell lines are in progress. Moreover, the host-specificity of toxic substances produced by cultures of P. lingam is being investigated.

Reference: Thomas, E., Hoffmann, F., Potrykus, I., Wenzel, G. (1976): Protoplast regeneration and stem embryogenesis of haploid androgenetic rape. Molec. gen. Genet. 145: 255-247.

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PROGRESS IN DEVELOPMENT OF CLUBROOT RESISTANT CABBAGE AND BROCCOLI

M. S. CHIANG

Three triploid hybrids (2n=28, genomes a_1c_1c) were obtained from the cross between Brassica napus (2n=38, a_1a_1cc) and B. oleracea ssp. capitata (2n=18, cc). These triploid hybrids were back crossed to cabbage cultivar Badger Shipper and a few B_1 seeds were obtained. B_1 plants were planted in the field inoculated with races 2 and 6 of Plasmodiophora brassicae. One clubroot-resistant plant was selected and it has somatic chromosome number 2n=18. Since this particular B_1 plant not only has a desirable low chromosome number but also shows very resemblance to its cabbage parent, therefore, it has been used extensively in further backcrossess with cabbage and broccoli. We hope that new clubroot resistant cabbage and broccoli will be available soon.

All our triploid hybrids are highly sterile, we doubled the chromosome number by colchicine treatment. The chromosome doubled plant produced abundant of pollens and set seed when selfed. When the self-progeny is stabilized after a few generations it will become a new species (2n=56, $a_1a_1c_1c_1cc$) for fundamental research and breeding work.

PROGRESS ON DEVELOPING CLUBROOT RESISTANT BRASSICA

S. Honma

Attempts to obtain commercial type rutabaga is progressing at a slow rate from progenies obtained from interspecific crosses (J. Amer. Soc. Hort. Sci. 101:299-302. 1976). Through the kindness and cooperation of Rene Crete, Agriculture Research Station, St. Jean, Quebec, we are having some of our lines tested for race 2 Plasmidophora brassicae (16/02/31 international classification).

Our work on cauliflower has been delayed by losses of plants that appeared resistant. Looking into various methods of propagation.

STUDIES ON THE GENETICS OF SELF-INCOMPATIBILITY IN CAULIFLOWER /BRASSICA OLERACEA VAR. BOTRYTIS L. SUB.VAR.CAULIFLORA D.C./[x]

Julia Hoser-Krauze

During the investigation carried out from 1973 to 1978, in Plant Breeding Laboratory at Institute of Vegetable Crops, Skierniewice, the collection of 151 cultivars of cauliflower were tested for self-incompatibility and horticultural value under polish climatic conditions[xx]. The mode of inheritance of self-incompatibility in the cauliflower and number of different S alleles were determinated. The value of homozygous self-incompatible lines for F_1 hybrids production was also investigated.

It was proved that cultivars belonging to the group of summer cauliflowers, mainly cultivated in temperate climate are self-compatible. Most of the self-incompatible plants occured in the group of cultivars from the tropical climate, mainly in Indian cultivars. The heightest percentage /60%/ of self-incompatible plants was found in Indian Pusa Katki cultivar.

The inheritance of self-incompatibility was analysed in Pusa Katki cv. and also additionally in two Indian cv. PI 277277 and PI 271445. It was stated that the self-incompatibility system in cauliflower is the same as in varieties and species from the cruciferae family, for it is sporofitic and determined by one series of multiple S alleles. S alleles in heterozygous genotypes showed four types of interaction in pollen grains and in pistil:

I type Sx > Sy in ♂ and in ♀
II " Sx > Sy in ♂ and Sx : Sy in ♀
III " Sx : Sy in ♂ and Sx > Sy in ♀
IV " Sx : Sy in ♂ and in ♀
> means - dominance and : means codominance.

Activity of recessive S alleles in heterozygous genotypes was lower and changed in the range of 0-72% as compared with dominant and codominant S alleles, the activity not less than 90%, changing in the range of 10% only. The activity of the same S allele in different heterozygous combinations changed depending on the second S allele interacting with it.

In the homozygous self-incompatible lines of Pusa Katki, PI 277277 and PI 271445 cv. seven different S alleles were identified. These lines were used for the production of three line F_1 hybrids. The maternal form of these hybrids were F_1 obtained by crossing two homozygous self-incompatible lines with different S alleles. The lines in a pair were similar to each other in such characteristics as height of plant, shape and colour of leaves, earliness of curd creation and curd quality. The father components /pollinators/ were self-compatible selfed lines /I_2/ obtained from three early summer cultivars.

Three line F_1 hybrids differed considerably in commercial crop of curd and their quality.These differences were dependent on reciprocal crosses of maternal F_1. This suggested the influence of cytoplasm on the inheritance of curd's quality.

Some of the obtained 3-line F_1 hybrids were characterised by early,uniform,crop of high quality curds.

The results of these above described investigations showed that the breeding of F_1 hybrids in summer cauliflower is possible,as it is the case with other varieties and species of cruciferae family.

x/ The work was financed under project No PL-ARS-6,Grant No FG-Po-313, USDA, USA

xx/ The cauliflower seeds obtained from Indian Agric.Res. Institute New Delhi and from Reg.Plant Introduction Station, Geneva, New York, USA

MILDEW IN THE SWEDE BREEDING GLASSHOUSE AT ABERYSTWYTH

T. D. Johnston

The relative importance of mildew (Erysiphe cruciferarum) in the swede crop in western Britain varies from year to year. In 1976 at the Welsh Plant Breeding Station there was a severe mid-summer attack of the disease compared with a moderate, later developing incidence of mildew in 1977 and its virtual absence, at least up to mid-September, in 1978. Forage kale normally appears to be free of the disease in the field during the growing season.

However, in the Brassica breeding glasshouse the disease builds up each spring, generally necessitating application of a systemic fungicide to the pot-grown plants of swede and rape. In the early spring of 1978 some of the swede varieties being used in the breeding programme became heavily infected. One modern continental variety showed considerable plant to plant variation in severity of attack, and is undergoing further investigation. The breeding selections generally showed quite good resistance, and some plants of a few progeny lines remained almost completely free of mildew until the flowering season was well advanced. Such high level resistance, if expressed in the field throughout the vegetative growth phase of the crop, would be very useful in helping to eliminate a major constraint to early sowing of the swede crop. Progenies of these lines are growing in the breeding nursery field, but comparative assessments of infection to confirm the relevance of the glasshouse observations to field performance have not been possible in 1978 because weather conditions have not favoured development of the disease.

