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CONSENSUS DOCUMENT ON THE BIOLOGY OF BRASSICA NAPUS L. (OILSEED RAPE)

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

Paris

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Series on Harmonization of Regulatory Oversight of Biotechnology

No. 7

Consensus Document on the Biology of *Brassica napus* L. (Oilseed Rape)

Environment Directorate

Organisation for Economic Co-operation and Development

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FOREWORD

The OECD's Expert Group on Harmonization of Regulatory Oversight in Biotechnology decided at its first session, in June 1995, to focus its work on the development of ***consensus documents*** that are mutually acceptable among Member countries. These consensus documents contain information for use during the regulatory assessment of a particular product. In the area of plant biosafety, consensus documents are being initiated on the biology of certain crop plants and on selected traits.

This document, which was prepared by Canada as lead country, addresses the biology of the crop plant *Brassica napus* L. (oilseed rape). The OECD's Working Group for Environmental Biosafety of Transgenic Plants reviewed the format of the document at a meeting in Washington, D.C. in October 1995. The document was forwarded to National Co-ordinators for technical comments in January 1996, and subsequently revised.

As part of a joint project with the United Nations Industrial Development Organization (UNIDO) on centres of origin of diversity, this document was reviewed by experts in several countries in central and eastern Europe, northern Africa, and Asia. Relevant comments submitted by these experts have been incorporated.

The Joint Meeting of the Chemicals Group and Management Committee of the Special Programme on the Control of Chemicals has recommended that this document be made available to the public. It is published on the authority of the Secretary-General of the OECD.

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Preamble

OECD Member countries are moving rapidly towards the commercialization and marketing of agricultural and industrial products of modern biotechnology. They have therefore identified the need for harmonization of regulatory approaches to the assessment of these products, in order to avoid unnecessary trade barriers.

In 1993, **Commercialization of Agricultural Products Derived through Modern Biotechnology** was instituted as a joint project of the OECD's Environment Policy Committee and Committee on Agriculture. The objective of this project is to assist countries in their regulatory oversight of agricultural products derived through modern biotechnology – specifically in their efforts to ensure safety, to make oversight policies more transparent and efficient, and to facilitate trade. The project is focused on the review of national policies, with respect to regulatory oversight, that will affect the movement of these products into the marketplace.

The first step in this project was to carry out a survey concentrating on national policies with regard to the regulatory oversight of these products. Data requirements for products produced through modern biotechnology, and mechanisms for data assessment, were also surveyed. The were published in *Commercialisation of Agricultural Products Derived through Modern Biotechnology: Survey Results* (OECD, 1995).

Subsequently, an OECD Workshop was held in June 1994 in Washington, D.C. with the aims of improving awareness and understanding of the various systems of regulatory oversight developed for agricultural products of biotechnology; identifying similarities and differences in various approaches; and identifying the most appropriate role for the OECD in further work towards harmonization of these approaches. Approximately 80 experts in the areas of environmental biosafety, food safety and varietal seed certification, representing 16 Member countries, eight non-Member countries, the European Commission and several international organisations, participated in the Workshop. The *Report of the OECD Workshop on the Commercialisation of Agricultural Products Derived through Modern Biotechnology* was published by the OECD in 1995.

As a next step towards harmonization, the Expert Group on Harmonization of Regulatory Oversight in Biotechnology instituted the development of ***consensus documents*** that are ***mutually acceptable*** among Member countries. The purpose of these documents is to identify common elements in the safety assessment of a new plant variety developed through modern biotechnology, in order to encourage information sharing and prevent duplication of effort among countries. These common elements fall into two general categories: the biology of the host species, or crop; and the gene product. This consensus document on the biology of oilseed rape (*Brassica napus* L.) is one of the first in a planned series of such documents.

In reviewing this document, and the biology of other plants, two OECD publications will prove particularly useful. *Traditional Crop Breeding Practices: An Historical Review to Serve as a Baseline for Assessing the Role of Modern Biotechnology* provides information about 17 different crop plants. It includes sections on phytosanitary considerations in the movement of germplasm and on current end uses of the crop plants. There is also a detailed section on current breeding practices. *Safety Considerations for*

Biotechnology: Scale-Up of Crop Plants provides a background on plant breeding, discusses scale dependency effects, and identifies various safety issues related to the release of plants with "novel traits".[1]

The safety issues identified in the consensus documents on crop specific biologies are intended to address the potential for gene transfer within the crop plant species, and among related species, and the potential for weediness. They make no attempt to be definitive in this respect, however, as the many different environments in which the crop species may be grown are not considered individually.

This document is a “snapshot” of current information that may be relevant in a regulatory risk assessment. It is intended to be useful not only to regulatory officials as a general guide and reference source, but also to industry and others carrying out research.

In order to ensure that scientific and technical developments are taken into account, Member countries have agreed that these consensus documents will be updated regularly. Additional areas relevant to the subject of each consensus document will be considered at the time of updating.

Users of this document are therefore invited to provide the OECD with new scientific and technical information, and to make proposals for additional areas to be considered. ***There is a short, pre-addressed questionnaire for that purpose at the end of this document. The completed questionnaire (or a photocopy) should be returned to the Environmental Health and Safety Division at the address shown.***

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[1] For more information concerning these two publications, contact the OECD’s Publications Service, 2 rue André-Pascal, 75775 Paris, Cedex 16, France. Fax: (33) (01) 49 10 42 76. Internet: Compte. PUBSINQ@ oecd.org.)

Section I – General Information

This consensus document addresses the biology of the species *Brassica napus* L. Included are general descriptions of this species as a crop plant, its origin as a species, its reproductive biology, its centres of origin, and its general ecology. The ecology of this species is not described in relation to specific geographic regions. Special emphasis has been placed on detailing potential hybridization between *B. napus* and its close relatives, although this discussion is limited to hybridization events which do not require intervention through means such as embryo rescue (i.e. these events could possibly occur in nature, and could result in fertile offspring).

