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IMPORTANCE & BIOLOGY OF OILSEED *Brassica* species

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Rapeseed–mustard crops in India are grown in diverse agro-climatic conditions ranging from north-eastern/north-western hills to down south under irrigated/rainfed, timely/late sown, saline soils and mixed cropping. Indian mustard accounts for about 75-80% of the 5.8 million hectares (mha) under these crops in the country during 2009-10. The cultivation of brown sarson which once dominated the entire rapeseed-mustard growing region is now shadowed by Indian mustard. There are two different ecotypes of brown sarson: lotni (self-incompatible) and tora (self-compatible). The ‘lotni’ is predominantly cultivated in colder regions of the country particularly in Kashmir and Himachal valley. The ‘tora’ on the other hand is cultivated in limited areas of eastern Uttar Pradesh. Yellow sarson is now mainly grown in Assam, Bihar, north-eastern states, Orissa, eastern Uttar Pradesh and West Bengal. Toria is a short duration crop cultivated largely in Assam, Bihar, Orissa and West Bengal in the east mainly as winter crop. In Haryana, Himachal Pradesh, Madhya Pradesh, Punjab, Uttarakhand and western Uttar Pradesh, it is grown as a catch crop. Taramira is grown in the drier parts of north-west India comprising the states of Rajasthan, Haryana and Uttar Pradesh. Gobhi sarson and karan rai are the new emerging oilseed crops having limited area of cultivation. Gobhi sarson is a long duration crop confined to Haryana, Himachal Pradesh and Punjab. Rapeseed-mustard crops because of their low water requirement fit well in the rainfed cropping system of resource poor farmers.

Importance

The oleiferous *Brassica* species, commonly known as rapeseed-mustard, are one of the economically important agricultural commodities. Rapeseed-mustard comprising eight different species viz., Indian mustard, toria, yellow sarson, brown sarson, gobhi sarson, karan

rai, black mustard and taramira, are being cultivated in 53 countries spreading all over the globe. The oil and protein content varies from 37 to 49% and 22-28%, respectively. The seed and oil are used as condiment in the preparation of pickles and for flavouring curries and vegetables. The oil is utilized for human consumption throughout the northern India in cooking and frying purposes. It is also used in the preparation of hair oils and medicines. It is used in soap making, in mixtures with mineral oils for lubrication. Rapeseed oil is used in the manufacture of grease. The oil cake is used as feed and manure. Green stem and leaves are a good source of green fodder for cattle. The leaves of young plants are used as green vegetable as they supply enough sulphur and minerals in the diet. In the tanning industry, mustard oil is used for softening leather. Rapeseed-mustard oil contains lowest level of saturated fatty acids among all vegetable oil, which is quite desirable for good health. Both the essential fatty acids (EFA) such as linoleic acid (C18:2) and linolenic (C18:3), are present in rapeseed-mustard oil. Rapeseed-mustard oil has high level of antioxidant, which retards growth of free radicals mainly responsible for disease like cancer and ageing. Glucosinolates present in seed meal has shown anticancer properties. *Brassica* species are very rich in phenolic compounds and glucosinolates. Rapeseed-mustard crops in India comprise traditionally grown indigenous species, namely toria (*Brassica campestris* L. var. toria), brown sarson (*Brassica campestris* L. var. brown sarson), yellow sarson (*Brassica campestris* L. var. yellow sarson), Indian mustard [*Brassica juncea* (L.) Czern & Coss], black mustard (*Brassica nigra*) and taramira (*Eruca sativa/vesicaria* Mill.), which have been grown since about 3,500 BC along with non-traditional species like gobhi sarson (*Brassica napus* L.) and Ethiopian mustard or karanrai (*Brassica carinata* A. Braun).

Table-1: Systematic position of *Brassica* Species.

Benthum and Hooker	Engler and Prantle	Hutchinson
Division Spermatophyta	- Division - Embryophyta	Phylum - Angiospermae
Class - Dicotyledons	Sub-Division - Angiospermae	Sub-Phylum - Dicotyledonae
Sub-Class - Polypetalae	Class – Dicotyledonae	Division - Archichlamydae
Series - Thalamiflorae	Sub-Class - Archichlamydae	Sub-group - Herbaceae
Order - Parietales	Order – Rhoedales	Order - Cruciferae
Family - Brassicaceae	Family – Brassicaceae	Family - Cruciferae

Floral Biology of *Brassica* Species

Flowers of both the species have 4 sepals and 4 petals of deep yellow to pale yellow colour. Four flower has 6 stamens; 4 with long and 2 with short filaments. The pistil is compound and the ovary matures into a 2 celled fruits. It is made up of 2 carpels, which are separated by a false septum, thus providing 2 chambers.

Floral Parts (General for *Brassica*)

Flowers: Regular and cruciform, bisexual and complete, hypogynous, ebracteate.

