International Journal of Biodiversity and Conservation Vol. 3(14), pp. 721-734, December 2011
Available online http://www.academicjournals.org/IJBC
DOI: 10.5897/IJBCX11.003
ISSN 2141-243X ©2011 Academic Journals

Review

Prunus diversity- early and present development: A review

Biswajit Das*, N. Ahmed and Pushkar Singh

Central Institute of Temperate Horticulture, Regional Station, Mukteshwar 263 138, Nainital, Uttarakhand India.

Accepted November 28, 2011

Genus *Prunus* comprises around 98 species which are of importance. All the stone fruits are included in this group. Three subgenera namely: *Amygdalus* (peaches and almonds), *Prunophora* (plums and apricots) and *Cerasus* (cherries) under *Prunus* are universally accepted. Major species of importance are *Prunus persica*, *Prunus armeniaca*, *Prunus salicina, Prunus domestica, Prunus americana, Prunus avium, Prunus cerasus, Prunus dulcis, Prunus ceracifera, Prunus behimi, Prunus cornuta*, *Prunus cerasoides, Prunus mahaleb etc*. Interspecific hybrids namely: plumcots, pluots and apriums also produce very delicious edible fruits. Rootstocks namely: Colt, F/12, Mahaleb, Mazzard etc are for cherry, whereas, Marrianna, Myrobalan, St. Julian, Higgith, Pixy etc are for other stone fruits. Cultivars namely: Flordasun, Elberta, Crawford's Early, Nectared, Sun Haven etc are peaches, Perfection, St. Ambroise, Royal, New Castle etc are apricots, Santa Rosa, Kelsey, Methley, Frontier, Burbank etc are plums, Lapins, Stella, Van, Black Heart, Compact Stella etc are cherries, and Nonpareil, Drake, Ne Plus Ultra, Jordanolo, Merced etc are almonds. Isozymic studies conducted to understand the phylogeny of *Prunus* sections *Prunocerasus* reveal that *Pronocerasus* is polyphyletic with *P. americana*, *P. munsoniana*, *P. hortulana*, *P. subcordata* and *P. angustifolia* in one group, and *P. maritima* and *P. umbellata* in another group that is closely related to *Cerasus*. The ECPGR *Prunus* working group, Biodiversity International, INRA (Bordeaux), NPGS (USA), GRIN (USA) and NBPGR (India) are some organizations actively involved in management and conservation of *Prunus* genetic resources.

Key words: *Prunus* diversity, *Prunus* origin, species conservation, varieties, stone fruits, data base.

INTRODUCTION

The stone fruits namely: peach, plum, apricot, almond and cherry of genus *Prunus* have attained a prime position amongst all the temperate fruit crops as delicious edible drupe, and many species have ornamental values as well. There are over 400 to 430 species in the genus *Prunus*, but only 89 are listed in the Genetic Resource Information System (Willis, 1948; Anonymous, 1969; Bailey and Bailey, 1976; Ghora and Panigrahi, 1984). In India, about 36 *Prunus* species have been reported so far and 18 species are useful for cultivation for different purposes (Santapau and Henry, 1973; Ghora and Panigrahi, 1984; Pandey et al., 2008). Diverged wild and domesticated species as well as traditional cultivars of these fruit crops across the globe are paving the way for creation of new genetic variability by employing different approaches such as exploration, passport data generation, introduction, conservation (*in situ, ex situ, in vitro*) in genebanks as well as breeding techniques namely: selection, hybridization, mutation and by various biotechnological tools. Vulnerability of germplasm base of *Prunus* to environmental stress, hazards, climate change/global warming, scattered and rare occurrence of species, lower rate of seed production, insect-pest and disease resurgence or incidence, low regeneration, competition with other dominating species, over exploitation for commercial purposes, and urbanization load has reached an alarming stage and presently this vast diversity is threatened (Russel, 2003).

The objective of the present study is to assess about the status of the *Prunus* biodiversity spectrum distributed world over, which will be helpful for *Prunus* genetic

*Corresponding author. E-mail: biswajitsom_dr@yahoo.co.in. Tel: +91 9411323821. Fax: +91 05942 286 027.

resource management and conservation.

ORIGIN AND DISTRIBUTION

Peach

China is the centre of origin for peach and was domesticated there 4-5000 years ago (Hedrick, 1917; Wang and Zhuang, 2001; Aranzana et al., 2011). *P. kansuensis* Rehd. and *P. davidiana* (Carr.) Franch. are native to north western China and north China respectively. Where as, native of *P. mira* Koehne is Tibetan plateau and areas neighbouring Nepal and India. *P. ferganensis* (Kost. and Rjab.) Kov. and Kost. is native to western China (Scorza and Sherman, 1996). China is also place of origin for Chinese wild peach (*P. consociiflora* Schneid.). Flat peaches (P. persica var. platycarpa) also originated in China. It is believed that nectarines might have originated in Europe, which was introduced to China. However, it is also considered that nectarines are also native to China. The main routes of peach movement from China to west were sea through India and mid east as well as silk route through Persia (Janick, 2003). According to Hedrick (1917), peaches were introduced in Mediterranean basins from Persia and during 400 to 300 BC it was brought to Greece. Further, it is believed that early Greek and Roman writers gave the 'Peach' nomenclature. Three groups of peaches are recognized in China, southern group is found in provinces along the Yangtze river, northern group is grown in the provinces along the Yellow river and third group is grown in arid north west China (Li, 1984). It is also thought that peach tree was first introduced into the colonial settlement of the US by French explorers in 1562 along the Gulf coastal territories near Mobile, Alabama, and then by Spanish with the founding of St. Augustine, Florida in 1565 on the Atlantic seaboard (Malcolm, 2006).

The next phase of introduction in the USA took place by direct introduction from China and England in mid 1850 (Scorza and Sherman, 1996; Bassi and Monet, 2008).

Plum

The centre of origin is extended from Asia, Europe to America for different biotypes/landraces. Centres of origin for major plum species (Crane and Lawrence, 1956; Watkins, 1976) can be broadly designated as China for Japanese plum (*Prunus salicina* Lindl.), southern Europe or western Asia for European plums (*Prunus domestica* L.), North America for American plum (*Prunus americana* Marsh.), western Asia or Europe for Damson plum (*P. insititia* L.), western and central Asia as well as Europe for cherry plum (*P. ceracifera* Ehrh.). Native places of other species (Wight, 1915; Rehder, 1954) have been identified as Italy, Greece and Yugoslavia for Italian plum (*P. cocomilia* Ten.), Europe and Asia for Blackthorn sloe (*P. spinosa* L.), north China for Apricot plum (*P. simonii* Carr.), Manchuria, along the Ussuri river for Manchurian plum (*P. ussuriensis* Kov. and Kost.), north eastern US for Allegheny plum or sloe (*P. alleghaniensis* Porter), southern US for Sand plum (*P. angustifolia* Marsh.), Florida for Scrub plum (*P. geniculata* Harper), south central US for Oklahoma plum (*P. gracilis* Engelm. & Gr.), central US for Hortulan plum (*P. hortulana* Bailey), north eastern US coast for Beach plum (*P. maritima* Marsh.), central US for Inch plum [*P. lanata* (Sudw.) Mack. & Bush], south central US and Mexico for Mexican plum (*P. mexicana* S. Wats.), south central US for wild Goose plum (*P. munsoniana* Wight & Hedr.), Canada and US for Canada plum (*P. nigra* Ait.), southern US for Hog plum (*P. reverchonii* Sarg.), Texas for Creek plum (*P. rivularis* Scheele), Oregon and California for Pacific plum (*P. subcordata* Benth.), Texas for Texas almond cherry or Texas peach bush or Texas wild plum (*P. texana* Dietr.) and south eastern US for Flatwood plum (*P. umbellata* Ell.). Many hybrids have been also identified at different centers of origin like France for *Blireiana* plum (*P* x *blireiana* Andre), south Dakota for purple leaf sand cherry (*P.* x *cistena* Koehne), Europe for *fruiticans* plum (*P*. x *fruiticans* Weihe.), Texas for Marianna (*P*. x *marianna*), New York for *Dunbars* plum (*P*. x *dunbarii* Rehd.), south central US for *orthosepala* plum (*P*. x *orthosepala* Koehne) and Kansas and Oklahama for *slavinii* plum (*P*. x *slavinii* E. J. Palm.).

Wild strands of *P. salicina* are still reported in Hubei and Yannan areas (Okie and Weinberger, 1996). *P. domestica* is assumed to be relatively young species and its wild state is unknown. Luther Burbank reported Caucasus mountains near the Caspian Sea as the origin place for *P. domestica* and its ancestors (Malcolm, 2006). Crane and Lawrence (1956) suggested Asia Minor as the place where natural hybrids between *P. ceracifera* and *P. spinosa* originated first, and dissemination of seeds of such hybrids from Iran and Asia Minor might have been the progenitors of *P. domestica* in Europe. *P. americana* Marsh. is the common wild plum and most widely spread amongst the American plum species.

Apricot

Prunus armeniaca L., the cultivated and wild apricot is native to Asia and Caucasus including north and north eastern China. *P. brigantina* Vill. (Alpine or Briancon apricot) is native to Alps in south eastern France, *P.* x *Dasycarpa* Ehrh. (Purple apricot) is native to south west Asia including Russia and adjoining regions, *P. mandshurica* (Maxim.) Koehne (Manchurian apricot) is native to north east of China, Manchuria and Korea, *P. mume* (Sieb) Sieb. & Zucc. (Japanese apricot) is native to Japan and south China, *P. sibirica* L. (Siberian apricot) is native to eastern Siberia, Manchuria, northern China and north Korea, *P. ansu* Maxim. is native to eastern China, south Korea and Japan, *P. holosericea* (Batal.) Kost. is native to Tibetian mountain (Faust et al., 1998; Mehlenbacher et al., 1991; Layne et al., 1996; Anonymous, 2002a; Mratinic et al., 2011)). The main areas of distribution of wild apricots are generally reported to be north China, Manchuria, north Korea, Khingan mountains and north eastern Mongolia. Kostina (1969) after evaluating various apricot forms and collections distinguished four ecogeographical groups and 13 regional subgroups within the *P. armeniaca.* Layne et al. (1996) further proposed that the cultivated apricots be classified into six ecogeographical groups and added two more groups to the Kostina's group: 1) Central Asian, 2) Irano-Caucasian, 3) European, 4) Dzhugar-Zailij, 5) North Chinese, and 6) East Chinese. Vavilov (1951) reported three centers of origin namely: 1) Chinese centre (north eastern, central and western China), 2) Central Asian centre (Hindu Kush to Kashmir mountains) and 3) Near eastern center (north eastern Iran to Caucasus and central Turkey). The richest diversity is available in the central Asian region comprising Sinkiang (China), Afganistan, Baluchistan, Pakistan and northern India. In India, cold arid region exhibits a great extent of variability in seedling population of apricot genotypes found in wild, semi wild and cultivated forms (Mir, 2000; Das et al., 2004).