This document was prepared by a lead country, Canada. It is based on material developed in OECD Member countries – for example, for risk assessments or for presentation at conferences and scientific meetings. It is intended for use by regulatory authorities and others who have responsibility for assessments of transgenic plants proposed for commercialization, and by those who are actively involved in these plants' design and development.

The table in the Appendix showing potential interactions of *B. napus* with other life forms during its life cycle was developed **with respect to Canada**. As such, it is intended to serve as an example. Member countries are encouraged to develop tables showing interacting organisms specific to their own geographic regions and environments.

Section II – General Description and Use as a Crop

Brassica napus L. is a member of the subtribe *Brassicinae* of the tribe *Brassiceae* of the Cruciferous (Brassicaceae) family, sometimes referred to as the mustard family. The name “cruciferous” comes from the shape of its flowers, which have four diagonally opposite petals in the form of a cross. The dark bluish green foliage of *B. napus* is glaucous, smooth or has a few scattered hairs near the margins, and is partially clasping. The stems are well branched, although the degree of branching depends on variety and environmental conditions; branches originate in the axils of the highest leaves on the stem, and each terminates in an inflorescence. The inflorescence is an elongated raceme; the flowers are yellow, clustered at the top but not higher than the terminal buds, and open upwards from the base of the raceme (Musil, 1950).

There are two types of *B. napus*: 1) oil-yielding oleiferous rape, of which one subset with specific quality characteristics is often referred to as "canola" (vernacular name), and 2) the tuber-bearing swede or rutabaga. This document is written for oil-yielding oleiferous rape. The oleiferous type can also be subdivided into spring and winter forms. Sanskrit writings of 2000 to 1500 BC directly refer to oleiferous *B. napus* forms (sarson types) and mustard. Greek, Roman and Chinese writings of 500 to 200 BC refer to rapiferous forms of *B. rapa* (Downey and Röbbelen, 1989). In Europe, domestication is believed to have occurred in the early Middle Ages. Commercial plantings of rapeseed are recorded in the Netherlands as early as the 16th century. At that time rapeseed oil was used primarily as an oil for lamps. Later it came to be used as a lubricant in steam engines.

Although used widely as an edible oil in Asia, only through breeding for improved oil quality, and the development of improved processing techniques, has rapeseed oil become important in western countries. Since the Second World War, rapeseed production in Europe and Canada has increased dramatically as a result of improved oil and meal quality. Modern techniques of plant transformation and genotype identification using isozymes, restriction fragment length polymorphism (RFLP) markers, or random amplified polymorphic DNA (RAPDs) markers will complement classical breeding for the production of other improved lines (Buzza, 1995). China, India, Europe and Canada are now the top producers, although this crop can be successfully grown in the United States, South America and Australia, where annual production has increased sharply over the last few years.

Today, two species of *Brassica* have commercialized varieties with "double low" characteristics, i.e. low erucic acid content in the fatty acid profile and very low glucosinolate content in the meal, characteristics desirable for high-quality vegetable oil and high-quality animal feed. In North America these species (*B. napus* and *B. rapa*) are considered to be of "canola" quality. *B. napus* is grown as a winter annual in regions where winter conditions do not result in very low temperatures, which would kill the plants. These biotypes typically require vernalisation before the onset of stem elongation, raceme development, flowering and seed set. In North America and northern parts of Europe, a spring biotype of *B. napus* that requires no vernalisation prior to flowering is grown. These biotypes are typically lower yielding than the winter annual types, but require considerably less time to complete their life cycle.

Section III – Agronomic Practices for Oleiferous *B. napus*

The spring-type oleiferous *B. napus*, a cool season crop, is not very drought tolerant. It is widely adapted and performs well under a range of soil conditions, provided that moisture and fertility levels are adequate. Air and soil temperatures influence plant growth and productivity. The optimum temperature for maximal growth and development of spring-type oilseed rape is just over 20°C, and it is best grown between 12°C and 30°C. After emergence, seedlings prefer relatively cool temperatures up to flowering; high temperatures at flowering will hasten the plant's development, reducing the time from flowering to maturity. Among cultivated crop plants, *Brassica* species show the highest nutritional demand for sulphur.

Due to increased awareness of soil conservation issues, minimal or no-till *B. napus* production is advised, in which most of the crop residue and stubble are left on the soil surface to trap snow, reduce snow melt run-off, reduce wind and water erosion of the soil, and increase soil water storage. Reduced tillage techniques, however, are only effective when combined with a good systematic weed control programme. Winter oilseed rape covers the soil for ten to eleven months. It has high nutritional demands in autumn and reduces soil erosion in winter.

Weeds can be one of the most limiting parameters in rapeseed production. The closely related cruciferous weeds, for example wild mustard (*Sinapis arvensis*), stinkweed (*Thlaspi arvense*), shepherd's purse (*Capsella bursa-pastoris*), ball mustard (*Neslia paniculata*), flixweed (*Descurainia sophia*), wormseed mustard (*Erysimum cheiranthoides*), hare's ear mustard (*Coringia orientalis*), common peppergrass (*Lepidium densifolium*), etc., are often problematic. Spring-type oilseed rape does not compete well with weeds in the early growth stages, as it is slow-growing and slow to cover the ground. Weeds must be controlled early to avoid yield loss due to competition. Although rapeseed crops can be attacked by a number of insect pests, insect control must be carefully designed to reduce unnecessary and costly pesticide applications, the chances of resistance build-up in insects, and damage to honeybees and native pollinating insects. Diseases can be severe in large production areas, and are greatly influenced by cultivation practices and environmental factors, so that disease management programmes are advisable (refer to the table in the Appendix for examples of *B. napus* pests and diseases in Canada).

When the first siliques begin to shatter, *B. napus* can be cut just below the level of the seed pods and swathed. The use of dessicants allows a reduction of shattering, and possibly allows direct combining.