Calyx: Sepals 2 + 2, free, in two whorls.

Corolla: Petals 4, free, in one whorl, valvate, cruciform with distinct limb and claw, imbricate.

Androecium: Stamens 6, in two whorls-2 outer short and 4 inner long, tetradynamous.

Gynoecium: Carpels 2, syncarpous, ovary superior, at first 1- celled, later 2- celled owing to the development of a false septum called replum, placentation parietal.

Inflorescence: Long racemose.

Fruits: A siliqua.

Seeds: Ex-albuminous.

Floral formula: $K_{2+2} C_{x4} A_{2+4} G_2$.

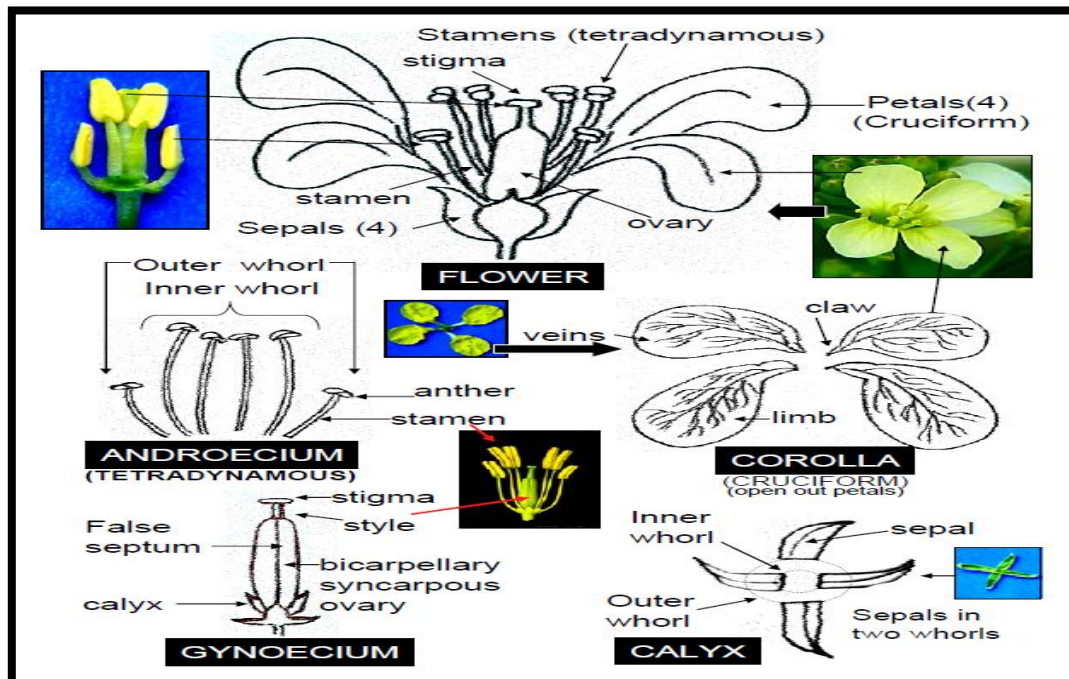


Fig.- 1: Flower Parts of Rapeseed And Mustard

Cultivated Species

Rapeseed *i.e.* *Brassica campestris* ($2n = 20$) is one mainly cultivated species. This species has three ecotypes, *viz.* Yellow sarson (*Brassica campestris* var. yellow sarson), brown sarson (*Brassica campestris* var. brown sarson) and toria (*Brassica campestris* var. toria). Yellow sarson and brown sarson are collectively called as turnip rape, and toria is known as Indian rape. The other cultivated species is *Brassica napus* ($2n = 34$). In India, there are two main cultivated species of mustard, *viz.*, Rai or Indian mustard (*Brassica juncea* $2n = 4x = 36$) and Banarasi Rai or black mustard (*Brassica nigra* $2n = 16$).

Table-2: Commonly grown species of rapeseed and mustard

Common name	Botanical name	Local name
Indian mustard	<i>Brassica juncea</i> Coss	Rai or laha
Rugosa	<i>Brassica juncea</i> var. rugosa	Pahari rai
Black mustard	<i>Brassica nigra</i> Koch	Banarasi rai
Yellow sarson	<i>Brassica campestris</i> L. var. yellow sarson	Yellow sarson
Brown sarson	<i>Brassica campestris</i> L. var. brown sarson	Brown sarson
Indian rape	<i>Brassica campestris</i> L. var. Toria	Toria or lahi
White mustard	<i>B. alba</i> ; <i>B. hirta</i> Moench	Ujli sarson
Rocket cress	<i>Eruca sativa</i> Mill	Taramira