The European group is the youngest in origin, whereas, Dzhugar-Zailij (Soviet central Asia such as Kazakhstan) is the most primitive. Three sub-groups in Oasis zones around the Tarim basin in southern Xinjiang are Kuche, Kashi and Hetian, and they are the dominant sub-groups within the central Asian group (Yuan et al., 2007). Apricots moved from central Asia to Transcaucasian area and further towards western parts through Iran (Blaha et al., 1966). In Europe, such as Italy and Greece, it was distributed by Armenian Traders during 2000 years ago and to England in the 13th century (Westwood, 1978). Arabs spread apricots through out the Mediterranean regions. European colonists were responsible for its spread in the America, Africa, Australia and New Zealand continents during 17th century (Layne, 2008). The cultivars grown in the Mediterranean region and the USA belong to the European group and are especially low in genetic diversity (Badenes et al., 1998).

Cherry

Most of the cherry species are indigenous to Europe and Asia (Rehder, 1974). Sweet (*Prunus avium* L.) and sour (*P. cerasus* L.) cherries are native to Near East centre which includes Asia Minor, Iran, Iraq and Syria (Vavilov, 1951). More specifically, sour cherry is native to Carpathian Basin (Anonymous, 2002a). Sweet cherries (mazzard) have been grown in southern Russia, north of the Caucasian mountains to the north of France for a long time. Natural range of sweet cherry also includes the temperate regions of Europe, from the northern part of Spain to the south eastern part of Russia (Hedrick, 1915). Ground cherry (*P. fruticosa* Pall.) is native to western and central Asia, specifically in Russia (Watkins, 1976; Iezzoni, 2008), and widely spread over the major parts of central Europe, Siberia and northern Asia. *P. tomentosa* Thunberg (Nanking or Hansen Bush cherry) is native to north west China (Kask, 1989), whereas, *P. besseyi* Bailey and *P. pumila* L. (Sand Cherries) are native to north America (Wight, 1915). The first diploid *Prunus* species originated in central Asia, and sweet, sour and ground cherries were early derivatives of this ancestral *Prunus* (Watkins, 1976). *P. fruticosa* Pall., the ground cherry is considered the probable parent of both *P. avium* and *P. cerasus* (Fogle, 1975). Sour cherry is believed to be a natural hybrid of ground cherry and sweet cherry. Cherry laurel *(P. laurocerasus* L.) originated in central and west Asia, south eastern Europe and Anatolia ((Olden and Nybom, 1968; Schquenberg and Paris, 1975). This species is grown in the eastern Black Sea region of Turkey, which is one of the places of origin of cherry laurel (Ansin and Ozkan, 1993).

Wild species, *P. serrulata* Lindl. is native to Asia, and is distributed in northern and central China through Manchuria to Korea and Japan. Duke cherries (*P. gondouinii* (Pot. & Turpin) Rehd.) are hybrids between sweet and sour cherry varieties. Cherry was brought under cultivation first in Greece (Marshall, 1954), and in 74 B.C the Roman General Lucullus brought to Rome from Cerasunt on the Black Sea (Anonymous, 2002a). Cherry was introduced in England by Romans from Persia in the first Century (Layne et al., 1996). Thereafter, its cultivation started in other European countries. In Europe, gradual domestication and cultivation have resulted in many landraces which differed only in few traits (Iezzoni et al., 1991; Kolesnikova, 1975). In North America, cherry was brought by the early settlers and thereafter, it was spread westward.

Almond

Almond originated in the central to south western Asia (Watkins, 1976). A wide range of distribution of different species or forms has been reported in the most north eastern parts of Asia comprising western China and Mongolian region, and in most northern parts comprising Balkan peninsula to Altai mountains (Browicz, 1974; Kester and Gradziel, 1996). Though, there is a close genetical relationship between almond and peach, however, their places of origin were different. Almond originated in the more western Asian regions having arid, mountainous terrains, dry and desert climatic conditions (Watkins, 1976). Botanical relationship of almond species with other groups namely: peach group, section Spartioides Spach, section Lycioides Spach, section Chameamydalus Spach and Leptopus Spach has been well reported (Kester and Gradziel, 1996). Moreover, gametophytic incompatibility nature has facilitated wide range of variability and distribution of seedling population (Socias y Company, 1992).

Native species or wild forms of almonds are generally bitter kernelled due to higher levels of cyanogenic glycoside amygdalin (CONN, 1980; Kester et al., 1991).

Mutation and seedling segregation within almond species as well as other *Prunus* species probably resulted in sweet kernelled types (Bailey and Hough, 1975). One hypothesis stated that cultivated types emerged within *Amygdalus communis* L. in Iran, Turkmenistan and Tadjikistan or even extended in the Transcaucasus, central Turkey, Syria, Lebanon and Jordan (Browicz, 1974). On the other hand, it is also believed that hybridization occurred among the species namely: *P. fenzliana* Fritsch (found in Caucasian mountains), *P. bucharica* (Korsh.) Hand.-Mazz (found in central Asia), *P. kuramica* (Korsh.) Kitam. and some other species (Evreinoff, 1958). *P. kuramica* evolved in the Afganistan and northern Pakistan region which is more xerophytic, whereas, *P. dulcis* is mesophytic (Kester and Gradziel, 1996).

Human selection for sweet types during the ancient times resulted in domestication of superior quality almonds over the years. *P. webbii* (Spach) Vierh. occurred in the Mediterranean region, Balkan Peninsula and western Turkey, and intercrossing took place with cultivated ones under natural ecology. *P. orientalis* (Miller) Koehne is distributed in central Asia and *P. tenella* Batsch (dwarf Russian almond) is found in Europe (Anonymous, 2002a). Domestication of almond happened during the third millennium BC in the central Asian region (Kovalev and Kostina, 1935). Almond seeds were carried to Mediterranean region by the Caravans on their way to western world from China across the central Asian mountains (Mohamed, 2004). In Mediterranean region further hybridization took place. Evolution and early distribution of almond populations have demarcated three geographical zones namely: Asiatic, Mediterranean and Californian (Kester et al., 1990). Apart from central and south western Asian and Mediterranean regions, Arabs introduced almond in Tunisia, Morocco and other areas creating another route across the central Africa during 500 to 600 AD (Laghezali, 1985). In California, it was introduced from Mediterranean region. Initially almond was introduced in California during Spanish Mission period, which was accelerated again during Gold Rush (Wood, 1925). Simultaneously, its introduction happened in west Australia, South Africa as well as in some areas of South America such as Chile and Argentina. *P. dulcis* (Mill.) D. A. Webb syn.

P. amygdalus Batsch exhibits a wide range of variability in terms of tree growth habit, bloom period, fruiting behaviour, nut and kernel characteristics as well as biotic and abiotic tolerance level. In India, a rich diversity of seedling population of almond landraces is also found in Kashmir (J&K) and Kinnaur (Himachal Pardesh).

TAXONOMY, SPECIES DIVERSITY AND CYTOLOGY

The word '*Prunus*' might have been taken from Greek '*Prounos* or *Proumnos*'. Linnaeus used four genera which designate present day's *Prunus* as *Amygdalus*, *Cerasus*, *Prunus* and *Padus*, which were modified in 1758 to *Amygdalus* and *Prunus*. Linnaeus in 1753 divided species domestica into 14 sub species referring the publication of Bauhin in 1663. Hooker (1785 to 1865), A. Engler (1844 to 1930) and K. A. Prantl (1849 to 1893) grouped all the stone fruits under *Prunus* (Bentham and Hooker, 1865; Faust and Suranyi, 1999). Watkins (1976) was of opinion that *P. salicina* has a linkage between *Euprunus* and *Prunocerasus*. Three subgenera under genus *Prunus* are universally accepted (Westwood, 1978) namely: *Amygdalus* (peaches and almonds), *Prunophora* (plums and apricots) and *Cerasus* (cherries). According to Strasburger et al. (1991), *Prunus* genus has been classified into seven subgenera particularly on the basis of distinctive morphological characteristics like the pattern of leaf rolling in the bud, cymes or racemes inflorescence, size and colour of the flowers, traits of fruit, stone and seeds. The different sub genera are (Komarov, 1971): i) *Amygdalus* (almond), ii) *Persica* (peach), iii) *Armeniaca* (apricot), iv) *Prunus* (plums and prunes), v) *Cerasus* (sweet and sour cherry), vi) *Padus* (Bird cherry) and vii) *Laurocerasus* (Laural or bay cherry *P. laurocerasus*). Under genus *Prunus*, reproductive and vegetative buds are born separately and are always lateral, well developed superior ovary and fruit is drupe. Subgenus *Pronophora* Focke. is characterized by solitary and axillary flower buds born on short spur or shoots, flowers on umbel like clusters usually 2 to 4 numbers or solitary. Fruits are sulcate, glabrous and usually bloom on epidermis and pedicel is intact.

Rehder (1954) classified European and Asian plums under section *Euprunus* and American plums under *Prunocerasus* based on some specific traits like flower numbers per bud, physical characteristics of stone and orientation of leaves in the bud. According to Westwood (1978) section *Euprunus* has usually 1 to 2 flowers together, while, section *Prunocerasus* has 2 to 5 flowers in clusters. Leaves are rolled inward in bud in *Euprunus* and folded in *Prunocerasus*. Taxonomic identification guide for naturalized and native peach and plum in America was also given by Preston (1976). Donmez and Yildirimli (2000) described *Prunus* species in Turkey on the basis of their habit, distribution, leaf shape, flower and fruit characters, trees or shrub, thorny or unarmed etc. In flora of China, Gu and Bartholomew (2003) described the *Prunus* species on their morphological characters. Perez et al. (2010) surveyed Spanish cherry germplasm and described 18 cultivars of sour, sweet and duke cherries employing 48 agromorphological parameters, and quantitative (acidity and lenticels) and qualitative (central and lateral lobes of flower fascicles, shape and margin of leaf, pubescence on under side of leaf, petal colour, leaf stipule type, seed shape and viability and seed coat sulci) descriptors were found to be useful for species specific identification of cultivars. Peach is commonly designated as *Prunus persica* (L.) Batsch and free stone cultivars of peaches are classified as *P. persica* var. *domestica* Risso. (syn. *Persica domestica* Risso) and cling stone (pavies) cultivars are designated as *P. persica* var. *vulgaris* Risso (syn. *Persica vulgaris* Risso) (Hakan, 2003). *P. persica* (L.) Batsch var. *nucipersica* (Suckow) C.K. Schneid. (*P. persica* (L.) Batsch var. *nectarina* (Ait. f.) Maxim.) is nectarine. *P. davidiana* (*P. persica* var. *potaninii*) is known as mountain peach, David peach, Shan tao or Chinese wild peach.

