

## I N T R O D U C T I O N

Interspecific hybridization has been studied from a very early date mainly for two reasons - 1) to determine the interrelationship between the species, and 2) to produce new improved types by combining desirable characters of two or more species.

Early breeders tried interspecific hybridization freely with a fair amount of success. According to Bradley (1719), Fairchild, an English grower produced the first artificial interspecific hybrid between two species of Dianthus. Linnaeus (1759) crossed the yellow flowered Tragopogon pratensis with purple flowered T. porrifolius and obtained hybrids bearing red flowers with yellow bases. Köelreuter (1761-1766) hybridized Nicotiana rustica with N. paniculata and studied the hybrid in detail, which had shrivelled pollen and was completely self-sterile. It produced viable seeds when back-crossed with either of the parents.

Interspecific hybridization is usually difficult. By definition a "species is a population set apart from the rest of the living world by reproductive isolating mechanisms" (Grant, 1957 pp.74). Such ideal species are the end products of the processes of species formation and differ from each other in morphological characters, in ecology, in the genetic systems by which they control this ecological fitness and

in the homology of the chromosomes. The differentiating processes however, do not always proceed simultaneously at the same rate along all these fronts. This sometimes leads to the formation of morphologically distinct species which may not be well differentiated in other aspects. Moreover, the reproductive isolating mechanisms (or the crossability barriers) are often not perfect. Hybridization between species is possible due to such weakness in crossability barriers. The species with weak isolating mechanisms between each other are taken as less diversified or closely related.

With the advent of cytological methods, assessment of the degree of relationship between species was based largely on the nature of chromosome pairing at meiosis in  $F_1$  hybrids. Interspecific hybridization and subsequent chromosome doubling were suggested by Winge (1917), as possible mode of speciation. Clausen and Goodspeed (1925) supported Winge's hypothesis by synthesizing Nicotiana digluta, an amphidiploid of N.tabacum and N.glutinosa cross. Müntzing (1930) synthesized an amphidiploid Galoopsis tetrahit (which was subsequently found to be a naturally occurring species) from G.pubescens and G.speciosa cross. Primula kewensis, a natural species was found to be the amphidiploid of a cross between P.floribundum and P.verticillata (Newton and Pellew, 1929).

Amphidiploid nature of many crop plants gradually became evident. Common bread wheat, Triticum aestivum is a

in the homology of the chromosomes. The differentiating processes however, do not always proceed simultaneously at the same rate along all these fronts. This sometimes leads to the formation of morphologically distinct species which may not be well differentiated in other aspects. Moreover, the reproductive isolating mechanisms (or the crossability barriers) are often not perfect. Hybridization between species is possible due to such weakness in crossability barriers. The species with weak isolating mechanisms between each other are taken as less diversified or closely related.

With the advent of cytological methods, assessment of the degree of relationship between species was based largely on the nature of chromosome pairing at meiosis in  $F_1$  hybrids. Interspecific hybridization and subsequent chromosome doubling were suggested by Winge (1917), as possible mode of speciation. Clausen and Goodspeed (1925) supported Winge's hypothesis by synthesizing Nicotiana digluta, an amphidiploid of N.tabacum and N.glutinosa cross. Müntzing (1930) synthesized an amphidiploid Galoopsis tetrahit (which was subsequently found to be a naturally occurring species) from G.pubescens and G.speciosa cross. Primula kewensis, a natural species was found to be the amphidiploid of a cross between P.floribunda and P.verticillata (Newton and Pellew, 1929).

Amphidiploid nature of many crop plants gradually became evident. Common bread wheat, Triticum aestivum is a

hexaploid species (Sakamura,1918; Sax,1922). It was suggested that bread wheat had originated through allopolyploidy from the hybrids between tetraploid emmer wheat and some species of Aegilops. A close relative of bread wheat was synthesized by crossing Aegilops squarrosa with emmer wheat and subsequent chromosome doubling of the hybrid (McFadden and Sears,1946).

Tobacco (Nicotiana tabacum) is supposed to have allopolyploid origin from a cross between some progenitor of N.sylvestris and a species from 'tomentosa' group of the genus (Goodspeed and Clausen,1928).