Characteristics Features of Some Important Types

- 1. Toria (*Brassica campestris* var. toria).** It is grown as an autumn crop. This variety is susceptible to cold and is sown early in middle or late September and takes about 75-100 days to mature. The variety is obviously low yielding but it responds to irrigation and adequate fertilization.
- 2. Yellow and sarson (*Brassica campestris* var. *glauca* and var. *dichotoma*).** It is widely grown in North and Central India. There are two main types yellow sarson and brown sarson so named because of its seed colour. It is high yielding than ‘toria’ and brown sarson and also from yellow ones. The crop is sown in October and harvested in March/April after 150-160 days time.
- 3. Brown or Indian mustard (*Brassica juncea*).** It is very widely grown in India. The crop is sown in October/November and harvested in March/April after about 110-160 days period. This type gives better yield than *Brassica napus*.

4. **Black mustard (*Brassica nigra*)**. It is grown in very limited area. It has very low oil content into it but the main purpose of its cultivation is to use it as condiment.
5. **Taramira (*Eruca sativa*)**. It is relatively of recent introduction into India. It is believed to be native of south Europe and north Africa. It is relatively a low yielding cruciferous oilseed crop grown in northern India and very often grouped with rape and mustard crops. The variety is particularly adapted to poor soils and low rainfall areas.

Table-3: Classification of rapeseed and mustard grown in India

Indian group	International commercial name	Species	Common name	Local name	Ch. No. (n =)
Sarson	Indian colza, Colza rape	<i>Brassica rapa</i> var. yellow sarson	Turnip rape	Yellow sarson	20
		<i>Brassica rapa</i> var. brown sarson	Turnip rape	Brown sarson	20
Toria	Indian rape	<i>Brassica rapa</i> var. yellow toria	Indian rape	Yellow toria or lahi	20
		<i>Brassica rapa</i> var. brown toria	Indian rape	Black toria or lahi	20
Rai	Mustard	<i>Brassica juncea</i>	Indian mustard	Rai or raya or laha	36
		<i>Brassica juncea</i> var. rugosa	Rugosa	Pahari rai	36
		<i>Brassica nigra</i>	Black mustard	Banarasi rai	16
Dhuli Rai	White sarson	<i>Brassica hirta</i>	Ujli sarson	-	-
Taramira	Rocket cress	<i>Eruca sativa</i>	Duan	-	-

Crossing Techniques

In the selected plants racemes are to be selected in which flowers will be utilized for crossing. Keeping 6-8 flowers on the lower side the rest of the raceme is to be clipped off. Generally, 2-3 flowers open at a time. Selecting such buds which will open next day, the corolla is to be slit open by the fine tip of the pincer and the anthers will be removed just by jerking to achieve emasculation. Though pollen grains of the same flower will not be effective for pollination for the operation of self-incompatibility system, for the sake of ensuring purity of the cross, emasculation is necessary. The raceme with the emasculated flowers is to be covered by brown paper bags to save the flowers from contamination by unwanted pollen grains. The male parental plants from which anthers will be collected for dusting pollen grains on the stigmatic surface, are to be kept covered by fine cloth bags and flowers allowed to open under cover. Before taking up crossing programme, a study is to be

made to know actually when the opening of the flowers and dehiscence of anthers take place. When in the morning the flowers open, striking the time just before dehiscence of the anthers, these are collected in a watch glass or such anthers also can be collected which have just started dehiscing. If undehisced anthers are collected, time has to be given for its bursting. When with the help of magnifying glass the dehiscence/bursting of the anthers is observed, the whole anthers are lifted with the help of the fine forceps and taken on the stigma to touch the surface for pollination. After touching the stigmas with the burst anthers, it is to be checked with the help of the magnifying glass (3 or 4 X will do) whether the pollen grains are found on the stigmatic surface. After pollination the paper bag is to be replaced, so also the cloth bag protecting the plants with flowers used as pollen source. After pollinating all the flowers retained in the raceme the bag may be removed giving a proper tag to identify the crossed flowers.

Reproduction and Pollination

Brassica juncea and *Brassica napus* are self-pollinated species. yellow sarson (*Brassica campestris* var. yellow sarson) is also self-pollinated. *Brassica campestris* viz., brown sarson and toria are self-incompatible. *Brassica nigra* and *Brassica oleracea* are also self-incompatible. Self-incompatibility promotes cross-pollination in these species which occurs by wind and honey bees. Rapeseed produces yellow nectar-bearing flowers, which are able of both self-fertilization and intra-specific cross-fertilization. Honeybees are the primary pollinators of rapeseed. In India, isolation distance of 400 meters for foundation seed production is required.

Stigma Receptivity: The stigma becomes receptive 3 days before blooming of the flowers and remains so 3 days after anthesis. Breeder can hence plan their crossing work according to the convenience.