P. persica Batsch var. *compressa* Bean (syn. *P. persica platycarpa* Bailey) is known as flat peach or tomato peach or dunut peach and is a mutation of common peach. Some other species under this group are *P. ferganensis* (Kost. & Rjab.) (known as Xinjiang tao), *P. mira* Koehne (Tibetan peach, Xizang tao or smooth pit peach), *P. kansuensis* Rehder (Kansu peach or peach of Gansu) and *P. andersonii* A. Gray (Desert peach or desert almond). *P. behimi* (*P. mira* Koehne.), called Behmi or Behimi or Tirul grows wild in dry temperate regions of the Himalaya and reported to be a natural hybrid between almond and peach (Sharma, 1993; Sofi et al., 2007; Rana et al., 2007). Many other wild species are also found in the lower, mid and higher hills of temperate regions of India. They are locally called 'Kateru or Aran or Kataki aru' or simply 'wild peach' under *P. persica*. Ornamental peaches are small deciduous plants mainly under *P. persica* (L.) Batsch and *P. davidiana* (Carriere) Franch with glabrous branchlets, serrulate leaves and subsessile flowers. Flower colours ranges from pink, red, white, bicolour or even tricolour. Growth habit may be upright, dwarf, weeping or fastigiated (Hu et al., 2005). All these forms are catalogued under different nomenclature (Bailey, 1963) namely: *Persica vulgaris flore albo-plena*, *flore roseo-plena*, *flore sanguinea plena* representing different colours of double flowered types. On the other hand, *P. vulgaris foliis purpureis* is designated for purple or blood coloured flowers. Other forms are var. *camelliaeflora* (very large carmine flowers), subvar. *Plena* (double flowers) and var. *versicolor* (tree bearing multi coloured flowers).

Plums of Asiatic centre (*P. salicina* Lindl.) are characterized by early blooming, early fruit maturity and are sensitive to frost injury. European plum cultivars are characterized by high sugar content, good flavour, late flowering and fruit maturity, large stone and require higher chilling hours (Zhukovsky, 1965). Prunes are cultivars of *P. domestica* L. group which are very sweet and suitable for drying without any fermentation due to high sugar content. American group (*P. americana* Marsh., syn. *P. latifolia* Moench., *P. hiemalis* Machx., *P. ignota* Nels.) exhibits small to medium (4.5 to 7.5 m tall) tree with stout twigs or spine like growth. *P. insititia* (*P. insititia subsylvestris* Boutigny) group includes damsons, bullaces and mirabelles. Wild form or St. Julien plums are *P. insititia*. However, these groups are also classified separately as bullace under *P. insititia* L., damson under *P. damascene* L., gages under *P. italica* (*Prunus domestica* L. subsp. *italica* (Borkh.) Gams ex Hegi.), and mirabelle under *P. domestica* L. subsp. *syriaca* (Borkh.) Janchen ex Mansfeld. Bokhara plum or Alubukhara (*P. bokhariensis* Royle ex C. K. Schneider) is found in western Himalaya and is thought to have originated as a cross between *P. domestica* L. x *P. insititia* L. (Pandey et al., 2008). Two varieties of P. cerasifera are also found in India, var. cerasifera (Myrobalan plum or cherry plum) and var. pissardii (carr.) Bailey (Copper plum). Other species under plum group (Anonymous, 2009,) are *P. kurdica* Fenzl ex Fristch (an extreme form of *P. spinosa*), *P. sellowii* Koehne, *P. minutiflora* Engelm., *P. havardii* (W. Wight) S. C. Mason, *P. vachuschtii* Bregadze, *P. ursina* Kotschy, *P. gravesii* Small, *P. cerasia* Blanche etc. *P. armeniaca* L. is found in cultivated (commercial apricot cultivars), wild and semi wild form. Locally in India, the wild forms of this species are known as Chulli or Zardalu in Himachal Pradesh, Gurdalu and Cherkush in Kashmir, Chuaru, Chola and Kushmaru in Kumaon and Chult or Chuli in Ladakh (Parmer and Kaushal, 1982).

P. brigantina Villars. (Alpine plum) is a shrub or small tree (Layne et al., 1996). *P. ansu* (Maxim.) Kom. and *P. mume* Sieb and Zucc. grow in eastern China and Japan. *P. mume* Sieb and Zucc. is more disease resistant than *P. armeniaca* L. *P. sibirica* Koch and *P. mandschurica* (Maxim.) Koehne are cold resistant and used for imparting cold resistance in the commercial cultivars. *P*. x *dasycarpa* is a natural hybrid between *P. cerasifera* and *P. armeniaca*. *Amygdalus communis* L. was first used by Linnaeus in 1753, and in 1768 it was designated as *P. dulcis* for sweet almond (Webb, 1967). Earlier the nomenclature *P. amygdalus* Batsch was used, and finally the name *P. dulcis* (Miller) D. A. Webb was accepted. Under *P. amygdalus* Batsch three types have been reported in India (Pandey et al., 2008) namely: var. *amygdalus*, var. *amara* (DC.) Focke and var. *sativa* (Ludw) Focke. In Iran, around 12 species of wild almonds have been reported and P. scoparia Spach and P. webbii Vierh are widely distributed in arid and semi arid areas (Heidari et al., 2008). In Lebanon, high genetic diversity of Amygdalus communis L., Amygdalus korshinskyi Hand.-Mazz. and Amygdalus orientalis Duh. was reported by Talhouk et al. (2000). Other species under almond group (Anonymous, 2002a, 2002c, 2009) are *P. argentea* (Lam.) Rehder, *P. fasciculata* (Torr.) A. Gray, *P. fremontii* S. Watson, *P. glandulosa* (Hook.) Torr. & A. Gray, *P. scoparia* (Spach) C. K. Schneid., *P.*

spinosissima (Bunge) Franch., *P. tangutica* (Batalin) Koehne, *P. triloba* Lindl., *P. petunnikowii* (Litv.) Rehder, *P. velutipes* Nakai, *P. ulmifolia* Franch., *P. turneriana* (F. M. Bailey) Kalkman, *P. trichamygdalus* Hand.-Mazz., *P. tangutica* (Batalin) Koehne, *P. persicoides (*Ser.) M. Vilm. & Bois, *P. pedunculata* (Pall.) Maxim., *P. mongolica* Maxim., *P. lycioides* (Spach) C. K. Schneid., *P. haussknechtii* C. K. Schneid., *P. eburnea* (Spach) Aitch. etc which are distributed in different parts of the world. *P. avium* L. is known as sweet cherry, wild bird cherry, mazzard cherry, gean, gilas, krusbal in different regions. Fruits of cultivated form of *P. avium* are very good in quality and planted for commercial purpose in different parts of the world. Wild selection called 'Mazzard' which is self fertile is used as rootstock since centuries old. *P. cerasus* L. is sour cherry.

P. cerasoides D. Don. (syn. *P. puddum* Roxb.) is also known as Himalayan wild cherry or dwarf cherry, and locally called Paja in Himachal Pradesh, Alich in J&K and Payon or Dieng Kadi Tusao in different regions. Two distinctly identifiable forms also exist in India (Pandey et al., 2008) namely: var. *cerasoides* and var. *majestica* (Koehne) Ingram. *P. cornuta* (Wall. ex Royle.) Steudel is wild cherry locally called Jaman in India. It is considered to be closely related to *P. padus* (Moench) Koehne (European bird cheery), *P. napaulensis* (Ser) Steud., *P. bracteopadus* Koehne and *P. accuminata* (Arora and Nayar, 1984). Three botanical varieties also exist namely: var. *cornuta*, var. *villosa* and var. *integrifolia* (Ghora and Panigrahi, 1995). *P. mahaleb* L. is called mahaleb cherry, St Lucie, perfumed cherry, rock cherry and Gandhi cherry. Three sub-species of mahaleb occur in Hungary namely: ssp. *simonkai*, ssp. *cupaniana* and ssp. *mahaleb* (Hrotko, 1996) with great natural variability. Other species under cherry group (Radford et al, 1968; Anonymous, 2002a, 2002c, 2009) are *P. caroliniana* Aiton, *P. conradinae* Koehne, *P. cyclamina* Koehne, *P. dawyckensis* Sealy, *P. emarginata* (Douglas ex Hook.) Eaton, *P. incana* (Pall.) Batsch, *P. jacquemontii* Hook. f., *P. laurocerasus* L., *P. lusitanica* L., *P. maximowiczii* Rupr., *P. nipponica* Matsum., *P. okame*, *P. pleiocerasus* Koehne, *P. prostrata* Labill., *P. sargentii* Rehder, *P. serotina* Ehrh., *P. subhirtella* Miq., *P. virginiana* L., *P.* x *kanzakura* Makino, *P.* x *yedoensis* Matsum, *P. carmisina* Hara var. *rubea* C. Ingram, *P. pensylvanica* L., *P. himalaica* Kitamura, *P. javanica* (Teysm. & Binn.) Miq., *P. phaeosticta* (Hance) Maxim., *P. jenkinsii* Hk.f. & Thomas. ex Hk.f, *P. pygeoides* Koehne, *P. rufa* Steud. ex Hk. f. (var. *rufa*, var. *imanishii* (Kitamura) Ghora and Panigr. and var. *trichantha* (Koehne) Hara), *P. venosa* Koehne, *P. zippeliana* Miq., *P. wilsonii* (Diels ex C. K. Schneid.) Koehne, *P. incisa* Thunb., *P. japonica* Thunb., *P. pseudocerasus* Lindl., *P. maackii* Rupr., *P. capuli* L., *P. verecunda* (Koidz.) Koehne, *P. vaniotii* H. Lev., *P. tschonoskii* Koehne, *P. trichostoma* Koehne, *P. tatsienensis* Batalin, *P. ssiori* F. Schmidt, *P. speciosa* (Koidz.) Ingram, *P. setulosa* Batalin, *P. pauciflora* Bunge, *P. obtusata* Koehne, *P. nipponica* Matsum., *P. myrtifolia* (L.) Urb., *P. microcarpa* C.A. Mey, *P. melanocarpa* (A. Nelson) Rydb., *P. marasca* (Host) Rchb., *P. lyonii* (Eastw.) Sarg., *P. leveilleana* Koehne, *P. kurilensis* (Miyabe) Miyabe ex Takeda, *P. depressa* Pursh, *P. cuneata* Raf., *P. concinna* Koehne, *P. canescens* Bois, *P. bifrons* Fritsch, *P. aspera* Thunb., *P. ilicifolia* (Nutt.) Walp. etc.