CYTOPLASMIC-GENETIC MALE STERILITY IN BRASSICA NAPUS

F.W. HEYN

This system of cytoplasmic male sterility is based on the male sterility inducing radish cytoplasm found by OGURA (1968). This S_o plasm induces complete male sterility in B. napus and B. oleracea as found by BANNEROT et al. (1974) by substitution backcrosses. The same holds true for B. campestris, B. juncea, and B. carinata (HEYN, unpubl.). In all these above mentioned species the "normal" plasm is for this system functionally a F_o plasm; used as pollinators for the cms plants male sterile progenies result without any exception. That is to say: all euplasmic plants can be used as maintainers. Restorer genes can be found in Raphanus and have been introgressed into the cytoplasmic male sterile B. napus (see HEYN 1976 .Cruc. Newsl. 2). In order to elucidate the genetics of restoration of male fertility a series of backcrosses was conducted with one common restorer plant which was heterozygous for all genes involved. The data strongly suggest the following inheritance pattern: white flower colour is a prerequisite for the restorer genes to function. White flower colour is conditioned by two complementary dominant genes W_1 and W_2. Restoration of male fertility is controlled by Rf_1 and Rf_2, acting in a complementary manner also. Rf_1 is linked to W_1. So three chromosomes or chromosome pieces from Raphanus will have to be introgressed into the genomes A and C of B. napus in the restorer lines (HEYN 1978). Many of the restorer plants still show a low level of fertility in seed set. The better plants have up to 8 seeds per siliqua, the best restorer individual a maximum of 16 seeds by open pollination which was effected by the naturally occurring bees and other insects. Seed set on the cms plants grown together with the restorer lines in alternating rows is near to normal.

Some further generations will be needed to obtain complete fertility of the restorer lines.

In a small plot of $2m^2$ hybrid seed production with cms plants and swedes as pollinators (two rows out of six) was tested in the home garden. Seed set on the cms plants was complete when flowering at the same time as the pollinators.

Many cms plants have smaller flowers and poorly developed nectaries which is unfavourable for insect pollination. However, there are other cms plants with normally sized petals and nectaries exhaling a normal fragrance; they occur in varying proportions in certain progenies. These plants are visited by the bees nearly as intensively as the plants with pollen.

The slight chlorophyll deficiency under cool weather conditions can be overcome by selection for normal chlorophyll formation in the restorer lines.

These preliminary results show that this cms-system in Brassica napus can be developed to fulfill the requirements of practical F_1 hybrid seed production.

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GENETICS OF CYTOPLASM IN CRUCIFERAE. II. CYTOPLASM OF SPECIES HAVING "AA" GENOME.

OHKAWA, Y. AND T. SHIGA

We previously reported that 13 out of 14 Asian cultivars of "AA" genome species had cytoplasm which behaved like N cytoplasm of *Brassica napus*, and the rest had cytoplasm which we couldn't estimate(Cruciferae News Letter 2, 1977). We examined 20 cultivars having "AA" genome collected from European and other country(Sweden, West Germany, East Germany, Austry, Jugosrabia, Turkey, Ezypt, Spain,Canada, U.S.A. and New-Zealand) in 1978. Of 20 cultivars, three had the cytoplasm which behaved like S cytoplasm of *Brassica napus*,and 15 cultivars N like cytoplasm. We could not estimate the cytoplasm of the rest, two cultivars.

GENETICS OF GENUS- AND SPECIES-DIFFERENTIATING CHARACTERS IN CRUCIFERAE

Walter TITZ

Taxonomy of Cruciferae is a rather difficult topic not only for the plant breeder but also for the taxonomist, because there are hardly any indications how real phylogenetic relationships between genera could be traced. In this situation the usual systems of this family are necessarily artificial, based on a few more or less arbitrary characters, phylogenetic interpretations should consistently be avoided (as can be seen from recent studies by TITZ and H.SCHMID, unpubl.). Therefore it seems to be of great importance to gain knowledge about the inheritance of these characters usually employed in separating genera or even tribes. As a first step in this direction we examined the pair of genera Arabis - Turritis, the first being one of the large genera of Cruciferae, the second a small, rather doubtful one. Turritis has been separated from Arabis by the arrangement of myrosin cells (and the structure of the pod septum, HAYEK,1911), by the chromosome number x=6 (cf. BURDET,1967), and by some authors also by the tetragonous siliquae with small biseriate (±notorhizal) seeds occurring in T.glabra (cf. DVOŘÁK,1967). However, all these characters are also shared by several different, especially North American species of Arabis (cf. TITZ,1967,1968,1971), and on the other hand a close relative of Turritis glabra namely T.pseudoturritis does not share the pod and seed characters with it ! Our recent investigations (TITZ and SCHNATTINGER, unpubl.) have revealed that these two "species" of Turritis can easily be hybridized without any sterility barriers. Character analysis of the parental taxa and their F_1 hybrids revealed only the following differences between them (otherwise a distinction is not possible). The given character states are mean values obtained by statistical evaluation, their differences are statistically significant (except $^+$).

	T.glabra	F_1 hybrids	*T.pseudoturritis*
area	Europe		Mediterranean
pod pedicel length	9,9 mm	8,1 mm	6,3 mm
seed arrangement	biseriate (in N.America also uniseriate)	uniseriate	uniseriate
seed length (mm)	0,783	0,963 +)	0,954 +)
seed width (mm)	0,507	0,616	0,688
seed wing width(mm)	0,017	0,066	0,099
radicle position	tendency towards notorhizy		tendency towards pleurorhizy

Moreover for T.glabra and T.pseudoturritis as well as for a number of bi- and uniseriate American and European species of Arabis a strong correlation between uniseriate seeds and pleurorhizy, and between biseriate seeds and a tendency towards notorhizy could be proved statistically.