Generally, oilseed rape should not be grown on the same field more often than once every three to four years in order to prevent the build-up of diseases, insects and weeds. Chemical residues from herbicides and volunteer growth from previous crops (including rapeseed crops grown for different oil types) are also important factors to consider when selecting sites, although suitable soil treatments following harvest may considerably reduce the volunteer problem.

Section IV – Centres of Origin/Diversity[2]

A. Geographic origin of *B. napus*

The origins of *B. napus* (an amphidiploid with chromosome n=19) are obscure, but were initially proposed to involve natural interspecific hybridization between the two diploid species *B. oleracea (n* = 9) and *B. rapa* (syn. *campestris)*[3] (n = 10) (U, 1935). Recent evidence (Song and Osborn, 1992), through analyses of chloroplast and mitochondrial DNA, suggests that *B. montana (n* = 9) might be closely related to the prototype that gave rise to both cytoplasms of *B. rapa* and *B. oleracea*. It also suggests that *B. napus* has multiple origins, and that most cultivated forms of *B. napus* were derived from a cross in which a closely related ancestral species of *B. rapa* and *B. oleracea* was the maternal donor. In Europe, it is predominantly the winter form which has become a common yellow crucifer found along roadsides, on waste sites and cultivated ground, on docks, in cities and towns, on tips, and on arable fields and along riverbanks. In the British Isles, it has been naturalised wherever oilseed rape is grown. It is a relatively recent introduction into Canada and the United States, and is described as an occasional weed, escape or volunteer in cultivated fields (Munz, 1968, and Muenscher, 1980). It is found typically in crops, fields and gardens, along roadsides, and on waste sites.

B. Geographic origin of *B. oleracea*

The wild form of *B. oleracea,* a suffrutescent (low, shrubby plant with woody lower parts of stems and herbaceous upper parts) perennial, grows along the coast of the Mediterranean from Greece through to the Atlantic coasts of Spain and France, around the coast of England, and to a limited extent in Helgoland (Snogerup et al., 1990). Typically the wild type is found on limestone and chalk cliffs in situations protected from grazing. Individuals are often found below cliffs in scree, where they grow among other shrubs, and some populations are found on steep grassy slopes. In Helgoland, populations are found on open rocky ground. In Europe and North America, domesticated types have been reported as escapes but do not form self-sustaining populations outside cultivation. *B. oleracea* is a recent introduction into North America.

C. Geographic origin of *B. rapa*

Wild *B. rapa* (subspecies *sylvestris* L.) is regarded as the species from which the ssp. *rapa* (cultivated turnip) and *oleifera* (turnip rape) originated. It is native throughout Europe, Russia, central Asia and the Near East (Prakash and Hinata, 1980), with Europe proposed as one centre of origin. There is some debate as to whether the Asian and Near Eastern types arose from an independent centre of origin in

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[2] This section draws heavily on discussions with, and a review paper prepared by, Dr S.I. Warwick and A. Francis (1994), Centre for Land and Biological Resources Research, Agriculture and Agri-Food Canada.

[3] First described as two species by Linnaeus, with *B. rapa* being the turnip form and *B. campestris* the oleiferous form. Metzger in 1933 concluded that these were the same species and chose the name *B. rapa* (Toxeopus et al., 1984).

Afghanistan and then moved eastward as *B. rapa* became domesticated. Prakash and Hinata (1980) suggest that oleiferous *B. rapa* subspecies developed in two places, giving rise to two different races, one European and the other Asian.

Typically, *B. rapa* is found in coastal lowlands, high montane areas (the slopes of high valleys or mountain ranges), and alpine and high sierras. In Canada, where it is a recent introduction, it is found on disturbed land, typically in crops, fields and gardens, along roadsides, and on waste sites (Warwick and Francis, 1994).

D. Geographic origin of *B. montana*

B. montana, possibly a progenitor species of *B. napus* (see above) and also a suffrutescent perennial, originates in the Mediterranean coastal area between Spain and Northern Italy (Snogerup et al., 1990). It is found typically on or below limestone cliffs and rocks, walls, etc., often on disturbed ground. Although usually found in coastal areas and on rocky islets, it has been recorded at an elevation of 1000 m somewhat inland of the coast.

Section V – Reproductive Biology

Under field conditions the fertilization of ovules usually results from self-pollination, although outcrossing rates of 5-30 per cent have been reported (Hühn and Rakow, 1979, and Rakow and Woods, 1987). The pollen, which is heavy and sticky, can be transferred from plant to plant through physical contact between neighbouring plants and by wind and insects. Oilseed rape pollen has been detected in the air above rape fields (Williams, 1984) and beyond the borders of a rape crop (Olsson, 1955); however, the concentration decreases rapidly with increasing distance from the source of the pollen and windborne pollen may make no or only a negligible contribution to long-distance pollination of oilseed rape (Mesquida and Renard, 1982, and McCartney and Lacey, 1991). Timmons et al. (1995), using pollen traps and "bait" plants whose petals had been removed and which had been emasculated, reported airborne pollen at distances up to 2.5 km from commercial plantings of *B. napus*. The "bait" plants also produced some seed at this distance from the commercial oilseed rape, suggesting the airborne pollen might be capable of successful fertilization events.

Pollinating insects, in particular honeybees (*Apis mellifera*) and bumblebees (*Bombus* sp.), play a major role in *B. napus* pollination and are believed to be involved in the transfer of pollen over long distances. Oilseed rape is very attractive to bees because it produces large quantities of nectar and pollen. Williams et al. (1987) reported that "plants in plots caged with bees had their flowers pollinated faster, shed petals sooner, finished flowering earlier and were shorter than plants caged without bees." *B. napus* pollen is a major food source for bees, and hives are often placed near rapeseed fields during flowering to take advantage of the honey production potential (Marquard and Walker, 1995).