Some of the Brassica species are unique examples of amphidiploidy. Morinaga (1934) proposed that B.juncea, B.napus and B.carinata had originated from intercrosses between B.nigra, B.campestris and B.oleracea followed by doubling of chromosomes in the hybrids. U (1935) and Olsson (1960 b) synthesized B.napus from crosses between B.campestris and B.oleracea. Sikka (1940) concluded the chromosomes of B.campestris were involved in the origin of B.juncea. Synthetic B.juncea was produced from crosses between B.nigra and B.campestris. (Howard,1942; Ramanujan and Srinivasachar,1943; Frandsen,1943 and Olsson, 1960b). The remaining species, B.carinata was synthesized from a hybrid between B.oleracea and B.nigra (Frandsen,1947).

New world cottons, Gossypium barbadense and G.hirsutum,

arose through amphidiploidy from some hybrids of Asiatic and American diploid species (Skovsted, 1934; 1937).

Interspecific hybridization has improved many crop plants. In bread wheat, the varieties resistant to rust have usually been evolved from wide crosses. 'Marquillo', a stem rust resistant variety was produced by Hayes, Parker and Kurtzweil (1920) from a cross between 'Iumillo' (Triticum durum) and 'Marquis' (T.vulgare). McFadden (1930) evolved Hope and H44, two varieties resistant to stem rust from T.durum and Marquis (T.vulgare) cross. Koo and Ausemus (1951) mentioned 'Timstein', a stem/<sup>rust</sup>resistant variety which was selected from a cross of T.timopheevi with Steinwedel, T.vulgare.

In the breeding of better varieties of potato, interspecific hybridization has played a very important role. Some economic lines with good yield and blight resistance were obtained from the back-cross progenies of the hybrid between Solanum antipoviczii and S.tuberosum (Kameraz, 1940). A variety with good table quality was evolved by Salaman (1943) from the cross between S.demissum and S.tuberosum. Races of plants with resistance to aggressive blight were evolved from crosses of S.tuberosum with S.semidemissum. From the hybrid between hexaploid S.vallismexici and S.tuberosum, a variety named 'Puskinskij' was produced, which was resistant to common and aggressive blight races, early in maturity, good in yield and tuber form, and high in starch content. Potato varieties

giving two tuber yields per year were evolved from the crosses of S.tuberosum with S.boyacense and S.caniarensis (Bukasov and Kameraz,1959). In India several hybrids were developed from crosses between S.tuberosum and S.demissum, which were resistant to blight and approached commercial standards in quality (Pushkaranth,1957). 'Kufri Kuber', a commercial variety with resistance to several diseases was bred from three species - S.cutilobum, S.tuberosum and S.andigenum (Pushkarnath,1960).

The improvement of tomato through interspecific hybridization is spectacular. 'Pan America', a variety highly resistant to Fusarium wilt was bred from a cross between Lycopersicon esculentum and L.pimpinellifolium (Porte and Walker 1941). Some lines with useful characters were obtained from L.esculentum X L.pimpinellifolium cross (Pal and Singh, 1943). In 1948, at Idaho Agricultural Experiment Station, L.chilense was crossed with L.esculentum and some selections were made which proved to be highly resistant to curly top virus (Thomas 1952, pp.97), Lesley (1948) evolved some lines from a cross between L.chilense and L.esculentum which combined the commercial qualities of tomato with resistance to Verticillium wilt. High vitamin C content of L.peruvianum was transferred to commercial varieties of tomato by Yeager (1950).

