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Unlocking the Hidden Strength of Crop Wild Relatives for Rapeseed-Mustard Enhancement

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Brassica spp., commonly known as rapeseed-mustard, plays an important role in the Indian economy by providing edible oils, vegetables, condiments and animal feed. Mustard is an edible oilseed crop and its consumption ranks second after soybean oil in India. Mustard is cultivated in India during the Rabi season widely in regions of Rajasthan, Uttar Pradesh, Haryana, and Madhya Pradesh. Rapeseed-mustard is a member of the flowering plant family *Brassicaceae* or *Cruciferae*, in which a total of 338 genus and 3709 species are known so far. The Brassica family comprises 37 species, and 6 of these species are mainly domesticated. Three of these are *Brassica rapa*, *Brassica nigra*, and *Brassica oleracea*, which are diploids used as spices and vegetables. Today, there are two centers of diversity i.e. China and Eastern India based on the prevalence of their wild progenitors and relatives. At present, it has been proved that there are two geographical races i.e. Chinese and Indian of B. juncea based on molecular and biochemical studies. The diploid and tetraploid (amphidiploid) species share genomes amongst themselves. *Brassica juncea* (AABB=36) and *Brassica napus* (AACC=38) are mainly used for cooking oil. These species are known by different names in different regions, as shown in figure 1, explaining the interspecific relationship among Brassica cultivated species. It can be understood that amphidiploid species developed from natural crossing between the progenitor diploid species.

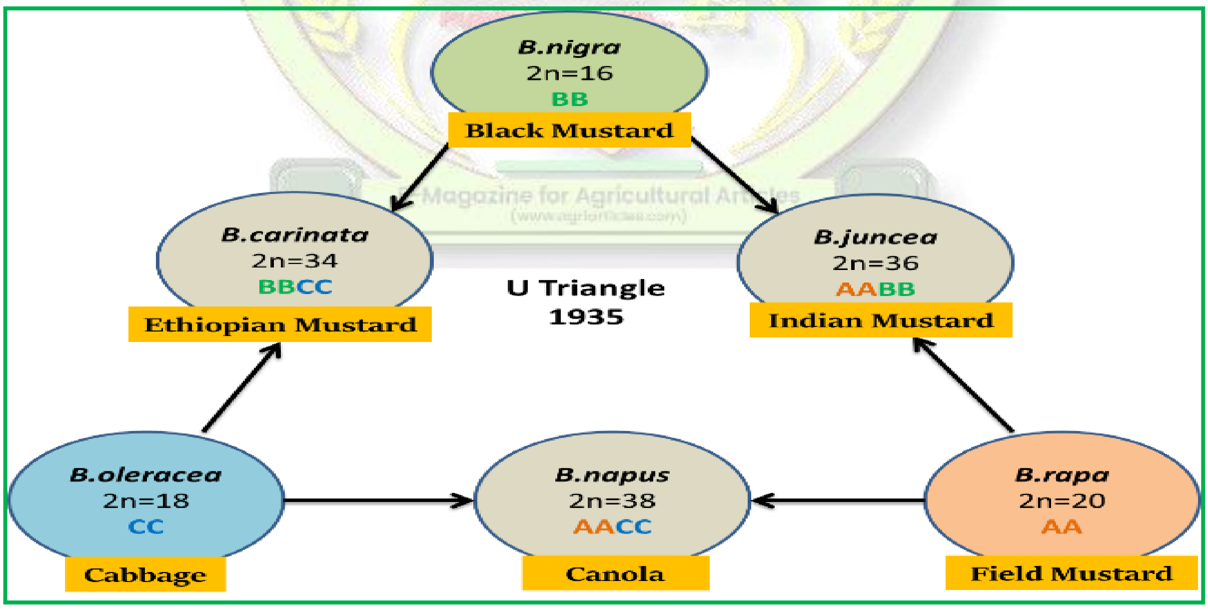

Figure 1. TheTriangle of U, given by Nagaharu U in 1935, shows the relationship among diploid and amphidiploid species of Brassica.

Economic importance of brassica crop wild relatives

The cultivated species are known to get affected adversely by many biotic and abiotic stresses and lack the resistance needed to curb against such factors, due to which productivity is poorly affected. Such problems impose a challenge to gain higher productivity even in unfavourable conditions. The crop wild species can be looked upon for solutions to such issues. Naturally occurring wild species are known for their resistance to many diseases and stresses such as diseases, pests, drought, high temperature, salinity, etc. Using them for crop improvement can increase the productivity of mustard varieties. Isolation and transfer of such desirable genetic traits also lead to the gene pool's expansion. These beneficial traits can be transferred from wild to cultivated species for elite germplasm development by using different gene transfer methods. Cross-pollination occurring in nature also helps in exchanging of genetic material among species. Genetic variations of wild species can be used in many ways, such as genetic recombination, broadening of the genetic base in cultivated crops, transferring selected genes from wild to cultivated species, development of new plant types, development of hybrid species, cytoplasmic male sterile plants, as well as to understand the evolutionary pattern of diploid and polyploid species.

Gene transfer from wild mustard species to cultivated varieties is complex and time-consuming. This is achieved by various early breeding methods such as wide hybridization, somatic hybridization, embryo rescue and advanced techniques, viz. genome sequencing, transgenics, and genome editing. However, several difficulties are faced during hybridization programs like difficulty in obtaining hybrid plants after crossing wild and cultivated species, production of a very small number of seeds/embryos, use of tedious tissue culture techniques, infertility in hybrid plants (sterility), chromosomal doubling using colchicine, chimeric plants, partial fertility in subsequent generations, cytoplasmic male sterile in plants, etc. Examples of successful gene transfer from wild species to increase crop quality and yield can be seen in many crops. Wild species have been used to transfer stem rust resistance in wheat; resistance against potato blight, leaf roll, and charcoal rot diseases in potato; fungus and nematode resistance in tomato; cyst nematode resistance and cold tolerance in gram. Many wild species have also been identified that can tolerate various biotic and abiotic stresses, the details of which are given in Table 1.

S.No.	Trait	Brassica Crop Wild Relatives
1	Alternaria blight resistance	Brassica desnottesii, D. catholica, Camelin sativa, Diplotaxisberthautii, , Sinapis alba
2	Aphid resistance	Brassica fruticulosa, Brassica incana, Brassica vilosa, Eruca sativa
3	White rust resistance	Diplotaxiserucoides, Camelina sativa, Lepidium sativum, Eruca vesicaria
4	Cabbage white fly resistance	Brassica incana, Brassica vilosa; Brassica spinosa, Brassica cretica
5	Cabbage root fly resistance	Brassica incana, Brassica vilosa; Brassica macrocarpa
6	Stem rot resistance	Brassica cretica, B. fruticulosa, Erucastrum gallicum
7	Resistance to Pod shattering	Brassica macrocarpa, Brassica hilerionis,
8	High erucic acid content	Brassica incana, Brassica vilosa, Brassica cretica,
9	High oleic & linoleic acid	Orychophragmus violaceous, Moricandia spp.,
10	Cytoplasmic male sterility	Moricandia arvensis, Diplotaxiserucoides, Diplotaxisberthautii, Brassica oxyrrhina

Table 1:- Wild mustard species with their specific traits that can be used in crop improvement.

Conclusion

All over the world many scientists have successfully transferred some traits from wild mustard species to cultivated varieties. In addition, efforts are going on to transfer more desirable characteristics not available in the primary gene pool. The introgression lines are being developed for B. juncea, B. carinata and B. napus so that important traits can be transferred to the widely used cultivars. New improved varieties can be developed for crop improvement in mustard breeding through these strategies.

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