When beehives were placed at the centre of each side of a 1 ha square of non-transgenic *B. napus* plants with a 9 m circle of transgenic plants at the centre, Scheffler et al. (1993) reported outcrossing ranging from 1.5 per cent at 1 m to 0.00033 per cent at 47 m. In a later study using 20 x 20 m plots of transgenic and non-transgenic plants, separated by distances of 200 and 400 m, the space separating the plots being either bare ground or planted with barley (*Hordeum vulgare*), Scheffler et al. (1995) reported the average frequency of hybridization to be 0.0156 per cent at 200 m and 0.0038 per cent at 400 m.

The dynamics of bee-mediated pollen movement depend on the quantity of pollen available (size and density of donor population) and the size and location of the receiving populations, as well as on environmental conditions and insect activity (Levin and Kerster, 1969, Ellstrand et al., 1989, and Klinger et al., 1992). These studies, together with the findings of Scheffler et al. (1993 and 1995), suggest that surrounding an experimental plot of *B. napus* with other plants of the same species flowering synchronously with the experimental plants could decrease the long-distance dispersal of pollen from experimental plants by insects.

Section VI – Cultivated *B. napus* as a Volunteer Weed

As with all crops cultivated and harvested at the field scale, some seed may escape harvesting and remain in the soil until the following season, when it germinates either before or following the seeding of the succeeding crop. In some instances the volunteers may give considerable competition to the seeded crop and cause deterioration in the quality of the crop harvest. In such instances, chemical and/or mechanical control is essential.

The problem of volunteer plants in succeeding crops is common to most field crop species. Much depends on the management practices used in the production of the crop, for example whether the plants have disbursed seed at the time of harvest, the setting of the harvesting equipment, and the speed of the harvesting operation, which will determine whether more or less seed is lost by the harvester. With crops of the *Brassica* family, because of the small seed size and large number of seeds produced by the crop, poor management practices can result in severe volunteer problems in succeeding crops. Suitable soil treatment after the harvest can considerably reduce the volunteer problem.

Section VII – Crosses

A. Inter-species/-genus

In considering potential environmental impact following the unconfined release of genetically modified *B. napus*, it is important to have an understanding of the potential for the development of hybrids through interspecific and intergeneric crosses between the crop and its related species. The development of such hybrids could result in the introgression of the novel traits into these related species, and result in:

- the related species becoming weedy or more invasive of natural ecosystems;

- altered environmental interactions, potentially causing harm to the environment or to human health and safety.

While many interspecific and intergeneric crosses have been made between *B. napus* and its relatives (Prakash and Hinata, 1980, Warwick and Black, 1993, and Scheffler and Dale, 1994), many have necessitated intervention in the form of ovary culture, ovule culture, embryo rescue and protoplast fusion. Reported in **Table 1**, and ranked in order of relative ability to form hybrid progeny when crossed with *B. napus*, are instances reported by Scheffler and Dale (1994) of sexually obtained interspecific and intergeneric crosses with *B. mapus*.

Flowering periods of *B. napus* and these species are critical. For interhybridization events to occur, their flowering periods, which are largely environmentally influenced, must overlap at least partially. To evaluate hybridization potential, it is important to know the flowering chronology of both the cultivated plant and related species; the physical distance between potentially hybridizing species; occurrence of vectors for pollination; and how pollination takes place.

The chromosome numbers of the cultivated species and relatives are also important. Many hybrids fail to occur due to lack of development of the endosperm (tissue resulting from the fertilization of the two polar nuclei of the embryo sac by a male reproductive nucleus). The ratio of maternal and paternal chromosomes must be of 2:1 or higher (Nishiyama and Inomata, 1966). This explains why the direction of crossing is often important. The pollination of a tetraploid female parent by a diploid male usually produces seeds. The reciprocal cross, on the other hand, is sterile. In order to understand existing exceptions, Johnston et al. (1980) proposed the concept of the endosperm balance number (EBN), where the value attributed to a given species is not linked to its chromosome number but to an arbitrary value determined from a successful cross and from the hypothesis that the EBN ratio is 2:1 in the endosperm.

Table 1 Sexually obtained interspecific and intergeneric crosses with *B. napus*
(reported by Scheffler and Dale, 1994)

Cross female x male	Progeny	References
B. rapa x *B. napus*	**SH, F1, F2, BcP**	Morinaga, 1929 U and Nagamatu, 1933 U, 1935 Bing et al., 1991 Jørgensen and Andersen, 1994 Mikkelsen et al., 1996
B. napus x *B. rapa*	**SH, F1, F2, BcP**	Morinaga, 1929 U and Nagamatu, 1933 U, 1935 Bing et al., 1991 Jørgensen and Andersen, 1994 Mikkelsen et al., 1996
B. juncea x *B. napus*	**SH, F1, F2, BcP**	Morinaga, 1934 Roy, 1980 Bing et al., 1991 Fernandez-Serrano et al., 1991 Frello et al., 1995
B. napus x *B. juncea*	**SH, F1, F2, BcP**	Morinaga, 1934 Roy, 1980 Bing et al., 1991 Fernandez-Serrano et al., 1991 Frello et al., 1995
B.oleracea x *B. napus*	**F1**	U, 1935
B. napus x *B. oleracea*	**F1, F2, BcP**	Roemer, 1935 Röbbelen, 1966 Yamagishi and Takayanagi, 1982
B. carinata x *B. napus*	**F1, F2, BcP**	Roy, 1980 Fernandez-Escobar et al., 1988 Fernandez-Serrano et al., 1991
B. napus x B. carinata	**F1, F2, BcP**	U, 1935 Roy, 1980 Fernandez-Escobar et al., 1988 Fernandez-Serrano et al., 1991
B. nigra x *B. napus*	**SH, F1, BcP**	Bing et al., 1991
B. napus x *B. nigra*	**SH, F1, F2, BcP**	Heyn , 1977 Bing et al., 1991
B. napus x *Hirschfeldia incana*	**SH, SH(BnMS), F1, BcP**	Lefol et al., 1991 Chevre et al., 1992 Eber et al., 1994

(continued on next page)

Table 1 (continued)