In tobacco, resistance to various diseases has been imparted through interspecific hybridization. 'Glutinosa' type of mosaic resistance was transferred to commercial varieties using amphidiploid Nicotiana digulata in crosses with

N.tabacum (Holmes,1938). A new variety, N.tabacum var.Virid with necrotic reaction to mosaic virus was evolved from a complex cross involving N.rustica, N.tabacum and N.digluta (Kostoff,1944). Commercial varieties of tobacco were made resistant to wildfire disease by crossing with tetraploid plants of N.longiflora (Clayton,1947). Several strains of petiolate tobacco were evolved from a complex cross involving N.tabacum, N.sylvestris and N.tomentosiformis (MacRae,1948). 'Burley 21', a commercial variety with wildfire resistance from N.longiflora and mosaic resistance from N.glutinosa was reported by Clausen and Cameron (1957). 'White Burley' and 'Orinoco' varieties with resistance to black root rot and blue mold were evolved from crosses of N.tabacum with N.debneyi (Clayton,1958).

Interspecific hybridization has played a vital role in the improvement of cotton by enhancing the quality of fibre and resistance to various diseases. 'CO-ano-8', an improved strain of Gossypium hirsutum was evolved by hybridization with G.anomalum (Pandya and Patel,1958). In U.S.A., breeding stocks of G.hirsutum possessing better spinning and better fibre strength were produced from the hybrids involving G.thurberi. (Richmond,1950). Jassid resistant types of G.hirsutum were evolved from crosses with G.tomentosum (Ganesan,1958). Black-arm resistant strains had been isolated from the back cross progenies of the hybrid between G.arboreum and G.barbadense (Knight,1956). 'Madras Cambodia, Uganga 2'; an early type

with superior fibre qualities was evolved from G.hirsutum X G. barbadense cross. (Jagannatha Rao, Marar and Santhanam, 1953). From a hybrid of G.hirsutum with a perennial type of G.barbadense, 'Mysore American 2', a type with a good yield and quality fibre was selected. (Srinivasa Iyengar, 1956). A new technique was adopted by Beasley (1940) in the improvement of G.hirsutum. He crossed G.arboreum var. neglectum, an Asiatic species with G.thurberi, a new world species and the chromosome number of the resulting hybrid was doubled by colchicine treatment. This allopolyploid was crossed with G.hirsutum and 'Triple Hybrid', a new variety with high quality of lint was evolved from the backcross progenies. G. hirsutum was crossed with G.thurboreum - an amphidiploid of G.thurberi X G.arboreum, to impart the disease resistance of G.arboreum (Ganesan, 1947). Some improved strains of cotton were obtained from colchicine induced amphidiploids of G. anomalum X G. hirsutum (Deodikar, 1949).

Sugarcane (Saccharum officinarum) has been remarkably improved by interspecific crosses. S. spontaneum, a wild species when crossed with S.officinarum transmitted a vigorous root system to the hybrids and contributed to their vigour and comparative disease resistance (Venkataraman, 1938). The 'Co' varieties of commercial canes bred at Coimbatore, India, constitute complex interspecific hybrids between S.officinarum, S. barberi and S. spontaneum.

Improved varieties of legumes have also been obtained through interspecific hybridization. In alfalfa, creeping rooted types and varieties with resistance to frost, drought and diseases have been evolved from interspecific hybrids. 'Vernal alfalfa', a new variety, resistant to bacterial wilt has been produced from an interspecific cross (Brink et al., 1955). Coumarin free varieties of sweet clover have been bred from species crosses. In vetch, Colletotrichum resistant types have been evolved from interspecific crosses (Moriya, 1961).

In view of the fact that legumes often respond well to interspecific crosses and considerable scope of work still exists in this direction, the present project was envisaged. Attempt was made to find out the crossability of the two Phaseolus crops of South East Asia namely P. aureus Roxb. and P. mungo L. with other tropical Phaseoleae and to secure a basic understanding as far as possible on the problems of species crosses and the method of species origin. In due course more cross combinations were tried. It was also thought that the successful crosses would be potential materials for the transference of desirable characters from one species to another through suitable breeding technique, especially through back crosses. And lastly, as all the Phaseolus species have so far been found to possess only  $2n = 22$  chromosomes (excepting the species from Brazil with  $2n = 44$ ), their improvement through synthetic amphidiploid breeding has large potentiality. Some of our important crop plants have originated through



amphidiploidy and as in nature at least one amphidiploid  
Phaseolus is in existence (the tetraploid species from Brazil),  
attempts have been made to produce more such desirable forms.