Basic chromosome number in *Prunus* is x = 8. Polyploidy played an important role in the process of evolution of new species or strains. Natural interspecific hybridization is responsible for polyploidy of *Prunus* during phylogeny. This is the main cause for self-sterility and intersterility in this genus. Somatic chromosome numbers (Darlington and Ammal-Janaki, 1945; Rehder, 1954; Anonymous, 2002a) of different *Prunus* species vary from diploid to hexaploid. Under plum, *P.salicina* is 2n = 16, 32, *P. simonii* is 2n = 16, *P. domestica* is 2n = 48, *P. spinosa* is 2n = 32, 24, 40, 48, *P. cerasifera* is 2n = 16, 17, 24, 32, 48, *P. insititia* is 2n = 24, 48, *P.* x *dasycarpa* is 2n = 16 and *P. americana* is 2n = 16. Most of the American species are 2n = 16. Almond species namely: *P. amygdalus*, *P. bucharica* etc., peach species namely, *P. persica*, *P. davidiana*, *P. mira* etc. and apricot species namely (Brown et al, 1996; Olden and Nybom, 1968): *P. armeniaca, P. mandshurica*, *P.* x *dasycarpa* etc are all 2n = 16. *P. mume* is 2n = 16 or 24. Much variation in ploidy level is also found in cherry species namely: *P. avium* (2n = 16, 24, 32), *P. cerasus* (2n = 32), *P. besseyi* (2n = 16), *P. fruticosa* (2n = 32), *P. mahaleb* (2n = 16), *P. tomentosa* (2n = 16), *P. padus* (2n = 16) and *P. serotina* (2n = 32).

Varietal diversity

Peach

A number of cultivars came into existence from seedlings of unknown origin in America like Early Crawford, Late Crawford, Reeves, Iron Mountain, Oldmixon Cling etc between the period of revolution and civil war, however, development in genotypes that gave rise to majority of the present day cultivars took place after civil war. As indicated from genotype of many of the modern day cultivars inheritance can be traced back to J. H. Hale, Elberta or Belle and ultimately to Chinese Cling (Scorza et al., 1985). The name 'Nectarine' was first used in England during 1616. The first introduction of peaches in India can be traced during the reign of King Kanishka by Chinese hostages in 1st century AD (Sharma, 1993). Mr. A. N. Lee, son of Captain R. C. Lee during late 19th century introduced many varieties of peaches and plums along with other temperate fruits in Himachal Pradesh. Peach cultivars J. H. Hale, Early Hale, Halbarta, Candoka, June Elbarta and Hale Haven with Hale in their parentage show self sterility (male sterile) and require pollinizers for fruit set. Otherwise, all the peach cultivars are self fruitful. Peach varieties are grouped on the basis of flesh colour (yellow and white), melting nature of flesh (melting and non-melting), stone adhesion to flesh (free stone, semi cling stone and cling stone) and chilling requirement. Cultivars Harflame, Nectared 1, Fantasia, Arctic Snow, Summer Fire, Arctic Star, Sunglo, Mayfire, and Flavortop are some popular nectarine cultivars. Cultivars Olimpia, Orex Mex, Flordagem, Flordaglo, Newbelle, Tropic Prince etc. are some popular low chill peach cultivars. Peento peach cultivars are China Flat, Sweet Bagel, Galaxy, Sauzee Queen, Saturn, UFO and Ruipan No. 1 etc. Peach ecotypes as well as cultivars are grown in different provinces in China and commercial cultivation is concentrated in northern, central-eastern and north-western China (Wang and Zhuang, 2001). In North China provinces the Mitao cultivars are generally cultivated, whereas, Shumitao peaches (Honey peach), are commonly grown in Southern parts of China. Leading cultivars in China are Feicheng Tao, Shenzhou Mitao, Zhaohui, Chunlei, Jincheng, Kurakato, Yidou Mitao etc. (Huang et al., 2008). Gene bank of NBPGR, Regional Station, Shimla (India), has about 22 indigenous and 27 exotic accessions (Sharma et al., 2001) namely: Summer Glo, NemaGuard, Candor, Stark Early Glo, Flordaball, Flordasun, Sunred, Dixi Red, C. O. Smith, Snow Queen, Peach S-37, July Elberta, Fire Prince, Duke, Alton Peach, Ambri, Okubo, Kanto 5, Nishiki, Luna etc. Recommended cultivars in India (Anonymous, 2003; Das et al., 2007) are Shan-i-Punjab, July Elberta, J. H. Hale, Crawford's Early (locally selected as Paradelux), Red June (Elberta selection), Shaharanpur Prabhat and Flordasun.

Plum

American plum industry is based on European and Japanese plums or hybrids of native and imported plum varieties. European plums particularly greengage, bullaces, prunes, damsons and mirabelles etc were mainly distributed in the cooler regions of America. Luther Burbank in 1885 imported 12 seedling trees of 12 cultivars from Japan (Dreyer, 1985) and selected two main cultivars Satsuma and Burbank. Japanese seedlings were extensively used by Burbank to develop hybrids like Beauty, Formosa, Santa Rosa, Shiro, Golden, Methley, Wickson etc. More than 600 cultivars were developed mainly from native American species as well (Wight, 1915) by many contemporary breeders over the later stage of 18th century. Cultivar Marianna introduced by C. Eley became an important rootstock which originated in Marianna, Texas, in 1884 as a chance hybrid of *P. munsoniana* and *P. cerasifera* (Hedrick, 1911). In 1893 and 1913 breeding programme of European plums was initiated in Geneva, New York and Vineland, Ontario, respectively (Cullinan, 1937). Cultivars Friar, Black Amber, Santa Rosa, Red Beaut, Black Beaut, Kelsey etc are some of the leading Japanese cultivars popular in California (Okie and Weinberger, 1996).

Collaborative breeding programme in University of California and USDA, initiated in 1932, resulted in release of Burmosa and Redheart in 1950. USDA released Frontier in 1967, Frier in 1968, Queen Rosa in 1972, Black Amber in 1980 and Fortune (a Red plum) in 1990.

In California, some mutants from Santa Rosa have been selected like Late Santa Rosa, July Santa Rosa etc. Native American species or their hybrids are more hardy, late blooming, small fruit size and adapted to Northern American areas. Plum germplasm available (Sharma et al., 2001) in the genebank at NBPGR, Regional Station, Shimla (India) are Au Rosa, Au Cherry, Grand Prize, Black Amber, Queen Ann, Satsuma, Fortune, Monarch, Plum Beauty, Tarrol, Red Plum, Santa Rosa, Yellow Plum, Black Plum, Late Plum, Methley, Prune, Frontier, etc. Cultivars namely: Pershore, French Damson, Stanley, Golden Transparent, Giant Prune, Victoria etc are self fruitful. Cultivars namely: Satsuma, Black Champa, Raine Claude, Transparent, Golden Drop, Frogmore, Italian Prune, Red Beaut, President, Mariposa, Burmosa, Kelsay, Frontier etc are self unfruitful. Whereras, cultivars Santa Rosa, Beauty, Early Orleans etc are partially self-fruitful. Recommended cultivars in India (Anonymous, 2003) are Sweet Early, Methley, Red Beaut, Santa Rosa, Beauty, Frontier, Satsuma, Burbank and Alucha Purple.

Apricot

Inclusion of the central Asian and other more diverse sources of germplasm into current apricot breeding programmes especially in the USA have potentially led to development of apricots with improved quality and broader adaptation (Bassi and Sansavini, 1988). Many cold tolerant and drought resistant apricot cultivars were identified at Nikitsky Botanic Garden, Russia (Draczynski, 1958). Cultivars Harlayne, Hargrand and Harglow were developed at Harrow Research Station (Layne, 1989) and cold hardy cultivars namely: Haggith, Alfred, Farmingdale, Earligold etc were also identified from different ecogeographical groups (Mehlenbacher et al., 1991). Cultivars of European origin are self compatible, whereas, majority of the Central Asian, North African, Near East and Caucasian origin cultivars are self incompatible (Layne, 2008). In USA, about 131 cultivars and 13 rootstocks have been reported (Brooks and Olmo, 1997), and around 1300 cultivars are listed by Biodiversity International (Layne, 2008). The apricots grown for the fresh market in California and Michigan are Blenheim, Wenatchee Moorpark, Tilton etc and Sekerpare, Tabarza, Tokbam, Lasgherdi, Hacihaliloglu, Tokaloglu, Hasanbey, Cataloglu, etc are important cultivars of Turkey (Layne, 2008). Cultivars namely: Kaisha, New Castle, Early Shipley, Saffaida, Charmagaz, Shakarpara, Gilgati Sweet, St Ambroise, Moorpark, Nari Halman, Rakcha Karpu, Narmo are commonly grown in, India (Anonymous, 2003; Das et al., 2004).

Malik et al. (2010) explored apricots from high altitude north-western Himalayas of India and grouped cultivars Margulam, Lodi, Shakarpara, Narmo and Khurmani as table type, while drying type cultivars were Halman, Shakarpara, Rakchey Karpo and Tachu. Cultivars Chuli and Shadi were found to be widely distributed with greater variability.

Cherry

In USA, sweet cherry production is mainly dominated by 'Bing', a chance seedling identified in Oregon during the late 19th century. Improvement programme was initiated as early as in 1911 and three major U.S. public organizations namely: Cornell University-NYSAES (Geneva), University of California and Washington State University took the initiative first. Many of the new sweet cherry cultivars were released from the breeding programmes initiated by Agriculture and Agri-Food Canada in the last 30 years. Cultivars developed by North American breeding programmes showed a narrow genetic base as most of the cultivars derived from few clones (Choi and Kappel, 2004). Cultivars Lambert and Republican were developed after Bing. On the basis of fruit firmness, cherry cultivars are divided into two groups, i) the Heart cherry group with mainly early ripening cultivars namely: Early Purple, Black Heart, Black Tartarian, Elton etc which have soft flesh, dark fruit colour and reddish juice, and ii) the Bigarreau group includes late cultivars with firm flesh, such as Lambert, Stella, Bing, Van, Windsor, Napoleon etc which have dark red, black, yellowish fruits and dark flesh (Anonymous, 2002a). Cultivars namely: Van (1944), Sam (1953), Sue (1954), Compact Lambert (1964), Stella (1968), Compact Stella (1973), Lapins (1984), Sunburst (1984), Sylvia (1988) etc were released from Summerland Research Station, Canada (Brown et al., 1996) apart from many other important cultivars from other stations such as Vineland Station.