Cross female x male	Progeny	References
B. napus x *Raphanus raphanistrum*	**SH, SH(BnMS), F1, BcP**	Chevre et al., 1992 Lefol et al., *in press* Eber et al., 1994
Diplotaxis erucoides x *B. napus*	**F1, BcP**	Ringdahl et al., 1987
D. muralis x *B. napus*	**F1, BcP**	Ringdahl et al., 1987
B. napus x *Erucastrum gallicum**	**F1, BcP**	Lefol et al., *in press*
B. napus x *Sinapis alba*	**F1**	Heyn, 1977
B. napus x S. arvensis	**F1**	Heyn, 1977
B. napus x B. fruticulosa	**F1**	Heyn, 1977
B. napus x B. tournefortii	**F1**	Heyn, 1977
B. napus x D. tenuifolia	**F1**	Heyn, 1977
B. napus x Eruca sativa	**F1**	Heyn, 1977
B. napus x R. rugosum	**F1**	Heyn, 1977
B. napus x R. sativus	**F1**	McNaughton and Ross, 1978

Note:

SH *= spontaneous hybrids formed without the aid of emasculation and manual pollination transfer;*
SH(BnMS) *= spontaneous hybrids with male sterile* B. napus *as female parent;*
F1 *= F1 hybrids produced through intervention of some sort, i.e. emasculation and manual pollination;*
F2 *= F2 hybrids produced;*
BcP *= backcross progeny produced.*

* *This hybridization event not reported by Scheffler and Dale (1994)*

Generally, crosses between two species are possible only if the female species has a polyploidy level at least as high as the pollinating male species. Since *B. napus* is tetraploid, it will cross more readily with wild species (diploid) as a female parent (Sikka, 1940, Harberd and McArthur, 1980, and Kerlan et al., 1991). In the case of *Raphanus raphanistrum,* no difference was noted in the direction of crosses (Kerlan et al., 1991); in the case of *Sinapis alba,* the opposite situation occurs (Ripley and Arnison, 1990).

For a trait to become incorporated into a species genome, recurrent backcrossing of plants of that species by the hybrid intermediaries, and survival and fertility of the resulting offspring, will be necessary.

B. Introgression into relatives

The potential hybridization events listed are intended to assist the assessment of the potential for introgression of "novel traits" introduced from cultivated *B. napus* into wild relatives. The first step in this assessment is to determine which, if any, of the potential "mates" of *B. napus* are recorded as present in the geographic region where the cultivation is proposed. Should there be potential wild relative "mates" present, the frequency of hybridization events and the potential for environmental impact should introgression occur would then be considered. Should a trait with positive selective value be introgressed into wild or weedy populations, the gene may become a permanent part of the gene pool of these populations.

The above listed species are all plants of "disturbed land" habitats. Their success will be dependent on their ability to compete for space with other primary colonizers, particularly other successful weedy plant types. This in turn will depend on how well suited they are to the particular climate, soil conditions, etc. of individual sites. Equal ability of the hybrids to compete among wild populations or in cultivated fields has been shown for *B. napus* and hybrids (Lefol et al., 1995).

C. Interactions with other organisms

The table in the Appendix is intended as an identification guide for categories of organisms which interact with *B. napus*. This table, **representative of Canada**, is intended to serve as an example only. Environmental safety assessors should, on a country-by-country basis, draw up their own lists as a guide for assessing potential effects of the release of genetically modified plants on interacting organisms in their country.

Section VIII – Ecology

B. napus and its progenitors grow in "disturbed land" habitats. In non-managed ecosystems these species may be considered "primary colonizers," i.e. plant species that are the first to take advantage of the disturbed land, where they compete for space with plants of similar types. Unless the habitats are disturbed on a regular basis, for example along the edges of cliffs, rivers, and pathways, populations of these types of plants will be displaced by intermediaries and finally by plants that form climax ecologies, such as perennial grasses on prairies and tree species and perennial shrubs in forests.

In non-natural ecosystems, including along roadsides and on industrial and waste sites as well as cropland, there is potential, because of their "primary colonizing" nature, for ever-present populations of these species to be maintained. It is in such habitats that the species are recorded among the flora of countries where *B. napus* has been introduced as a crop plant. Their success will depend on their ability to compete for space with other primary colonizers, in particular successful weedy types. This, in turn, will depend on how well suited they are to the particular climate, soil conditions, etc. of individual sites.

In crop production systems, poor management practices and insufficient resistance to pod shattering may result in large amounts of *B. napus* seed not being harvested. Especially where there are high crop densities, this may cause volunteer "weed" problems in succeeding crops as well as contamination of such crops with respect to their seed quality.

Section IX – References

Bing, D.J., R.K. Downey and G.F.W. Rakow (1991) Potential of gene transfer among oilseed *Brassica* and their weedy relatives. GCIRC 1991 Congress, pp. 1022-1027.

Buzza, G.C. (1995) Plant breeding. In: Brassica oilseeds - Production and utilization. D.S. Kimber and D.I. McGregor, eds. Centre for Agriculture and Biosciences, pp. 153-176.

Chevre, A.M., M. Renard, F. Eber, P. Vallee, M. Deschamps et M.C. Kerlan (1992) Study of spontaneous hybridization between male-sterile rapeseed and weeds. 13th EUCARPIA Congress pp. 67-68.

Downey, R.K. and G. Röbbelen (1989) *Brassica* species. In: Oil Crops of the World. G. Röbbelen, R.K. Downey and A. Ashri, eds. McGraw-Hill, New York, pp. 339-362.

Eber, F., A.M. Chevre, A. Baranger, P. Vallee, X. Tanguy and M. Renard (1994) Spontaneous hybridization between a male sterile oilseed rape and two weeds. Theor. Appl. Genet. 88: 362-368.

Ellstrand, N.C., B. Devlin and D.L. Marshall (1989) Gene flow by pollen into small populations: data from experimental and natural stands of wild radish. Proc. Nat. Acad. Sci. USA 86: 9044-9047.