According to these results it is clear that:

1. The pod and seed characters (and all other characters too) do not support in any way the separation of Turritis from Arabis (accordingly Arabis glabra (L.)BERNH. is the correct name for our "Turritis glabra L.").
2. Biseriate or uniseriate arrangement of seeds is connected with the position of the radicle in the seeds and with seed-size. The inheritance of these characters seems to be relatively simple: dominance of big, uniseriate seeds. As characters suitable for distinguishing closely related species or even infraspecific taxa they seem to be of little importance for higher categories . From the phylogenetic point of view they might be easily changeable and thus without relevance.
3. Arabis(Turritis) glabra and pseudoturritis seem not to be enough separated morphologically and isolated genetically from each other as would be expected for good species.

Further investigations are in progress.

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ANEUPLOIDS HAVING LOWER NUMBER OF CHROMOSOMES BELOW DIPLOIDS IN *BRASSICA NAPUS*

S. Tokumasu and M. Kato

In a population from the diploid (2n=38) x tetraploid (2n=76) cross in *Brassica napus* L., several hypodiploids were found. Of these, two plants, which had 2n=29 and 30 chromosomes respectively, were used for further examination. Meioses in microsporocytes of some plants in the open-pollinated progenies of these two plants were examined. Frequency of chromosome numbers of the plants examined was as follows:

Parents	Chromosome number of progenies															
	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	Total
2n=29		1			1	3	4				1	4	4	3	12	33
2n=30	1						2	5	5	6	1	5	1		1	27

In each progeny the majority of plants had higher number of chromosomes than their parent. They were situated between their parent and the diploid in terms of chromosome number. That is, there was a tendency to reversion to the diploid. It cannot be determined whether the increase of chromosome numbers in these plants was due to the selective fertilization of gametes with higher chromosome numbers in selfing or due to the fertilization with normal n=19 pollen from neighbouring diploids.

Then, three 2n=29 plants and a 2n=32 plant newly chosen from the above plants were selfed or crossed. Chromosome numbers of plants derived from the selfing or crossing are as follows:

Parents	Chromosome number of progenies							
	29	30	31	32	33	34	35	Total
2n=29 self	3	2		1		1		7
2n=32 self				1	2	3	1	7
2n=29 x 2n=29				2				2

Also in this case, the progenies showed the increase of chromosome numbers. Therefore, it is deduced that out of gametes produced from aneuploids only those having higher chromosome numbers are viable or fertilizable, or among zygotes only those having higher chromosome numbers are viable. This deduction is evidenced by the pollen- or seed-fertilities of the hypodiploids obtained here.

There is a correlation between chromosome number and fertility (pollen fertility, r=0.785***; seed fertility, r=0.792***) : pollen- or seed-fertility gradually increased as chromosome numbers of the aneuploids became higher from 24 through 38.

In monogenomic species of *Brassica* such as *B. campestris* or *B. oleracea* the occurrence of hypodiploids is very rare. In *B. napus*, however, hypodiploids can survive and have some fertility. *B. napus* is composed of two genomes, *a* and *c*, which are partially homologous to each other. It is considered that the lack of some chromosomes from *a* genome may be compensated by other chromosomes from *b* genome and *vice versa*. According as the number of lacking chromosomes becomes larger, this compensation will become incomplete owing to the decrease of homologous parts of chromosomes. Therefore, the aneuploids having lower number of chromosomes are less fertile than those having higher number of chromosomes.

ANEUPLOID INDUCTION IN *BRASSICA OLERACEA*

A. B. Wills

As knowledge of genetics and chromosome morphology develops in *Brassica* species it becomes increasingly desirable to relate genes or linkage groups to particular chromosomes. Knowledge of such relationships would have practical breeding implications as well as more theoretical interest. The use of a trisomic (2n + 1) chromosome series has become a standard method to achieve these objectives in plants and it was decided to investigate whether a trisomic series could be produced and maintained in *B. oleracea* and whether it was possible to identify the extra chromosomes at pachytene of meiosis.

Calabrese (*B. oleracea* var *italica*) seedlings were treated with a range of colchicine concentrations for varying periods immediately after germination. Subsequently a number of plants with heavy, thickened leaves and larger flowers were confirmed as tetraploid by examination of meiosis in pollen mother cells. The mean seed set of 4n plants was less than 2 seeds/flower (bud selfed) and less than 0.1 seeds/flower in 4n x 2n crosses, however, almost 1 seed/flower resulted from 2n x 4n crosses.

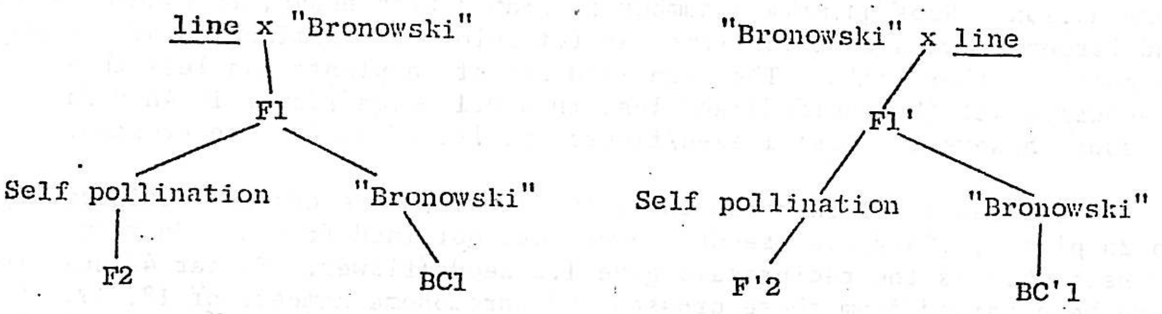
Triploids resulting from the above crosses were crossed reciprocally to 2n plants. Only 0.03 seeds/flower were obtained from the 3n x 2n crosses whereas the reciprocals gave 1.2 seeds/flower. So far 45 seedlings have been raised from these crosses and chromosome numbers of 18, 19, 20, 21 and 27 have been found. Pachytene analysis is in progress and trivalents involving two recognisably distinct chromosomes have been isolated. The plants have also set seed from hand pollinations.