Self-fertile cvs. Starkrimson, Lapins, Sunburst and New Star have Stella as parentage. Cutlivars namely: Black Heart (Siyah Gole), Guigne Pourpeara Prece (Awal Number), Guigne Noir Gross Lucenta (Tontal), Guigne Noir Hative (Makhmali), Bigarreau Napoleon (Double), Bigarreau Noir Grossa (Misri) are grown in India (Anonymous, 2002b). Sour cherries are also divided into two groups Iezzoni, 2005): i) Amerelles (upright vigorous trees, pale reddish fruits, juice light coloured and low in acidity) cultivars are Montmorency, Kentish, Early Richmond etc., and ii) Morello (small bushy compact trees, dark red fruits, red fleshed, juice reddish in colour and high in acidity) cultivars are Stockton, Vladimir, North Star etc. Early Richmond, English Morello, Rheinische Schattenmorelle and Montmorency are the leading sour cherry cultivars. More than 80 sour cherry varieties are listed in various catalogues in Russia and over 270 cultivars are available in USA (Kramer, 1985; Brown et al., 1989).

Almond

Improvement and cultivation of almond during the early period was based purely on seedling populations. Gradually superior types were isolated on the basis of specific traits in different regions. Puglian (Italy) cultivars were late blooming, whereas, Sicilian cultivars were early blooming. However, both types were hard shelled (Kester and Gradziel, 1996). Marcona and Desmayo Larguetta were the dominating cultivars in Spain. Due to many disadvantages of France cultivars in California, superior selections were made from the seedling populations and cultivars namely: Nonpareil, IXL and Ne Plus Ultra were found to be very promising during 1879 (Wood, 1925). Later on, cultivars namely: Texas Prolific, Peerless, Drake, Merced, Price, Carmel, Fritz, Thompson and Livingston were selected and planted, though, Nonpareil became the main cultivar (Kester and Gradziel, 1996). Through extensive improvement programmes initiated from 1923 at different stations in USA, cultivars namely: Jordanolo, Harpareil, Kapareil, Sonora, Tardy Nonpareil, Jeffries etc were developed. In France, cultivars Ferregnes and Ferraduel were developed from the crossing programme initiated in 1961 (Grasselly, 1975). Successively, improvement programme was started in other countries as well such as in Greece, Israel, Turkey, USSR, Spain and Italy (Kester and Gradziel, 1996). Cultivars Nikitski 62, Primorski and Prianyi are from Russia, Solo, Dagan and Samish are from Israel, Retsou and Phyllis are from Greece, Ayles, Guara and Moncayo are from Spain, Chellastan, Johnston and White Brandis are from Australia. Self fertile cultivars namely: Tuono and Felippeo Ceo were developed under the Group de Recherche et d'etude Mediterranean Pour l'Amandier (GREMPA) during 1975 (Herrero and Felipe, 1975; Socias y Company, 1992). Recommended cultivars in India are Waris, Muhkdoom, Shalimar, Parbat, Nauni Selection, Prianyi, Merced, Primorski, Nonpareil, California Papershell, Ne Plus Ultra and Drake (Das and Kumar, 1996; Anonymous, 2002b, 2003).

INTERSPECIFIC CROSSING AND HYBRIDS IN *PRUNUS*

Natural and artificial inter generic and inter specific hybridization has been reported and many of them have been exploited commercially. In North America during 1925, a hybrid 'Nicollet' (*P. avium* x *P. pensylvanica*) x *P. besseyi* Bailey was introduced (Layne et al., 1996). Plumcots are hybrids between apricot and European plum (Gomez et al., 1993; Okie and Ramming, 1999).

Genetically, it bears 50% traits of apricot and 50% traits of plum. Aprium has been also produced by crossing a plumcot and apricot which exhibits 75% traits of apricot and only 25% of plum. On the other hand, Pluot is a hybrid produced from cross between a plumcot and plum with 75% plum and 25% apricot traits. Aprium and Pluots were developed by F. Zaiger in 1990 through intricate hybridization. Cultivars Red Velvet, Royal Velvet, Plum Parfait, and Flavor are plumcots, Flavor Delight, Honey Rich, Flavor Ann and Tasty Rich are apriums, and Dapple Dandy, Flavor King, Flavor Supreme, Sierra Rose and Flavor Rosa are pluots. Hybridization readily takes place between *P. amygdalus* and *P. persica* (Kester and Asay, 1988). Peach and almond hybrids GF 557 and 677 are good rootstocks. Damas GF 1869 is a hybrid of *P. domestica* and *P. spinosa*. Riggoti No. 2 is and Nemaguard are *P. persica* and *P. davidiana* hybrid. *P. domestica* and *P. munsoniana* are the parents of Marianna GF 8-1. Julior is a hybrid of P. insititia x P. demestica. North American species and their interspecific hybrids, created between 1907 and 1965, represent a distinct group of cultivated *Prunus* species. Cherry plums have been derived from *P. besseyi* and *P. pumila*, with the western and the eastern sand cherry as a common parent (Janick and Moore, 1975).

ROOTSTOCKS OF *PRUNUS* SPECIES

Different *Prunus* species namely: *P*. *cerasifera*, *P*. *cerasifera* x *P*. *munsoniana*, *P*. *domestica*, *P*. *insititia*, *P*. *americana*, *P*. *pumila*, *P*. *besseyi*, *P*. *spinosa*, *P*. *dulcis*, *P*. *amygdalus* x *P*. *persica*, *P*. *insititia* x *P*. *domestica*, *P*. *armeniaca*, *P*. *salicina*, *P*. *persica* x *P*. *davidiana* and *P. amygdalus* x *P. nemared* (*P. persica* x *P. davidiana*) are commonly used as rootstocks for peach, plum, apricot and almond in different countries (Kishore et al., 1991; Gradziel, 2008; Reighard and Loreti, 2008). Wild forms of peach, apricot, plum and almonds are also used as rootstock in India depending on varietal graft compatibility and soil types Almond as rootstock shows better resistance to limestone and drought conditions, and peach induces tree vigour and nematode resistance, whereas, different plum species as rootstock are more resistant to waterlogging and various diseases (Nicotra and Pellegrini, 1989). Peach almond Titan Hybrids (Titan almond x Nemaguard hybrid seedling) namely: Red and Green Leaf Titan are extreamly vigorous, resistant to nematode, tolerant to calcareous soil and cold. Guardian is another peach rootstock which exhibits nematode and peach tree short leaf resistance and moderatly cold hardy. Bailey is another hardy peach rootstock. Vito et al. (2001) reported a wide range of *Prunus* rootstocks resistant to nematode which includes Argot, P.S. Series Cadaman, Ishatara, Marianna 2624 and Garnem. In other countries, wild apricot selections namely: INRA Manihot and North African wild apricot are commonly used as rootstock. Apart from wild biotypes, seedlings or clonal selections of different species which are used as root stocks (Gradziel, 2008; Layne, 2008; Okie, 2008; Reighard and Loreti, 2008) are Royal, Higgith, Siberian C, Rubira, Harrow Blood, GF 677, Marianna series, Myrobalan series, Damas GF 1869, Rutger's Red Leaf, St. Julien series, Myram, Nemaguard, Nemared, Lovell, Pixy, Citation, Brompton, Pershore, Julior, Flordaguard etc. Seeds of *P. cerasoides* easily germinate and commonly used as seedling rootstock for sweet cherry in India (Singh et al., 1971). *P. cornuta* is a very good rootstock for cherry and has been found to be compatible (Singh and Gupta, 1972).

Mazzard seedlings and F/12 produce larger tree as rootstock having longer life span. Mahaleb induces precocious bearing on scion cultivars and gives very good performance on light textured sandy to sandy loam or calcareous soil and even under water stress condition. Trees on these rootstocks are better in hardiness, survival and yield in comparison to Mazzard and Stockton Morello. In some countries, Mahaleb seedlings such as CEMA (C500) and Korponay seedling are commercially used. A new series under *P. cerasus* was raised from seeds of 'Weiroot 11' namely: 53, 72 and 158 (Stehr, 1998). Many rootstocks are in use in different countries evolved from *P. cerasus* namely: Edabriz, Weiroot 10, Weiroot 13, Weiroot 53, Weiroot 72 and Weiroot 158. Some other rootstocks are Gisela 5 (*P. cerasus* x *P. canescens*), Giesela 6 (*P. cerasus* x *P. canescens*), LC-52 [*P. cerasus* x (*P. cerasus* x *P. maackii*)], Colt (*P. avium* x *P. psedocerasus*) and OCR and CAB series.

MOLECULAR BASIS OF *PRUNUS* BIODIVERSITY

Isozymes are used as markers for genetic identification in *Prunus* because of their stability, codominant expression and reproducibility (Martinez-Gomez et al., 2003). Detailed studies have been conducted to identify quantitative trait loci (QTLs), marker-trait association and in development of DNA markers in *Prunus* species (Canli, 2008). Molecular marker-based linkage maps have been found to be useful for identifying and localizing important genes controlling both qualitatively and quantitatively inherited traits. Isozymic studies conducted to understand the phylogeny of *Prunus* section *Prunocerasus* reveal that *Pronocerasus* is polyphyletic with *P. americana*, *P. munsoniana*, *P. hortulana*, *P. subcordata* and *P. angustifolia* in one group, and *P. maritima* and *P. umbellata* in another group that is closely related to *Cerasus* (Mowrey and Werner, 1990). This has been stated to be indicative of two stages of immigration of plums into North America. Badenes and Parfitt (1995) reported that cultivated *Prunus* species in pairs namely: *P. persica-P. dulcis*, *P. domestica-P. salicina* and *P. cerasus-P. fruticosa* were completely monophyletic, moreover, all the species were grouped into one monophyletic class except *Cerasus* which showed greater distance. Lee and Wen (2001) studied four species of *Prunocerasus* using Internal Transcribed Spacer (ITS) analysis and also found two major groups. To test the evolutionary trend and relationship of species under *Prunus*, Bortiri et al. (2002) used single copy nuclear gene s6pdh, a gene that encodes sorbitol-6-phosphate dehydrogenase, to construct phylogeny of 22 species of *Prunus*. This study suggested two clades, one comprising subgenera *Cerasus*, *Laurocerasus* and *Padus*, whereas, another is composed of *Amygdalus*, *Emplectocladus* and *Prunus*.