Fernandez-Escobar, J., J. Dominguez, A. Martin and J.M. Fernandez-Martinez (1988) Genetics of the erucic acid content in interspecific hybrids of Ethiopian mustard (*Brassica carinata* Braun) and rapeseed (*B. napus* L.). Plant Breeding 100: 310-315.

Fernandez-Serrano, O., L.C. Alonso and J. Fernandez-Escobar (1991) Genetic transfer among cultivated polyploid *Brassica* species. Groupe Consultatif International de Recherche sur la Colza 8th International Rapeseed Congress 4: 1016-1021.

Frello, S., K.R. Hansen, J. Hensen and R.B. Jørgensen (1995) Inheritance of rapeseed (*Brassica napus*) specific RAPD markers and a transgene in the cross *B. juncea* x (*B. juncea* x *B. napus*). Theor. Appl. Genet. 91: 236-241.

Harberd, D.J. and E.D. McArthur (1980) Meiotic analysis of some species and genus hybrids in the Brassiceae. In: *Brassica* crops and wild allies. S. Tsunoda, K. Hinata and C. Gômez-Campo, eds. Japan Scientific Societies Press, Tokyo, pp. 65-67.

Heyn, F.W. (1977) Analysis of unreduced gametes in the Brassiceae by crosses between species and ploidy levels. Z. Pflanzenzüchtg. 78: 13-30.

Hühn, M. and G. Rakow (1979) Einige experimentelle Ergebnisse zur Fremdfruchtungstrate bei Winterraps (*Brassica napus oleifera*) in Abhängigkeit von Sorte und Abstand. Z. Pflanzenzüchtg. 83: 289-307.

Johnston, S.A., T.P.M. den Nijs, S.J. Peloquin and R.E. Hanneman (1980) The significance of genic balance to endosperm development in interspecific crosses. Theor. Appl. Genet. 57: 5-9.

Jørgensen, R.B. and B. Andersen (1994) Spontaneous hybridization between oilseedrape (*Brassica napus*) and weedy *B. campestris* (Brassicaceae): A risk of growing genetically modified oilseed rape. Amer. J. Bot. 81(12): 1620-1626.

Kerlan, M.C., A.M. Chevre, F. Eber, J. Botterman and W. de Greff (1991) Risk assessment of gene transfer from transgenic rapeseed to wild species in optimal conditions. International Congress on Rapeseed, Canada, 1991.

Klinger, T., P.E. Arriola and N.C. Ellstrand (1992) Crop-weed hybridization in radish (*Raphanus sativus*): effects of distance and population size. Amer. J. Bot. 79: 1431-1435.

Lefol, E. (1993) Risques de transfert interspécifique d'un gène de colza transgénique. Thèse de Doctorat, Université de Paris-Sud, Centre d'Orsay [French, English abstract].

Lefol, E., V. Danielou, H. Darmency, M.-C. Kerlan, P. Vallee, A.M. Chèvre, M. Renard and X. Reboud (1991) Escape of engineered genes from rapeseed to wild *Brassicae*. Proc. Brighton Crop Protection Conference: Weeds 3: 1049-1056.

Lefol, E., V. Danielou, H. Darmency, F. Boucher, J. Maillet and M. Renard (1995) Gene dispersal from transgenic crops. I. Growth of interspecific hybrids between oilseed rape and the wild hoary mustard. J. Appl. Ecol. 32: 803-808.

Levin, D.A. and H.W. Kerster (1969) The dependence of bee-mediated pollen and gene dispersal upon plant density. Evolution 23: 560-571.

McCartney, H.A. and M.E. Lacey (1991) Wind dispersal of pollen from crops of oilseed rape (*Brassica napus* L.). J. Aerosol Sci. 22: 467-477.

McNaughton, I.H. and C.I. Ross (1978) Inter-specific and inter-generic hybridization in the Brassicae with special emphasis on the improvement of forage crops. Fifty-Seventh Annual Report of the Scottish Plant Breeding Station, pp. 75-110.

Marquard, R. and K.C. Walker (1995) Environmental impact of rapeseed production. In: Brassica oilseeds - Production and utilization. D.S. Kimber and D.I. McGregor, eds. Centre for Agriculture and Biosciences, pp. 195-214.

Mesquida, J. and M. Renard (1982) Etude de la dispersion du pollen par le vent et de l'importance de la pollinisation anémophile chez le colza (*Brassica napus* L., var *oleifera* Metzger). Apidologie 13: 353-366.

Mikkelsen, T.R., J. Jensen and R.B. Jørgensen (1996) Inheritance of oilseed rape (*Brassica napus*) RAPD markers in a backcross progeny with *Brassica campestris*. Theor. Appl. Genet. 92: 492-497.

Morinaga, T. (1929) Interspecific hybridization in *Brassica*. II. The cytology of F1 hybrids of *B. cerna* and various other species with 10 chromosomes. Jap. J. Bot. 4: 277-289.

Morinaga, T. (1934) On the chromosome number of *Brassica juncea* and *Brassica napus*, on the hybrid between the two and on offspring line of the hybrid. Jap. J. Genet. [Japanese] 9: 161-163.

Muenscher, W.G. (1980) Weeds. Second Edition. Cornell University Press, Ithica and London: 586 pp.

Munz, P.A. (1968) A Californian Flora. University of California Press, Berkeley and Los Angeles: 1681 pp.

Musil, A.F. (1950) Identification of Brassicas by seedling growth or later vegetative stages. USDA Circular 857. 26 pp.

Nishiyama, I. and N. Inomata (1966) Embryological studies on cross incompatibility between 2X and 4X in Brassica. Jap. J. Genet. 41: 27-42.

Olsson, G. (1955) Vindpollinering hos korsblomstriga oljeväxter. Sveriges Utsädesförenings Tidskrift 65: 418-4122.

Prakash, S. and K. Hinata (1980) Taxonomy, cytogenetics and origin of crop Brassicas, a review. Opera. Bot. 55: 3-57.