These results encourage the belief that there are good prospects of obtaining and maintaining the trisomic series and also of identifying the extra chromosomes. However, until progenies from trisomics have been grown and compared, it is not known whether each trisomic type can be readily identified morphologically or whether laborious cytological screening will be required.

STUDY OF A CYTOPLASMIC MALE STERILITY IN RAPESEED (B. napus)

P. ROUSSELLE M. RENARD

THOMPSON (1972) found evidence for cytoplasmic male sterility in rapeseed by using the Polish variety "Bronowski" as male parent in crosses. He proposed the following explanation : some varieties have a sterile cytoplasm (S) with the dominant restorer alleles (Rf, Rf) and "Bronowski" has a fertile cytoplasm (F) and the recessive male sterile alleles (rf, rf). In order to study this hypothesis, we made the following crosses :



In such crosses, 7 spring lines were used, the following results were obtained :

- male sterile plants appear only in crosses with "Bronowski" as male parent. No one was found in reciprocal crosses. So it seems, as THOMPSON said, that the sterility has a cytoplasmic explanation : "Bronowski" possesses a normal cytoplasm (F) and other lines a sterile one (S).

- in all crosses where "Bronowski" was male parent, we found male sterile plants, in F2 and BC1 generations. No results can be explained by only one gene. The statistical analysis (see figures 1 and 2) agrees with a segregation explained by two genes. A male sterile plant must be [(S) rf1,rf1 ; rf2, rf2] , every other combination gives male fertile plants.

- besides, we observed a certain instability of male sterility : many plants became fertile at the end of flowering period in field ; other sterile plants became fertile in green-houses. It seems that the stability of male sterility is better in söme crosses.

After these results, we are carrying on this work in two directions :

- The high frequency of cytoplasm (S) found in spring lines must be controlled in winter rapeseed. Crosses between 23 winter rape lines and "Bronowski" will be examinated.

- The role of environmental and genetical effects has to be studied to precise the stability of the male sterile plants.

Reference : THOMPSON K.F., Cytoplasmic male sterility in oil-seed rape. Heredity, 1972, 29 (2), 253-257.

SEGREGATION FOR MALE STERILITY WITH BRONOWSKI

1 - Segregation in F2 ♀ variety x 0 Bronowski

Theoretical ratio : 1/16 sterile
15/16 fertile

Variety	Sterile Observed	Fertile Observed	Sterile Expected	Fertile Expected	X2	Probability
CSSR	23	326	21,81	327,19	0,07	0,75 - 0,90
Argentine	20	292	19,50	292,50	0,01	0,90 - 1
Zellerngold	1	40	2,55	38,44	1,01	0,25 - 0,50
Janus	22	335	22,31	334,69	$4,6\ 10^{-3}$	0,90 - 1
Crèsus	24	320	21,50	322,50	0,31	0,50 - 0,75
Maris Haplona	16	253	16,81	252,19	0,04	0,75 - 0,90
R 69-1	6	154	10,00	150,00	1,71	0,10 - 0,25
R 70-1	29	370	24,94	374,06	0,70	0,25 - 0,50

2 - Segregation in BC1 : (♀ variety x 0 Bronowski) x 0 Bronowski

Theoretical ratio : 1/4 sterile
3/4 fertile

Variety	Sterile Observed	Fertile Observed	Sterile Expected	Fertile Expected	X2	Probability
CSSR	39	112	37,75	113,25	0,06	0,75 - 0,90
Argentine	33	99	33,00	99,00	0	1
Zellerngold	10	24	8,50	25,50	0,35	0,50 - 0,75
Janus	10	26	9,00	27,00	0,15	0,50 - 0,75
Crèsus	27	104	32,75	98,25	1,35	0,25 - 0,50
Maris Haplona	10	32	10,50	31,50	0,03	0,75 - 0,90
R 69-1	32	80	28,00	84,00	0,76	0,25 - 0,50
R 70-1	30	101	32,75	98,25	0,31	0,50 - 0,75

NUCLEUS SUBSTITUTION OF BRASSICA WITH RAPHANUS

M. Kato and S. Tokumasu

Brassicoraphanus was obtained by means of colchicine treatment of F_1 of Brassica japonica Sieb. x Raphanus sativus L. (Tokumasu, 1976 ; Kato & Tokumasu, 1976). Nucleus substitution of B. japonica with R. sativus was carried out using this Brassicoraphanus.

Two B_1 plants between Brassicoraphanus and 4x R. sativus were obtained using 645 flowers of Brassicoraphanus (25 plants) in 1971. Both of the B_1 plants had 36 chromosome numbers. One of them gave 10 B_2 plants from the cross with 2x R. sativus and 4 plants from the open pollination, but no plant from the cross with 4x R. sativus. The chromosome numbers of B_2 plants ranged 21-26, and plants from the open pollination had 21-36 chromosome numbers. Plants substituted completely with R. sativus were obtained through two backcrosses more.

In the course of nucleus substitution, plants with various numbers of chromosomes were obtained. The cotyledons and leaves of the plants having 18-23 chromosome numbers showed chlorophyll deficiency and were of yellow or whitish yellow colour, and those of the plants having 24-27 chromosome numbers showed a slight chlorophyll deficiency and were of yellowish green colour. The plants having more than 28 chromosome numbers did not show any chlorophyll deficiency.

Reciprocal crosses between the yellow radish (R. sativus having B. japonica cytoplasm, 2n=18) and normal green plants of B. japonica or various species or subspecies of Raphanus were examined. Yellow leaves always appeared in F_1 when various types of Raphanus were used as male parents and did not appear in any other crosses. That is to say, chlorophyll deficiency occurs when RR genome is combined with B. japonica cytoplasm, whatever the original subspecies of RR genome may be.

Chlorophyll content of the yellow radishes grown for two weeks at four different air temperatures (4.5, 7.0, 15.0, and 20.0°C) was examined. Chlorophyll content of control plants (R. sativus) increased with the rising of temperature. On the other hand, chlorophyll content of the yellow radishes did not vary under these air-temperature conditions and was approximately 50 % of that of control plants at 4.5°C and 15 % at 20.0°C.