The phylogenetic relationship shows subgenus *Cerasus* is nested within subgenera *Padus* and *Laurocerasus*, whereas, species of section *Microcerasus* are nested within subgenus *Prunus*. Subgenera *Amygdalus* and *Emplectocladus* are sisters to subgenus *Prunus*. It placed *P. subcordata* as sister to other species under *Prunocerasus*. Different oligogenic traits namely: leaf colour (Gr), leaf gland (E), double flower (Dl), skin hairiness (G), skin colour (Sc), flesh colour (Y), flesh adhesion (F) etc), and polygenic traits namely: leaf curl resistance, internodal length, powdery mildew resistance, flowering time, ripening time, maturity time, fruit development, cycle productivity, soluble solids etc) of peach with their specific markers have been also well documented (Martinez-Gomez et al., 2003). Shaw and Small (2004) sequenced trnG and rpLl16 introns, and the trnH-psbA and trnS-trnG intergenic spacers for representative species from each five subgenera in *Prunus*. Amongst several accessions studied under section *Prunocerasus*, 172 accessions of 12 taxa resolved in three primary clades, but *P. subcordata*, distributed in western North American is a sister to the rest of the group and all other taxa are distributed in east of the rockey mountains. Liu et al. (2005) used RAPD and clustered 108 accessions of plum and apricot genotypes into four main groups, where apricot and its hybrids with plum formed one group; second group comprised of Chinese plum types; *P. domestica* formed third group and one outgroup included *P. ussuriensis*, *P. cerasifera*, *P. nigra*, *P. spinosa* and *P. tomentosa*. They also indicated that *P. simonii* is a variant of *P. salicina* and *P. ussuriensis* is an independent species. On the other hand, *P. cerasifera* and *P. spinosa* have been considered distinct from the European group. Chin et al (2010) included all the species of *Maddenia* under *Prunus* on the basis of ITS analysis and ndhF analysis, and a close alliance was reported with a clade comprising subgenera *Laurocerasus* and *Padus*. On the basis of these findings, they proposed new names namely: *Prunus fujianensis* (Y. T. Chang) J. Wen, comb. nov., *Prunus himalayana* J. Wen, nom. nov., *Prunus hypoleuca* (Koehne) J. Wen, comb. nov., *Prunus hypoxantha* (Koehne) J. Wen, comb. nov., and *Prunus incisoserrata* (T. T. Yu & T. C. Ku) J. Wen, comb. nov. In Turkey, 18 wild sweet cherry genotypes collected from diverged environmental conditions were analysed using 10 SSR primers which generated 46 alleles with a range of 3 to 7 alleles/primer (Ercisli et al., 2011). The primer PS12A02 produced the higherst numbers of polymorphic bands and a greater extent of genetic diversity was observed. Availability of more transportable markers and increased number of common loci in *Prunus* species shall pave the way for wider understanding of gene order for gene manipulation as well as for framing out indentification, relationship and conservation in the genus *Prunus* under Rosaceae family.

PRUNUS GENETIC RESOURCE MANAGEMENT AND CONSERVATION STRATEGIES

Various organizations are involved world over for framing and implementation of the policies for *Prunus* genetic resource management as per specific standards (Dessylas, 1993; Maggioni et al., 2011). In Europe, International Plant Genetic Resource Institute (IPGRI), now called Biodiversity International has coordinated The European Cooperative Programme for Genetic Resources (ECPGR) for long term conservation of fruit genetic resources and their utilization in collaboration with different European countries (Zanetto and Formary, 1998; Zanetto et al., 2002; Dosba and Zanetto, 2004; Maggioni and Lipman, 2006). The ECPGR *Prunus* Working Group came into existence since 1983, when priority was given to the genus *Prunus* in 1982. The main objectives of this group are survey, documentation, passport data collection, characterization, preparation of descriptor lists, registration, exchange of materials and coordination for establishment of *Prunus* European collection. The European *Prunus* Database (EPDB) network, originally established at the Nordic Gene Bank is managed by INRA (Institut National de la Recherche Agronomique), Bordeaux. All the accessions have passport data as well as information regarding characterization as per the descriptors proposed by European *Prunus* Working Group. The group has also defined the European *Prunus* collection (EPC) with the purpose to coordinate efforts of individual European countries to conserve the *Prunus* accessions originating in Europe or otherwise important to European horticulture, and to make available for propagation and research purposes. Decentralized European *Prunus* Collection (DEPC) was established with the agreement that each country is responsible for its own genetic resources. However, the management and policy framework are based on the Convention on Biological Diversity (CBD) and the International Treaty of Plant Genetic Resources for Food and Agriculture. It has also adopted the guideline framed by Biodiversity International for germplasm collections.

A European Genebank Integrated System (AEGIS) was also an initiative by the ECPGR with the objectives to conserve genetically unique and important accessions for Europe. *Ex situ* conservation of those accessions as European accessions are carried out in accordance with commonly agreed quality standards. The plant section of NordGen (the Nordic Genetic Resource Center), based in Sweden is also actively associated in *Prunus* biodiversity conservation, its sustainable use, documentation and information generation as per international agreements. In USA, National Plant Germplasm System (NPGS) of USDA developed repositories of clonally propagated horticultural crops, and gene banks for temperate fruit crops have been established in Brown wood (Texas), Corvallis (Ore), Davis (California) and Genava (NY). These repositories maintain germplasm, carry out evaluation, create data base and share the clonal propagules for research and other germplasm related purposes (Postman et al., 2006). The National Clonal Germplasm Repository (NCGR) in Davis, California was established to preserve all *Prunus* germplasm except for the tetraploid cherries (including tart cherries) which are preserved at the NCGR in Geneva, NY and the ornamental *Prunus* are maintained at the National Arboretum in Washington D.C. (Anonymous, 2002c Iezzoni, 2005). The Germplasm Resource Inventory Network (GRIN) has listed all the *Prunus* germplasm collected at different stations in U.S. In China, Three major national peach germplasm repositories have established in Beijing, Zhengzhou and Nanjing, where, more than 1000 germplsm accessions have been maintained. Fruit Research Institute of the Chinese Academy of Agricultural Science maintains Fruit Germplasm Checklist with details of place of origin and other taxonomic and fruit characteristics (Huang et al., 2008). In India, National Bureau of Plant Genetic Resources (NBPGR), Central Institute of Temperate Horticulture (Kashmir), Dr. Y. S. Parmer University of Horticulture and Forestry (Himachal Pradesh), Sher-e-Kashmir University of Agricultural Sciences and Technology (Kashmir) are some leading institutes where *Prunus* germplasm are available for research and commercial use.

The commonly recommended conservation approaches for gene banks and repositories are *ex situ* or *in situ* management, *in vitro* culture maintenance, cryo-preservation, seed storage, pollen storage, establishment of seed orchards (especially for rootstocks) and protection of natural strands of seedling population in the forests (Vivero et al., 2001; Anonymous, 2002c, 2010, Maggioni et al., 2011, Jimu, 2011). INRA, Bordeaux is working on cryopreservation of different stone fruits by using embryonic axis, shoot tips and somatic embryos. Establishment of gene management zones have been proposed, where native vegetation of *Prunus* is protected within the framework of *in situ* conservation of genetic diversity in different parts of European countries (Gass et al., 1996). Vivero et al. (2001) described the status of six wild species of *Prunus* in Spain and proposed conservation strategies for wild population and varieties especially for three species namely: *P. avium*, *P. mahaleb* and *P. insititia*. As per their proposal, area was demarcated in Sierra Nevada for *in situ* conservation of these species along with generation of awareness among the local population and forest workers about the importance of conservation of these species. In this context, example of *Prunus africana* and *P. ceylanica* found in sub Sahara Africa and North-east and South Indian parts, respectively (Pandey et al., 2008; Potter, 2011) may be considered as threatened species and conservation of these two species by *in situ* and *ex situ* approaches is very important. Conservation of apricot diversity in the cold arid zone of India which are very important for their good fruit quality, cold tolerance and adaptation to dry and harse growing conditions should be taken up on priority.

CONCLUSION

The genus *Prunus* has a vast species and varietal biodiversity expanded world over as wild, semi wild and cultivated forms. Considering the significance in terms of its share to the plant biodiversity, genetic resources and horticultural utilization, it becomes very essential to create repositories, to generate data base and to adopt collaborative conservation strategies to mitigate the threats to this genus. A global network on *Prunus* for data base, gene bank management, conservation and information exchange will be helpful for *Prunus* genetic resource management in a sustainable manner.

REFERENCES

Anonymous (1969). The wealth of India- raw materials. Vol 8. Publication and Information Directorate, CSIR, New Delhi, India, pp. 250–282.

Anonymous (2002a). Consensus Document on the Biology of *Prunus* spp. (Stone fruits), Environment Directorate. Org. Eco. Co-op. and Dev. Paris., pp. 1-42.

Anonymous (2002b). Package of practices for temperate fruits. Directorate of Extension Education, SKUAST(K), Shalimar, Kashmir, India.

Anonymous (2002c). *Prunus* vulnerability statement. *Prunus* crop germplasm committee draft, VULNER99.DOC.

Anonymous (2003). Package of practices for fruit crops. Directorate of Extension Education, Dr. YSP University of Hort.& Forestry, Solan. H.P., India.

Anonymous (2009). Prunus. Taxonomy Botanica Sistematica online. www. Luirig.altervista.org /botanical.

Ansin Z, Ozkan ZC (1993). *Prunus laurocerasus* L. In Spermatophyta. Genel Yayin No. 167, Fakulte Yayin No. 19. Trabzon, Turkey, Karadeniz Technical Uni. Faculty of Forestry, p. 512.

Aranzana MJ, Abbassi EL-K, Howad W, Arus P (2010). Genetic variation, population structure and linkage disequilibrium peach commercial varieties. Bio. Med. Cen. Genet., 11(69): 1-12.

Arora RK, Nayar ER (1984). Wild relatives of crop plants in India. Sci. Monogr No. 7. National Bureau of Plant Genetic Resources, New Delhi, India.

Badenes ML, Martinez-Calvo J, Llacer G (1998). Analysis of apricot germplasm from the European ecogeographical group. Euphytica, 102: 93-99.

Badenes ML, Parfitt DE (1995). Phylogenetic relationship of cultivated Prunus species from an analysis of chloroplast DNA variation. TAG Theo. and App. Gen., 90(7-8): 1035-1041.

Bailey CH, Hough LF (1975). Apricots. In Janick J, Moore JN (eds.) Advances in Fruit Breeding, Purdue Univ. Press, West Lafayette, pp. 367-385.

Bailey L H, Bailey EZ (1976). Hortus Third: A concise dictionary of plants cultivated in the United States and Canada. MacMillan Company, New York, p. 1290.

Bailey LH (1963). The Standard Cyclopedia of Horticulture. The MacMillan Company, New York.

Bassi D, Monet R (2008). Botany and Taxonomy. In Layne DR, Bassi D (eds.) The peach: Botany, Productin and Uses, CABI, Oxfordshire, UK, pp. 1-36.

Bassi D, Sansavini S (1988). Genetic improvement of apricot: state of research and prospective. Rev. Di. Frutticoltura. 6: 11-22.

Bentham G, Hooker JD (1865). Genera plantarum. Vol. 1. Reeve and Co., London, UK.