Rakow, G. and D.L. Woods (1987) Outcrossing in rape and mustard under Saskatchewan prairie conditions. Can. J. Plant Sci. 67: 147-151.

Ringdahl, E.A., P.B.E. McVetty and J.L. Sernyk (1987) Intergeneric hybridization of *Diplotaxis* ssp. with *Brassica napus:* a source of new CMS systems? Can. J. Plant Sci. 67: 239-243.

Ripley, V.L. and P.G. Arnison (1990) Hybridization of *Sinapis alba* L. and *Brassica napus* L. via embryo rescue. Plant Breeding 104: 26-33.

Röbbelen, G. (1966) Beobachtungen bei interspezifischen Brassica - Kreuzungen, insbesondere über die Entstehung matromorpher F1 - Pflanzen. Angewandte Botanik [German, English summary] 39: 205-221.

Roemer, W. (1935) Fruchtbarkeits- und Vererbungsstudien bei Brassica-Artkreuzungen. Z. Pflanzenzüchtg [German] 20: 377-416.

Roy, N.N. (1980) Species crossability and early generation plant fertility in interspecific crosses of *Brassica.* SABRAO J. 12: 43-53.

Scheffler, J.A. and P.J. Dale (1994) Opportunities for gene transfer and origin of crop *Brassicas*, a review. Opera Bot. 55: 3-57.

Scheffler, J.A., R. Parkinson and P.J. Dale (1993) Frequency and distance of pollen dispersal from transgenic oilseed rape (*Brassica napus*). Transgenic Research 2: 356-364.

Scheffler, J.A., R. Parkinson and P.J. Dale (1995) Evaluating the effectiveness of isolation distances for field plots of oilseed rape (*Brassica napus*) using a herbicide-resistance transgene as a selectable marker. Plant Breeding 114: 317-321.

Sikka, S.M. (1940) Cytogenetics of *Brassica* hybrids and species. J. Genet. 40: 441-509.

Snogerup, S., M. Gustafsson and R. Von Bothmer (1990) *Brassica* sect. *Brassica* (Brassiceae). 1. Taxonomy and Variation. Willdenowia 19: 271-365.

Song, K. and T.C. Osborn (1992) Polyphyletic origins of *Brassica napus:* new evidence based on organelle and nuclear RFLP analyses. Genome 35: 992-1001.

Stace, C.A. (1991) New Flora of the British Isles. Cambridge University Press.

Timmons, A.M., E.T. O'Brien, Y.M. Charters, S.J. Dubbels and M.J. Wilkinson (1995) Assessing the risks of wind pollination from fields of *Brassica napus* ssp. *oleifera*. Euphytica 85: 417-423.

Toxeopus, H., E.H. Oost and G. Reuling (1984) Current aspects of the taxonomy of cultivated *Brassica* species. The use of *B. rapa* L. versus *B. campestris* L. and a proposal for a new intraspecific classification of *B. rapa* L. Crucifer Newsletter 9: 55-57.

U, N. (1935) Genomic analysis in *Brassica* with special reference to the experimental formation of *B. napus* and peculiar mode of fertilization. Jpn. J. Bot. 7: 389-452.

U, N. and T. Nagamatu (1933) On the difference between *Brassica campestris* L. and *B. napus* L. In regard to fertility and natural crossing I. Fertility under different modes of pollination. J. Imper. Agric Stat. Nishigahara (Tokyo) [Japanese, English summary] 2: 113-128.

Warwick, S.I. and L.D. Black (1993) Guide to the Wild Germplasm of *Brassica* and Allied Crops, Part III: Interspecific and intergeneric Hybridization in the Tribe Brassiceae (Cruciferae). Technical Bulletin 1993, 16E, Centre for Land and Biological Resources Research, Agriculture and Agri-Food Canada.

Warwick, S.I. and A. Francis (1994) Guide to the Wild Germplasm of Brassica and Allied Crops, Part V: Life History and Geographical Data for Wild Species in the Tribe Brassiceae (Cruciferae). Technical Bulletin 1994, Centre for Land and Biological Resources Research, Agriculture and Agri-Food Canada.

Williams, I.H. (1984) The concentrations of air-borne rape pollen over a crop of oil-seed rape (*Brassica napus* L.). J. Agric. Sci. Camb. 103: 353-357.

Williams, I.H., A.P. Martin and R.P. White (1987) The effect of insect pollination on plant development and seed production in winter oilseed rape (*Brassica napus* L.). J. Agric. Sci. Camb. 109: 135-139.

Yamagishi, H. and I. Takayanagi (1982) Cross-compatibility of Hakuran (artificially synthesized *Brassica napus*) with *Brassica* vegetables. Cruciferae Newsl. 7: 34-35.

Other references of interest (not referred to in text)

Alam, M., H. Ahmad, M.H. Quazi and H.I.T. Khawaja (1992) Cross compatibility studies within the genus *Brassica.* Amphidiploid combinations. Sci. Khyber 5: 89-92.

Baranger, A. (1995) Evaluation en conditions naturelles des risques de flux d'un transgène d'un colza (*Brassica napus*) résistant à un herbicide à une espèce adventice (*Raphanus raphanistrum*). Thèse de l'Université de Paris Sud, Orsay N° d'ordre 3668, 97 pp.

Baranger, A., A.M. Chevre, F. Eber and M. Renard (1995) Effect of oilseed rape genotype on the spontaneous hybridization rate with a weedy species: an assessment of transgene dispersal. Theor. Appl. Genet. 91: 956-963.

Chevre, A.M., F. Eber, A. Baranger, M.C. Kerlan, C. Primard, F. Vedel, M. Delseny and G. Pelletier (1994) Comparison of somatic and sexual *Brassica napus Sinapis alba* hybrids and their progeny by cytogenetical studies and molecular characterization. Genome 37(3): 367-374.

Chevre, A.M., F. Eber, A. Baranger, M.C. Kerlan, P. Barret, P. Vallee and M. Renard (1996) Interspecific gene flow as a component of risk assessment for transgenic *Brassicas*. Acta Horticulturae. *In press*.