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A YELLOW PETAL MUTANT IN CULTIVATED RADISH (RAPHANUS SATIVUS L.) ; HEREDITY OF THE CHARACTER.

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In 1976, a radish plant (Raphanus sativus L.) with yellow petals spontaneously occured in a line obtained by selfing in the Rubens variety. This line is half-long, red and white rooted and is suitable for glasshouse culture.

On the 48 plants of the line, the 47 other sib plants showed white petals. The yellow petal plant was exactly similar to the others except for flower coloration ; its progeny by selfing does not segregate.

This yellow petal character has never been reported in the Raphanus sativus L. species, but does exist in the spontaneous Raphanus : R. Raphanistrum L., R. segetum Baumg., R. landra Moretti, R. maritimus Sm.

Genetic studies of this character have been made by crossing the yellow petal plant with white petal plants. The results of the F_1, F_2 and BC_1 generations proved that the yellow petal character is controled by a single recessive gene ; we suggest to call it "yp" : yellow petal. For this character, radish has the same heredity than cabbage (Brassica oleracea L.) where the white petal allele is dominant to its yellow petal allelomorph (PEARSON, 1929).

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SEGREGATION OF FERTILITY RESTORATION IN F_2 AND TESTCROSS PROGENIES FROM CROSSES BETWEEN MALE STERILE LINE AND EUROPEAN CULTIVARS OF OIL SEED RAPE, *BRASSICA NAPUS* L.

SHIGA, T., Y. OHKAWA AND K. TAKAYANAGI

We previously classified European cultivars into three groups, S, N and S/N, according to the kind of their cytoplasm (SHIGA, *et al.* 1976, Cruciferae News Letter 1). This paper deals with the fertility restoration in F_2 progenies of crosses between male sterile line and European cultivars and in F_1 progenies of following four testcrosses; (1), (Cultivar*(MS*Cultivar)), (2), ((MS*Cultivar)*Cultivar), (3), ((*chi*)Isuzu-matane*(MS*Cultivar)), (4), ((Cultivar*MS)*Isuzu-natane) or ((Cultivar*Isuzu-natane)*Isuzu-natane). Cultivar Isuzu-natane used has non-male sterility inducing cytoplasm and non-restoring gene.Strain (*chi*)Isuzu-natane is derived from the backcross of (MS*(Isuzu-natane)5).The degree of fertility restoration was determined by scores indicating relative position of anther to stigma as previously reported (SHIGA, 1976).

The segregation of three classes, male sterile, partially male sterile and male fertile plants, were observed in 63 F_2 and 48 testcrosses populations. Sixty three European cultivars were classified into seven classes, i.e. S-I, S-II, S-III, S-IV, N-I, N-II and N-III. Roman numerals show the number of restoring genes which are estimated in F_2 segregation ratios. Of five cultivars with S cytoplasm, two had one or two restoring genes, and the others had three genes. Thirteen cultivars with N cytoplasm included six with a single restoring gene, two with one or two genes and five with three genes. Among 55 cultivars with S/N cytoplasm, eight had two restoring genes, one had two or three genes and the rest three or four genes. It could be concluded that European cultivars had S and N cytoplasms, and that there were ubiqutous fertility restoring genes in the cultivars having either cytoplasm.

Twelve European cultivars used in the testcrosses were randomly sellected from above 55 cultivars having S/N cytoplasm. From the results of the testcrosses of (1) and (2), we could not estimate the kind of cytoplasm of European cultivars used, because all hybrid plants were high in fertility. Of the twelve cultivars, ten had S cytoplasm since there was no difference between the testcrosses of (3) and (4) in the segregation ratios for the male sterile plants. The rest, two, had N cytoplasm, since the male sterile plants were segregated in the testcross of (3), and not segregated in that of (4). Hence. it was concluded that most European cultivars had S cytoplasm, and a small number of them had N cytoplasm.

DATA STORAGE AND RETRIEVAL FOR CRUCIFER GENE BANKS

P. Crisp

Several schemes exist for the tabulation of genetic characteristics of stored seed stocks. Many of these are computer-based, and as well as programmes constructed to meet local needs, others such as TAXIR are intended for more general use.

One of these general systems may eventually be adopted internationally by gene banks and, possibly, by breeders with working collections of material. Such a system is likely to incorporate a list of descriptors, each referring to a particular character of the crop concerned, with each genotype being described by statements (descriptor states) attached to each descriptor.

Although no such system is as yet agreed, it seems sensible at this stage to discuss the descriptors which may pertain to the crucifers, as this may ease any future integration of systems at present being developed in isolation. As a contribution to this discussion I propose the following. Comments sent to me at NVRS, Wellesbourne, Warwick, UK will be collated and could form the basis of a further note. Radical disagreement with my suggestions may be best expressed as counter proposals sent direct to the Editor of the Cruciferae Newsletter.

The crucifers are different from other crops because they contain a very wide range of crop types across a number of species, several of which are interfertile. I suggest that we consider a two-tier system of descriptors for the crucifers, rather than a cumbersome system designed to accommodate all crucifers, as most of the descriptors would be redundant for any one crop. The first tier would consist of descriptors which are relevant to all crucifers (such as S-alleles, and clubroot, turnip mosaic virus, and cabbage root fly resistances), and a descriptor each for species and crop type, thus allowing cross referencing between the same or interfertile species categorised separately in the second tier. The second tier would be of descriptors specific for each crop type (or wild taxon). I suggest that there should be six crop types, as follows. Some of these groupings will include considerable redundancy of descriptors, but far less than if we were to treat the Cruciferae as a single unit.

Crop type	to contain the appropriate forms of:
Oil seed forms	Brassica campestris, B. nigra, B. napus, B. juncea, B. carinata, Raphanus spp., Crambe spp., Eruca spp., Camelina spp., etc.
Mustard seed forms	B. campestris, B. nigra, B. juncea, etc.
Non-heading leafy fodders and vegetables	B. campestris, B. oleracea, B. napus, B. juncea, B. carinata, Raphanus spp., Nasturtium spp., Lepidium sativum, Raphano-brassica, B. napocampestris, etc.
Forms with swollen vegetative buds	B. campestris, B. oleracea, etc.
Forms with swollen stems or roots	B. campestris, B. oleracea, B. napus, Raphano-brassica, B. napocampestris, Raphanus spp., Armoracia rusticana, etc.
Forms with culinary inflorescences	B. alboglabra, B. oleracea, Raphanus cordatus, B. campestris, etc.