Blaha J, Luza L, Kalasek J (1966). Apricots (in Czech.). In Blaha J (ed.) Peaches, apricots, almonds, Czechoslovak Acad. Sci., Prague, pp. 227-414.

Bortiri E, Oh SH, Gao FY, Potter D (2002). The phylogenetic utility of nucleotide sequences of sorbitol-6-phosphste dehydrogenase in Prunus (Rosaceae). Amer. J. Bot., 89(11): 1697-1708.

Brooks RM, Olmo HP (1997). Register of Fruit & Nut Varieties, 3rd ed., ASHS Press, Alexandria.

Browicz K (1974). The genus Amygdalus in Turkey. Proc. Int. Symp. on Abies Equitrojani and Turkish Flora. Istanbul Univ., Orman Facult. Yainlari. 209: 239-255.

Brown SK, Iezzoni AF, Fogle HW (1996). Cherries. In Janick J, Moore JN (eds.) Fruit breeding Tree and Tropical Fruits, John Wiley and Sons, Inc, New York, 1: 213-255.

Brown SK, Way RD, Terry DE (1998). Sweet and tart cherry varieties: description and cultural recommendations. New York Food and life Sci. Bull. 127:1-8.

Canli FA (2008). Progress in genetic mapping of *Prunus* species. Erciyes University J. Inst. Sci. Tech., 24(1-2): 414 – 424.

Chin SW, Wen J, Johnson G, Potter D (2010). Merging Maddenia with the morphologically diverse Prunus (Rosaceae). The Linn. Soc. of London, Bot. J. Linn. Soc., 164: 236–245.

Choi C, Kappel F (2004). Inbreeding, coancestry and founding clones of sweet cherries from North Amer. J. Am. Soc. Hort. Sci., 129: 535-543.

Conn EE (1980). Cyanogenic compounds. Annu. Rev. Plant Physiol., 31: 433–451.

Crane MB, Lawrence WJC (1956). The genetics of garden plants. 4th ed., MacMillan Company, London.

Cullinan FP (1937). Improvement of stone fruits. USDA year book, Washington DC, pp. 703-723.

Darlington CD, Ammal-Janaki EK (1945). Chromosome Atlas of Flowering Plants. London. Allen & Unwin LTD., p. 149.

Das B, Kumar K (1996). Determining cross compatibility in almond (Prunus dulcis (Miller). D.A. Webb). The Hort. J., 9(2): 113-120.

Das B, Ranjan JK, Hare Krishna, Pragya (2007). Production of quality planting materials of temperate fruit crops. In Das et al. (eds.) Model Training Course on Advanced Tecnologies in Production of Temperate Fruit Crops, Central Institute of Temperate Horticulture. Regional Station, Mukteshwar, Nainital, Uttarkhand, India, pp. 26-31.

Das B, Sharma AK, Srivastava KK, Mir MS (2004). Studies on phenology and fruit characters of some commonly grown apricot cultivars/landraces in Ladakh. The Hort. J., 17(3): 205-211.

Dessylas D (1993). Genetic resources in Europe. Proc. of an inter. Symp. on plant genet. Resour. in Europe held in Gatersleben, Germany, December 6-8, 1993, pp. 124-123.

Donmez AA, Yildirimli S (2000). Taxonomy of the genus Prunus L. (Rosaceae) in Turkey. Turk. J. Bot., 24: 187-202.

Dosba F, Zanetto A (2004). The *Prunus* European cooperative programme for genetic resources: a networking activity for the European *Prunus* database and the challenge for European collections. J. Fruit Ornam. Plant Res., 78(12): 77-85.

Draczynski M (1958). The course of pollen differentiation in time in almond, peach and apricot and the influence of bud temperature on these processes. Gartenbauwissenschaft. 23: 327-341.

Dreyer P (1985). A garderner touched with genius. Univ. of California Press, Berkeley.

Ercisli S, Agar G, Yildirim N, Duralija B, Vokurka A, Karlidag H (2011). Genetic diversity in wild sweet cherries (*Prunus avium*) in Turkey revealed by SSR markers. Gen. Mol. Res., 10(2): 1211-1219.

Evreinoff VA (1958). Contribution in the study of the almond. Fruits and News from the North Africa., 28: 99-104.

Faust M, Suranyi D (1999). Origin and dissemination of plums. In Janik, J (ed.) Horticulture Reviews Vol. 23., John Willey and Sons. Inc., pp. 179-231.

Faust M, Suranyi D, Nyujto F (1998). Origin and dissemination of apricot. In Janik, J (ed.) John Willey and Sons. Inc., Horticult. Rev., 22: 225-265.

Fogle HW (1975). Cherries. In Janick J, Moore JN (eds.) Advances in Fruit Breeding, Purdue Univ. Press, West Lafayette, pp. 348-366.

Gass T, Tobutt KR, Zanetto A (1996). Report of the Working Group on Prunus. 5th meeting, 1-3 February 1996, MenemenIzmir, Turkey, p.70.

Ghora C, Panigrahi G (1984). Fascicles of flora of India. Rosaceae: genus Prunus. Botanical Survey of India, Calcutta, India. 18.

Ghora C, Panigrahi G (1995). The Family Rosaceae in India, Bishen Singh Mahandra Pal Singh, Dehra Dun. 2.

Gomez E, Ledbetter CA, Hartsell PL (1993). Volatile compounds in apricot, plum and their inter specific hybrids. J. Agr. Food Chem., 41: 1669-1676.

Gradziel TM (2008). *Prunus dulcis*- almond. In Janick J, Paull RE (eds.) The Encyclopedia of Fruits and Nuts, CAB International, UK., pp.705-717.

Grasselly C (1975). The almond variety 'Ferragnes'. French Pomology. 17(3): 43-49.

Gu CZ, Bartholomew B (2003). Prunus Linnaeus. Sp. Pl. 1: 473, 1753. Flora of China. 9:401-403.

Hakan E (2003). The peach industry in Turkey: state of art, research and development. Mediterranean Peach Symp., 10th September, 2003, Italy.

Hedrick UP (1911). The plums of New York. New York (Geneva) Agric. Exp. Sta. Rep.,

Hedrick UP (1915). The cherries of New York. J. B. Lyon, Albany, New York.

Hedrick UP (1917). The peaches of New York. Rep New York Agric. Exp. Sta.

Heidari M, Rahemi M, Daneshvar MH (2008). Effects of mechanical, chemical scarification and stratification on seed germination of Prunus scoparia Spach. and Prunus webbii (Space.) Vierh. Amer. Eura. J. Agic. Env. Sci., 3(1): 114-117.

Herrero M, Felipe AJ (1975). Pollinisation of the almond incompatibility in pollenstyle. 2nd Symp. GREMPA, Montepellier-Nimes.

Hrotko K (1996). Variability in Prunus Mahaleb L. for cherry rootstock breeding. Acta Hort., 410:183-188.

Hu D, Zhang Z, Zhang D, Zhang Q, Li J (2005). Genetic relationship of ornamental peach determined using AFLP markers. HortScience, 40(6): 1782-1786.

Iezzoni AF (2008). *Prunus avium*-sweet chery, *Prunus cerasus*- sour cherry, *Prunus fruticosa*- ground cherry. In Janick J, paull RE (eds.) The Encyclopedia of Fruits and Nuts, CAB International, UK., pp. 687-694.

Iezzoni AF, Schmidt H, Albertini A (1991). Cherries (*Prunus*). In Moore JN, Ballington JrJR (eds.) Genetic Resources of Temperate Fruit and Nut Crops, ISHS Wageningen, 1: 109- 173.

Janick J (2003) English title: History of Asian horticultural technology. Acta Hort., 620: 19-32.

Janick J, Moore JN (1975). Advances in fruit breeding. Purdue University Press, West Lafayette, Indiana.

Jimu L (2011). Threats and conservation strategies for the African cherry (*Prunus africana*) in its natural range- a review. J. of Ecol. and the Natur. Enviro., 3(4): 118-130.

Kask K (1989). The tomentosa cherry, *Prunus tometosa* Thunb. Fruit Var. J., 43: 50-51.

Kester DE, Asay R (1988). Hybridization between cultivated almond (*Prunus dulcis*) and almond species germplasm from Europe and

Asia. Abstracts of Intl. Symp. on Hort. Germplasm, cultivated and wild. Chin. Soc. Hort. Sci., Beijing, China.

Kester DE, Gradziel TM, Grasselly C (1990). Almonds (*Prunus*). Acta Hort., 290: 699–758.

Kester DE, Gradziel TM (1996). Almonds. In Janick J, Moore JN (eds.) Fruit Breeding, Nuts John Wiley and Sons, Inc. New York, 1: 1-97.

Kester DE, Gradziel TM, Grasselly C (1991). Almonds (*Prunus*). In Moore JN, Ballington HJ (eds.) Genetic Resources of Temperate Fruit and Nut Crops. ISHS, Netherlands, pp. 701-758.

Kishore DK, Pandey, RM, Sharma YP (1991). Plums. In Mitra et al (eds.) Temperate Fruits, Horticulture and Allied Publishers, Calcutta, pp. 241-278.

Kolesnikova AF (1975). Breeding and some biological characteristics of sour cherry in central Russian zone of the RSRSR. Orel, Russia: Priokstoc izdatel'stvo., p.328.

Komarov VL (1971). *Rosaceae: Rosoideae, Amygdaloideae*. In Flora of the USSR, Smithsonian Institution, Washington D.C., USA, 10: 1-512.

Kostina KF (1969). The use of varietal resources of apricots for breeding (in Russian). Trud. Nikit. Bot. Sad. 40: 45-63.

Kovalyov NV, Kostina KF (1935). A contribution to the study of the genus *Prunus* Focke. Questions of taxonomy and plant breeding [in Russian]. Trudy po Prikladnoj Botanike Genetike Seleksie Series, 8(4): 1–76.

Kramer S (1985). Production of cherries in the European socialist countries. Acta Hort., 169: 27-34.

Laghezali M (1985). The almond of Morocco. GREMPA Symp. Thessalonique. Options Mediterraneennes, I: 91-96.

Layne REC (1989). Breeding cold hardy peach cultivars for Canada. Acta Hort., 254: 73-78.

Layne REC (2008). *Prunus armeniaca*: apricot. In Janick J, Paull RE (eds.) The Encyclopedia of Fruits and Nuts, CAB International, UK. pp. 678-687.

Layne REC, Bailey CH, Hough LF (1996). Apricots. In Janick J, Moore JN (eds.) Fruit Breeding Vol. I: Tree and Tropical Fruits, John Wiley and Sons, Inc. New York, pp. 79-111.