Darmency, H., A. Fleury and E. Lefol (1995) Effect of transgenic release on weed biodiversity: oilseed rape and wild radish. Proceedings of the Brighton Crop Protection Conference – Weeds 2: 433-438.

Delourme, R., F. Eber and A.M. Chevre (1989) Intergeneric hybridization of *Diplotaxis erucoides* with *Brassica napus*. I. Bytogenetic analysis of F1 and BC1 progeny. Euphytica 41: 123-128.

Ellerström, S. (1978) Species crosses and sterility in *Brassica* and *Raphanus*. *Cruciferae* Newsletter 3: 16-17.

Fan, Z., W. Tai and B.R. Stefanson (1985) Male sterility in *Brassica napus* L. associated with an extra chromosome. Can. J. Genet. Cytol. 27: 467-471.

Harberd, D.J. (1972) A contribution to the cytotaxonomy of *Brassica* (*Cruciferae*) and its allies. Bot. J. Linn. Soc. 65: 1-23.

Harding, K. and P.S. Harris (1994) Risk assessment of the release of genetically modified plants: a review. Edited by Ministry of Agriculture, Fisheries and Food, London, 54 pp.

Hojland, J.G. and G.S. Poulsen (1994) Five cultivated plant species: *Brassica napus* L. ssp. *napus* (Rape), *Medicago sativa* L. ssp. *sativa* (Lucerne/Alfalfa), *Pisum sativum* L. ssp. *sativum* (Pea), *Populus* L. ssp. (Poplars), *Solanum tuberosum* L. ssp. *tuberosum* (Potato). Dispersal, establishment and interactions with the environment. The National Forest and Nature Agency, Copenhagen, Denmark, 94 pp.

Honna, S. and W.L. Summers (1976) Interspecific hybridization between *Brassica napus* L. (Napobrassica group) and *B. oleracea* L. (Byotrytis group). Journal of the American Society for Horticultural Science 101: 299-302.

Inomata, N. (1988) Intergeneric hybridization between *Brassica napus* and *Sinapis arvensis* and their crossability. Cruciferae Newsletter 13: 22-23.

Jandurova, O.M. and J. Dolezel (1995). Cytological study of interspecific hybrid between *Brassica campestris* x *B. hirta* (*Sinapis alba*). Sex Plant Reprod. 8: 37-43.

Kerlan, M.C., A.M. Chevre, F. Eber, A. Baranger and M. Renard (1992) Risk assessment of outcrossing of transgenic rapeseed to related species: I. Interspecific hybrid production under optimal conditions with emphasis on pollination and fertilization. Euphytica 62: 145-153.

Kerlan, M.C., A.M. Chevre and F. Eber (1993) Interspecific hybrids between a transgenic rapeseed (*Brassicae napus* L.) and related species: cytogenetical characterization and detection of the transgene. Genome 36: 1099-1106.

Lefol, E., A. Fleury and H. Darmency (1996) Gene dispersal from transgenic crops. II. Hybridization between oilseed rape and the hoary mustard. Sex. Plant Reprod. *In press*.

Mattson, B. (1988) Interspecific crosses within the genus *Brassica* and some related genera. Sveriges Utsadesforenings Tidskrift 98: 187-212.

Nishiyama, I., M. Sarashima and Y. Matsuzawa (1991) Critical discussion on arbotive interspecific crosses in Brassica. Plant Breeding 107: 288-302.

Salisbury, P. (1989) Potential utilization of wild crucifer germplasm in oilseed *Brassica* breeding. Proc. ARAB 7th Workshop, Toowoomba, Queensland, Australia, pp. 51-53.

Takeshita, M., M. Kato and S. Tokumasu (1980) Application of ovule culture to the production of intergeneric or interspecific hybrids in *Brassica* and *Raphanus*. Japanese Journal of Genetics 55: 373-387.

Thomas, P. (1994) Canola Growers Manual. Canola Council of Canada.

Warwick, S.I. (1993) Guide to the Wild Germplasm of *Brassica* and Allied Crops. Part IV: Wild Species in the Tribe Brassiceae (Cruciferae) as Sources of Agronomic Traits. Technical Bulletin 1993 – 17E, Centre for Land and Biological Resources Research, Agriculture and Agri-Food Canada.

Wojciechowski, A. (1985) Interspecific hybrids between *Brassica campestris* and *B. Oleracea* L. 1. Effectiveness of crossing, pollen tube growth, embryogenesis. Genetica Polonica 26: 423-436.

Appendix: Potential interactions of *B. napus* with other life forms during its life cycle (Canada)

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X indicates the type of interaction between the listed organisms and *B. napus*

	Interaction with *B. napus*			
Other life forms	Pathogen	Symbiont or beneficial organism	Consumer	Gene transfer
Albugo candida	X			
Alternaria spp.	X			
Botrytis cinerea	X			
Erysiphe spp.	X			
Leptosphaeria maculans	X			
Peronospora parasitica	X			
Plasmodiophora brassicae	X			
Pseudocercosporella capsellae	X			
Pseudomonas sp.	X			
Pyrenopeziza brassicae	X			
Pythium debaryanum	X			
Rhizoctonia solani	X			
Sclerotinia sclerotiorum	X			
Xanthomonas spp.	X			
Verticillium dahliae	X			
Mychorrhizal fungi		X		
Aster yellow mycoplasma	X			
Cauliflower Mosaic Virus (CaMV)	X			
Beet Western Yellow Virus (BWYV)	X			
Turnip mosaic virus	X			
Soil microbes		X		
Earthworms		X		
Flea beetle			X	
Pollinators		X	X	
Soil insects			X	
Animal browsers (e.g. deer, hare, rabbit)			X	
Birds			X	
Other *Brassica napus*				X
Brassica rapa				X
Brassica juncea				X
Brassica nigra				X
Raphanus raphanistrum				X
Erucastrum gallicum				X
Others				X

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