The list could be extended to include wild taxa.

Swede Genebank

Isabel K. Munro

In recent years many of the older varieties of swede (B.napus ssp. rapifera) have gone out of cultivation and are in danger of becoming extinct. This is partly due to lack of demand as better varieties become available and partly due to the failure to meet the legislative requirements for D.U.S. (distinctness, uniformity and stability) associated with the National List System.

Amongst the older varieties, some may have desirable characteristics, such as good leaf retention, high dry matter content or disease resistance, which could be useful in future breeding programmes. Although new genotypes of B.napus can now be readily synthesised from the component species there is an inherent shortage of variability which makes it imperative to preserve what already exists.

To this end a collection of seed samples of old swede varieties was started in 1977 at the Scottish Plant Breeding Station. So far 182 samples have been received. Seed of the 87 oldest samples were tested for germination, only 65 produced seedlings, thus emphasising the urgent need to rescue stocks whilst they remain viable. The procedure planned is that from each stock or variety a maximum of 25 plants will be grown in an insect-proof cage for seed production. If seed quantity and quality is satisfactory part of this bulk will be set aside for long term storage and part sown for a simple assessment of morphological and agronomic characters. Varieties with few plants or limited seed set will be multiplied again at once but otherwise this will not be done until there is evidence of a drop in viability.

It is hoped that it may be possible to encompass other forms of B.napus in due course including those synthesised artificially. At present the multiplication facilities which can be diverted from breeding to gene bank work are not sufficiently extensive to permit the supply of seed as a service to other breeders, although this will be considered later.

In order to make the collection as comprehensive as possible I should be glad to receive a few grams of seed of any old B.napus varieties from all parts of the world. A list of varieties in store will be published in a later Newsletter.

Please send seed to me at the Scottish Plant Breeding Station, Pentlandfield, Roslin, Midlothian, EH25 9RF, Scotland, U.K.

A description of the genetic stocks in subtribe Brassicineae by chromosome numbers and numerical characters

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With the purpose of studying the differentiation of cultivated and wild Brassicas, the species in subtribe Brassicineae have been investigated on their chromosome numbers and several morphological characters. Although this study is not completed yet, a tentative summary of our results is presented here, which may introduce the materials preserved in the Laboratory of Plant Breeding, Tohoku Univ., Sendai, Japan.

The materials were composed of 134 strains in 58 species in subtribe Brassicineae, the most of which were collected from the Mediterranean countries by the exploratory trips of Tohoku University in 1965 and in 1975. Some part of them were provided from several institutions as described in Table 1, to whom we express acknowledgement. Strains were identified under the guidance of Prof. C. Gómez-Campo, Escuela T. S. de Ing. Agr., Univ. Politecnica, Madrid, to whome we also express acknowledgement.

The counting of chromosome numbers was made on the PMC of plants after acetocarmine staining, but in some cases on the root tips after feulgen staining. The results are presented in Table 1. Most of them support the results ever contributed by Manton (1932), Harberd (1972, 76) and others.

Our contribution may be summarised as follows:
(A) The chromosome numbers of B. desnottesii, D. siettiana, Es. varium, Es. strigosum, Rh. granatensis and S. aucheri were newly determined. Of these 6 species, B. desnottesii is morphologically alike to B. repanda and they have the same number of chromosomes. Rh. granatensis has the same number of chromosomes with the other Rhynchosinapis species being assumed to be included in the Rhynchosinapis cytodeme decribed by Harberd (1976). The other 4 species seem to be in respective cytodeme different from those described by Harberd (1976).

(B) B. fruticulosa ssp. mauritanica and ssp. radicata were $n = 16$. The F_1 hybrids between each of them and B. fruticulosa ssp. cossoneana showed sixteen bivalents in almost all PMCs. Since the subspecies cossoneana was suggested to be autotetraploid by Harberd (1976), the three subspecies in B. fruticulosa are considered to be all autotetraploids.

(C) In B. gravinae, a strain from Algeria had the autotetraploid number of chromosomes. The morphology of the tetraploid and diploid strains are very alike but the former is a little larger in flower size.

(D) B. drepanensis, B. incana and B. macrocarpa were n = 9. Schulz (1936) indicated B. incana resembles to B. oleracea in morphology, and Harberd (1976) inferred these are involved in B. oleracea cytodeme.

(E) D. berthautii was reported to be n = 10 by Harberd (1976) and Es. arabicum 2n = 30 - 32 by Manton (1932). The chromosome number of the present investigation differed from their observations. Since only one strain was used in the respective species, we have a hope to obtain other viable specimens for the correct determination of them.

In order to know the vaiation of the subtribe Brassicineae, principal component analysis was carried out basing on the 30 numerical characters of seeds, cotyledones, flower organs and fruits. The measurements of the characters were made on the plants grown in a glasshouse in Japan. A part of the results is presented here. Strains were scattered by their score on the plane determined by the first (horizontal) and the second (vertical) component as shown in Fig. 1, where the strain numbers are comparable to those in Table 1.

In view of the eigenvector the first component indicated the variation of the general size (-, large, vs. +, small) and the second the relative size of beak in fruits (-, large, vs. +, small). The distribution of the genus was correlated with the morphological taxonomy carried out by Schulz (1936), Maire (1965), and Heywood (1964). This figure may suggest the general differentiation trend of the species in subtribe Brassicineae.

Some notable points are:-
(A) Rhynchosinapis and Hutera were not discriminated.Harberd (1976) pointed out they belong to the same cytodeme, and Gómez-Campo(1977) proposed they are the same genus.
(B) Diplotaxis, Erucastrum and Sinapidendron were not discriminated, too. They seems to be closely related.
(C) Cultivated species distribute at the left side of the figure. The species with large organs have been selected for cultivation and the species in cultivation have selected toward large size.
Details will be reported elsewhere.