Anthesis: Dehiscence of the anthers takes place around 8 AM in the morning depending upon the weather condition. If cloudy the anthers are delayed till the sun breaks. Warmth of the weather imparted by sun is necessary for dehiscence.

Pollen Grains and Viability: Pollen grains are round in shape, taking stain readily and remain viable for 24 hours after release from the anther sacs.

Blooming of The Flowers and Anthesis: The flowers begin to open by 8 AM with the rise in atmospheric temperature. The process continues till noon. Since it is a racemose type of

inflorescence the flowers placed lower in the raceme open first continuing to proceed upwards each day. This continues for a week or so depending upon the growth of the inflorescence.

Synchronized Flowering of Male and Female Parents: Oilseed *brassic*as have indeterminate flowering habit. Early onset of flowering in the female parent as compared to the pollen parents invariably results in female plants getting taller. This reduces the hybrid seed set as the access of the pollen to the stigma is reduced. Detopping of alternate plant of male parent (in 2M : 4F/2M : 6F) ratio coupled with additional application of N (@ 25 kg/ha) between pollinator rows after flowering was found effective to ensure pollen supply for longer duration.

Maintenance of Purity: In *Brassica juncea* and yellow sarson maintenance of purity of the lines is not difficult. This is achieved by covering the whole plants with fine cloth bag and leaving them as such. Since both the species are self-compatible pollination brought about by the pollen grains of the same flower results in fruit and seed setting. It is found that if the bags are shaken in the morning the seed setting is better. By shaking the cloth bags along with the plants dusting of pollen grains liberated by the anthers, is ensured though by structure and biology of the flower, dusting is not necessary to ensure pollination. Further, keeping the plants open for some time after the pollination is over in the morning, ensures better pod setting.

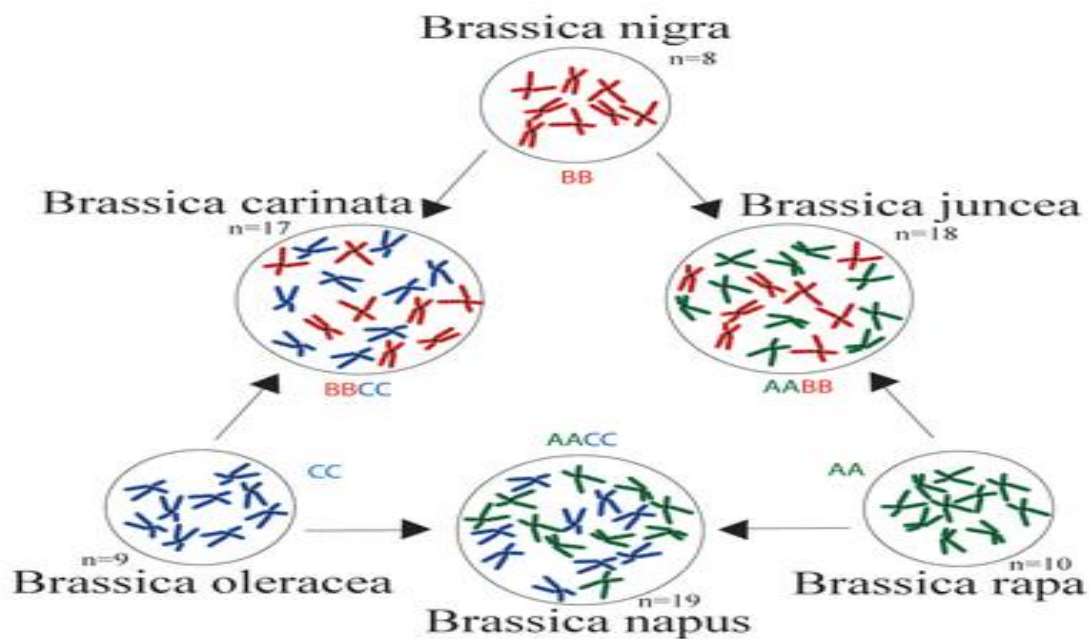


Fig.-2: 'U'-triangle of *Brassica* species (Nagaheru, 1935).

Conclusion

Important oil seed crop grown in cool season sub tropics, higher elevations and winter crops. Rapeseed oil was produced in the 19th century as a source of a lubricant for steam engines. It was less useful as food for animals or humans because it has a bitter taste due to high levels of glucosinolates. Varieties have now been bred to reduce the content of glucosinolates, yielding a more palatable oil. This has had the side effect that the oil contains much less erucic acid. The oil and protein content varies from 37 to 49% and 22-28%, respectively. The seed and oil are used as condiment in the preparation of pickles and for flavouring curries and vegetables. The oil is utilized for human consumption throughout the northern India in cooking and frying purposes. It is also used in the preparation of hair oils and medicines. It is used in soap making, in mixtures with mineral oils for lubrication.

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