Lee S, Wen J (2001). A phylogenetic analysis of *Prunus* and the Amygdaloideae (Rosaceae) using ITS sequences of nuclear ribosomal DNA. Amer. J. Bot., 88: 150–160.

Li ZL (1984). Peach germplasm and breeding in China. HortScience, 19: 348-351.

Liu WS, Liu DC, Feng, CJ, Zhang AM, Li SH (2005). Genetic diversity and phylogenetic relationships in plum germplasm resources revealed by RAPD markers. J. Hort. Sci. Biotech., 81(2): 242-250.

Maggioni L, Lateur M, Balsemin E, Lipman E (2011). Report of a Working Group on *Prunus*. 8th Meeting, 7-9 September 2010, Forli, Italy, Bioversity International, Rome, Italy.

Maggioni L, Lipman, E (2006). Report of a Working Group on *Prunus*. 6th Meeting, 20-21 June 2003, Budapest, Hungary, 7th Meeting, 1-3 December 2005, Larnaca, Cyprus. Bioversity International, Rome, Italy.

Malcolm P (2006). History of plum trees and their hybrids. www.The phantom writers.com.

Malik SK, Rekha C, Dhariwal OP, Mir, S (2010). Genetic diversity and traditional uses of wild apricot (*Prunus armeniaca* L.) in high-altitude north-western Himalayas of India. Plant Gen. Resour., 8: 249-257.

Marshall RE (1954). Cherries and cherry products. In Economic crops, , Interscience, New York. 5.

Martinez-Gomez P, Sozzi GO, Sanchez-Perez RS, Rubio M, Gradziel TM (2003). New approaches to Prunus tree crop breeding. Food Agri. Env., 1(1): 52-63.

Mehlenbacher SA, Cociu V, Hough LF (1991). Apricots. In Moore JN, Ballington JrJR (eds.) Genetic Resources of Temperate Fruit and Nut Crops ISHS Wageningen, 1: 65-107.

Mir MS (2000). Potential and problems of fruit crop production in Ladakh. In Sharma JP, Mir AA (eds.) Dynamics of Cold Arid Agriculture, Kalyani Publishers, Ludhiana, pp.188-213.

Mohamed BS (2004). The contribution of *Prunus webbii* to almond evolution. PGR Newsletter. 140: 9-13.

Mowrey BD, Werner, DJ (1990). Phylogenetic relationships among species of *Prunus* as inferred by isozyme markers. Theo. App. Gen., 80: 129-133.

Mratinic E, Popovski B, Milosevic T (2011). Evaluation of apricot fruit quality and correlations between physical and chemical attributes. Czech. J. Food Sci., 29(2): 161-170.

Nicotra A, Pellegrini M (1989). Almond rootstock breeding for easy propagation. Options Mediterraneennes - Serie Sem., 5: 51-60.

Okie WR (2008). *Prunus domestica*- European plum, Prunus salicina-Japanese plum. In Janick J, Moore JN (eds.) Fruit Breeding Vol. I: Tree and Tropical Fruits, John Wiley and Sons, Inc. New York, pp. 694-704.

Okie WR, Weinberger JH (1996). Plums. Janick J, Paull RE (eds.) The Encyclopedia of Fruits and Nuts, CAB International, UK., pp. 694-704.

Okie WR, Ramming DW (1999). Plum breeding worldwide. HortTech., 9(2): 162-176.

Olden EJ, Nybom N (1968). On the origin of Prunus cerasus. Hereditas. 59: 327-345.

Pandey A, Nayar ER, Venkateswaran K, Bhandari DC (2008). Genetic resources of *Prunus* (Rosaceae) in India. Genet. Resour. Crop Evol., 55: 91-104.

Perez R, Navarro F, Sanchez MA, Ortiz JM, Morales R (2010). Analysis of agromorphological descriptors to differentiate between duke cherry (*Prunus x gondouinii* (Poit. & Turpin) Rehd.) and its progenitors: sweet cherry (*Prunus avium L*.) and sour cherry (*Prunus cerasus L*.). Chilean J. Agril. Res., 70(1): 34-49.

Parmar C, Kaushal MK (1982). Wild fruits of Sub-Himalayan Region. Kalyani Publishers, New Delhi, India., p. 403.

Postman J, Hummer K, Stover E, Krueger R, Forsline P, Grauke LJ,

Zee F, Ayala-Silva T, Irish B (2006). Fruit and nut genebanks in the U.S. National Plant Germplasn System. HortScience, 41(5): 1188-1194.

Potter D (2011). Prunus. In Kole C (ed.) Wild Crop Relatives - Genomic and Breeding Resources: Temperate Fruits, Springer., pp. 129-146.

Preston RJ (1976). North American Trees. 3rd ed., The Iowa State University Press, Ames, Iowa., pp. 256-258.

Radford AE, Aheles HE, Bell CR (1968). Manual of the vascular flora of the Carolinas,The University of North Carolina Press, 2: 17.

Rana JC, Pradheep K, Verma VD (2007). Naturally occurring wild relatives of temperate fruits in Western Himalayan region of India: an analysis. Biodivers. Conserv., 16: 3963-3991.

Rehder A (1954). Manual of cultivated trees and shrubs. MacMillan Company, New York.

Rehder A (1974). Cultivated trees and shrubs hardy in North America. 2nd Edition. MacMillan Company, New York.

Reighard GL, Loreti F (2008). Rootstock development. In Layne DR, Bassi D (eds.) The peach: Botany, Productin and Uses, CABI, Oxfordshire, UK, pp. 193-220.

Russell K (2003). EUFORGEN technical guidelines for genetic conservation and use for wild cherry (*Prunus avium*). Inter. Plant Genet.Resour. Inst., Rome, Italy, p. 6.

Santapau H, Henry AN (1973). A dictionary of the flowering plants in India. Publication and Information Directorate, CSIR, New Delhi, India, p. 139.

Schquenberg PA, Paris F (1975). Healing plants. BLV. Werlagsgesellschaft, Munchen wien Zurih.

Scorza R, Mehlenbacher SA, Lightner GW (1985). Inbreeding and co-ancestry of freestone peach cultivars of the eastern United States and implications for peach germplasm improvement. J. Am. Soc. Hort. Sci., 110: 547-552.

Scorza R, Sherman WB (1996). Peaches. In Janick J, Moore JN (eds.) Fruit Breeding: Vol. 1- Tree and Tropical Fruits, John Wiley & Sons, Inc., New York, pp. 325-440.

Sharma BD, Rana JC, Yadav SK (2001). A glance at temperate fruits gene bank. NBPGR, Regional Station, Shimla- 4: 1-20.

Sharma RL (1993). Genetic resources of temperate fruits. In Chadha KL, Pareek OP (ed.) Advances in Horticulture Vol. 1-Fruit crops Part 1, Malhotra Publishing House, New Delhi, India, pp. 244-263.

Shaw J, Small RL (2004). Addressing the hardest puzzle in American pomology: phylogeny of *Prunus* sect. *Prunocerasus* (Rosaceae) based on seven non coding chloroplast DNA regions. Amer. J. Bot., 91(6): 985-996.

Singh RN, Gupta PN (1972). Rootstock problems in stone fruits and potentialities of wild species of *Prunus* found in India. Punjab Hort. J.,

12: 157-175.
Singh RN, Randhawa SS, Gupta PN (1971). Rootstock performance of two wild species of cherry, *Prunus cerasoides* and *Prunus cornuta* in the nursery. Indian J. Hort., 28: 196-198.
Socias y Company R (1992). Breeding self-fertile almonds. Plant breeding Rev., 8: 313-338.
Sofi AA, Verma MK, Chaudhury H (2007). Temperate fruit crops. In Peter KV, Abraham Z (eds.) Biodiversity in Horticultural Crops- Daya Publishing House, New Delhi, India, 1: 31-38.
Stehr R (1998). First results with dwarfing rootstocks in northern Germany as part of a National German rootstock trial. Acta Hort., 468: 297-306.
Strasburger E, Noll F, Schenck H, Schimper AF (1991). Text book of botany for Univertities, In Sitte et al. (eds.) Gustav Fischer Vg. Stuttgart, 33 edition. Jena, New York, pp. 778-780.
Talhouk SN, Lubani RT, Baalbaki R, Zurayk R, AlKhatib A, Parmaksizian L, Jaradat AA (2000). Phenotypic diversity and morphological characterization of Amygdalus L. species in Lebanon. Genet. Resour. Crop Evol., 12: 93–104.
Vavilov NI (1951). Phytogeographic basis of plant breeding. In Chester, K. S. (ed.) The Origin, Variation, Immunity and Breeding of Cultivated Plants, Chronica Bot., 13(1/3): 13-54.
Vito MD, Battistini A, Catalano L (2001). Response of *Prunus* rootstocks to root knot (*Meloidogyne* spp.) and root lesion (*Pratylenchus vulnus*) nematodes. Acta Hort., 592: 663-668.
Vivero JL, Hernandez-Bermejo JE, Ligero JP (2001).. Conservation strategies and management guidelines for wild Prunus genetic resources in Andalusia, Spain. Gen. Resour. and Crop Evol., 48(5): 533-546.
Wang ZH, Zhuang EJ (2001). China fruit monograph- peach flora. China Forestry Press, Beijing, pp. 42-51.
Watkins R (1976). Cherry, plum, peach, apricot and almond. *Prunus* spp. In Simmonds NW (ed.) Evolution of Crop Plants, Longman, London, pp. 242–247.
Webb DA (1967). Prunus dulcis (Miller). D.A. Webb. Comb. Nov. Repertorium Speciarum Novarum, Regni vegetabilis, Berlin, 74: 24.
Westwood MN (1978). Temperate zone pomology. Timber Press. Portland, Oregon., p. 428.
Wight WF (1915). Native American species of *Prunus*. USDA Bull., p.179.
Willis JC (1948). A dictionary of the flowering plants and ferns. 8th ed., Cambridge University Press, Cambridge.
Wood MN (1925). Almond varieties in the United States. USDA Bull, p.1282.
Yuan Z, Chen X, He T, Feng J, Feng T, Zhang C (2007). Population genetic structure in apricot (*Prunus armeniaca* L.) cultivars revealed by Fluorescent-AFLP markers in Southern Xinjiang, China. J. Genet. and Geno., 34(11): 1037-1047.
Zanetto A, Formery B (1998). International network on *Prunus* genetic resources: the European *Prunus* database. Acta Hort., 465: 237-242.
Zanetto A, Maggioni L, Tobutt KR, Dosba, F (2002). *Prunus* genetic resources in Europe: achievement and perspectives of a networking activity. Gen. Resour. and Crop Evol., 49: 331–337.
Zhukovsky PM (1965). Main gene centres of cultivated plants and their wild relatives within the territory of the USSR, Euphytica, 14: 177-188.