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Table I Materials and chromosome numbers

Genus / Species name (Chrom.no.reported) / Strain	Origin	Ref. no.+ for stock	Chrom.no. observed
Brassica			
amplexicaulis n=11(C)			
B01	Algeria	Am-3	n=11
B02	Morocco	Am-4	n=11
barrelieri n=10(C)			
B03	Spain	Ba-103	n=10
B04	"	Ba-106	n=10
B05	"	Ba-109	n=10
barrelieri ssp.oxyrrhina n=9(C)			
B06	Morocco	Ox-101	n=9
B07	Spain	Ox-107	n=9
B08	"	Ox-108	n=9
campestris n=10(0)			
B09	India	C-504[5)]	n=10
B10	"	C-506[5)]	n=10
B11	Japan	C-333	n=10
B12	Algeria	C-473	n=10
carinata n=17(G)			
B13	Ethiopia	Ca-101	
B14	"	Ca-104	n=17
B15	"	Ca-112	n=17
deflexa ssp. leptocarpa*			
B16	Iran	Df-1[1)]	n=7
drepanensis*			
B17	Italy	Dr-1[1)]	2n=18°
elongata n=11(I)			
B18	Iran	El-102[1)]	n=11
fruticulosa n=8(K)			
B19	Italy	Fr-103	n=8
B20	Spain	Fr-104[2)]	n=8
B21	Morocco	Fr-503	n=8
B23	Spain	Fr-202	n=8
fruticulosa ssp.cossoneana n=16(C)			
B22	Morocco	Fr-201	n=16
fruticulosa ssp.radicata*			
B24	Algeria	Fr-301	n=16
B25	"	Fr-502	n=16
fruticulosa ssp.mauritanica*			
B26	Algeria	Fr-401	n=16
gravinae n=10(D)			
B27	Algeria	Gr-1[1)]	n=10
B28	"	Gr-2	n=20*
incana*			
B29	Italy	Inc-1[1)]	n=9
juncea n=18(F)			
B30	India	J-113[5)]	n=18
B31	"	J-114[5)]	n=18
macrocarpa*			
B32	Italy	0-503[1)]	2n=18°
maurorum n=8(D)			
B33	Spain	Ma-1[1)]	n=8
B34	Morocco	Ma-2	n=8
B35	Algeria	Ma-5	n=8
napus n=19(L)			
B36	Japan	N-101	
B37	"	N-132	n=19
B38	"	N-137	n=19
B39	Algeria	N-472	
nigra n=8(F)			
B40	Ethiopia	Ni-116	n=8
B41	Algeria	Ni-138	n=8
B42	U.S.A.	Ni-141	n=8
oleracea n=9(F)			
B43	England	0-166	n=9
B44	"	0-169	
B45	Spain	0-171	
B46	Japan	0-8	
repanda ssp.maritima n=10(B)			
B47	Spain	Re-4[1)]	n=10
repanda ssp.nudicaulis n=10(C)			
B48	Spain	Re-5[1)]	
rupestris n=9(I)			
B49	Italy	0-402[1)]	2n=18°
spinescens n=8(D)			
B50	Algeria	Sp-1	n=8
tournefortii n=10(N)			
B51	Algeria	T-165	
B52	Spain	T-167	n=10
B53	Egypt	T-162	n=10
desnottesii*			
B54	Morocco	Ds-1[1)]	n=10
Diplotaxis			
assurgens n=9(C)			
D01	Morocco	ASSUR-1	n=9
D02	"	ASSUR-2	n=9
D03	"	ASSUR-3	n=9
berthautii n=10(D)			
D04	Morocco	BERTH-1[1)]	n=9
catholica n=9(I)			
D05	Spain	CATHL-4[2)]	n=9
D06	"	CATHL-5	n=9
erucoides n=7(I)			
D07	Italy	ERUCD-4	n=7
D08	Algeria	ERUCD-7	n=7
D09	Spain	ERUCD-9	n=7
harra n=13(D)			
D10	Egypt	HARRA-1	n=13
D11	Italy	HARRA-4	n=13
harra ssp.crassifolia n=13(C)			
D12	Morocco	HARRA-6	n=13
harra ssp.lagascana n=13(C)			
D13	Spain	HARRA-8	n=13

D14 Algeria HARRA-9 n=13
muralis n=21(J)
D15 MURAL-1[6] n=21
D16 Germany MURAL-3[1] n=21
pitardiana n=11(D)
D17 Algeria PITAL-1[1] n=11
siifolia n=10(C)
D18 Morocco SIFOL-2 n=10
D19 Spain SIFOL-3 n=10
D20 Morocco SIFOL-4 n=10
tenuifolia n=11(P)
D21 Morocco TENFO-3[3] n=11
tenuisiliqua n=9(C)
D22 Algeria TENSI-1 n=9
D23 Morocco TENSI-5 n=9
D24 " TENSI-6 n=9
D25 Algeria TENSI-7 n=9
D26 " TENSI-9 n=9
virgata n=9(M)
D27 Spain DVIRG-4 n=9
D28 Morocco DVIRG-10 n=9
D29 Morocco DVIRG-12 n=9
D30 Spain DVIRG-13[2] n=9
siettiana*
D31 Alboran SIETA-1[1] n=8

Eruca

sativa n=11(I)
E01 India ESATV-9 n=11
E02 Greece ESATV-12 n=11
vesicaria n=11(C)
E03 Morocco EVESC-3 n=11
vesicaria ssp.pinnatifida n=11(C)
E04 Spain EVESC-5 n=11
E05 Morocco EVESC-6 n=11
E06 Algeria EVESC-8 n=11

Erucastrum

abyssinicum n=16(I)
M01 ABYSS-1 n=16
M02 Ethiopia ABYSS-2 n=16
arabicum 2n=30-32(I)
M03 Ethiopia ARABI-1[7] n=14
cardaminoides n=9(H)
M04 Madeira CARDM-1 n=9
M05 CARDM-2 n=9
gallicum n=15(I)
M06 Germany GALCM-1[1] n=15
laevigatum n=14(C)
M07 Spain LEVGT-2 n=14
leucanthum n=8(C)
M08 Morocco LEUCT-1 n=8
nasturtiifolium n=8(A),n=16(I)
M09 Spain NASTF-1 n=8
M10 " NASTF-2 n=8
M11 " NASTF-3 n=8

varium*
M12 Algeria VARIM-2 n=7
M13 Morocco VARIM-3 n=7
M14 " VARIM-6 n=7
M15 " VARIM-7 n=7
M16 " VARIM-8 n=7
M17 Algeria VARIM-10 n=7
virgatum n=7(C)
M18 Italy EVIRG-1[1] n=7
strigosum*
M19 S.Africa STRGM-1[1] n=8

Hirschfeldia

incana n=7(E)
Hi1 Morocco Ad-111 n=7
Hi2 Algeria Ad-112 n=7
Hi5 Ad-118[4] n=7
incana ssp.consobrina
Hi3 Algeria Ad-115 n=7
incana ssp.geniculata
Hi4 Algeria Ad-116 n=7

Hutera

leptocarpa n=12(C)
Hu1 Spain LEPTC-1 n=12
rupestris n=12(C)
Hu2 Spain RUPST-1[1] n=12

Rhynchosinapis

cheiranthos n=12(C), n=24(Q)
R01 Spain CHEIR-1[1] n=24
granatensis*
R02 Spain GRANA-1[1] n=12
hispida n=12(C)
R03 Spain HISPD-1[1] n=12
R04 HISPD-2[2] n=12
longirostra n=12, 24(C)
R05 Spain LONGR-1 n=12
R06 " LONGR-2 n=12
pseuderucastrum ssp.cintrana n=12, 24(C)
R07 Portugal PSDER-2 n=12

Sinapidendron

angustifolium n=10(C)
Sd1 Madeira ANGST-1
rupestre n=10(C)
Sd2 Madeira SDRUP-1[1] n=10

Sinapis

alba n=12(F)
S01 Morocco SALBA-25 n=12
S02 Algeria SALBA-28 n=12
arvensis n=9(F)
S03 Morocco ARVNS-13 n=9
S04 Algeria ARVNS-16 n=9

S05	U.S.A.	ARVNS-18	n=9	pubescens		n=9(C)	
aucheri*				S07	Italy	PUBES-1[1)]	n=9
S06	Iran	AUCHR-1[1)]	n=9	turgida		n=9(C)	
				S08	Egypt	TURGD-1	n=9

* * * * *

Notes for Table 1:-

+: Reference number for the stock preservation in the laboratory of Plant Breeding, Tohoku University, Sendai, Japan.

*: Newly determined species.

°: 2n represents the root tip observation.

The marked strains were provided from 1) Inst. Nac. Inv. Agr., Univ. Politecnica, Madrid, 2) Facultad de Farmacia, Madrid, 3) Inst. e Orto Bot. Rome, 4) Jardin Botanico de Madrid, 5) Indian Agr. Res. Inst., New Delhi, 6) Scottish Plant Breed Stat., U. K., 7) H. S. Univ., Addis Ababa.

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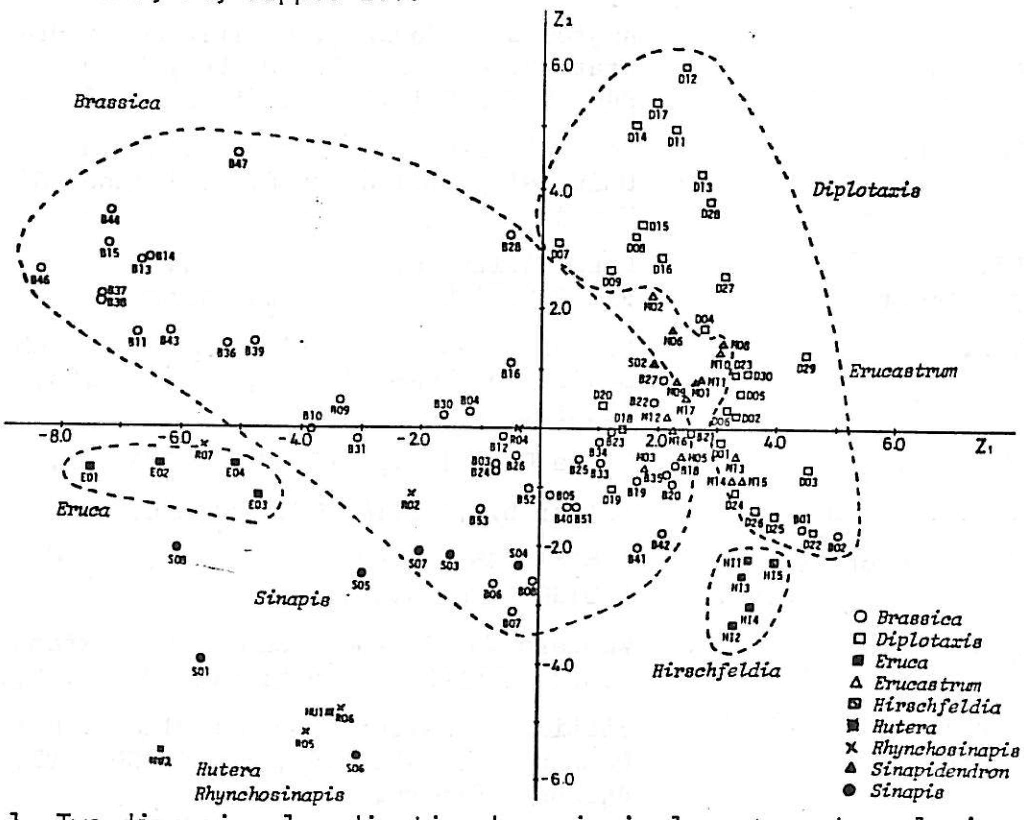

Fig. 1. Two dimensional ordination by principal component analysis

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3. Brassica napus
4. Brassica other species
5. Other genera
6. Interspecific & inter-generic hybrids

Usage

a. Vegetables and condiments
b. Fodder
c. Green manure
d. Oil and protein

Pests, diseases and weeds

e. Animal
f. Weeds
g. Fungal
h. Bacterial
i. Viral
j. Mineral

Disciplines

k. Agronomy
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