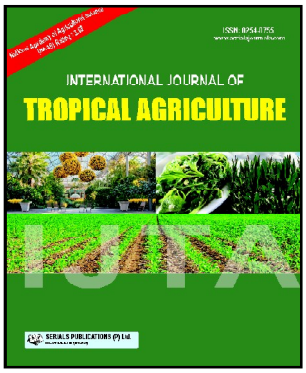

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Rootstocks and their Exploitation in Improving Productivity and Quality of Apple Crops

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Abstract: Biodiversity provides building blocks for sustainable food, health and livelihood security systems. It is the feedstock for the biotechnology industry and a climate-resilient farming system. The challenge is for every country to develop an implemental strategy to save rare, endangered and threatened species through education, social mobilization and regulation and their utilization for future use. Wild fruit plants have been an important source of food for mankind since early times. As man developed through the ages so did the utility of these fruits. For example, there is a gradual trend for declining productivity in temperate fruit crops. The most urgent need today is to enhance the production, productivity and quality of nutritious food in an eco-friendly manner so as to improve farm income to ensure household food and nutritional security. Low-density standard plantations need to be converted to high-density plantations to reduce the juvenile period and increase productivity per unit area. Apple is the most important fruit of the temperate region and its cultivation is confined to 5 states in India. It is the high time to find out new rootstock and pollinizers for apple& temperate fruit crop improvement.

All the crab apples exhibited a considerably less chilling hour requirement as compared to the standard apple rootstocks M 9 and MM106. Thus, these crab apples are likely to improve the productivity of apple varieties in areas where the chilling requirement is not being fully met. The germplasm that holds promise for using rootstock *viz.*, *Malus baccata* (Shillong), *Malus baccata* (Srinagar) etc. or in breeding programme for disease resistance or as pollinizers has been identified for the improvement of apple. An ideal rootstock should posses uniformity in vigour, resistance to diseases and pests without impairing the productivity and quality. The wild sources are important source for resistant/ elite traits and are used for crop improvement programmes. Biodiversity played an important role in the evolution of fruits crop plants and act as genetic reservoir for breeding purposes. So, diversity among crops, species, varieties is now paramount important to cope up with the climatic change as well as monocrop failure due to unavoidable circumstances.

INTRODUCTION

Biodiversity provides building blocks for sustainable food, health and livelihood security systems. It is the feedstock for the biotechnology industry and a climate-resilient farming system. The challenge is for every country to develop an implemental strategy to save rare, endangered and threatened species through education, social mobilization and regulation and their utilization for future use. The entire north-west Himalayan region comprising of Jammu Kashmir, H.P and Uttarakhand is very rich in temperate fruits plant diversity. Biodiversity is the key for sustainable fruit production. It has ecological, economic and cultural significance. It helps to ensure sustainability. There are three independent level of biodiversity namely ecosystem level, species level, genomic level. Genetic diversity represents variation within a species which represents varietals diversity in a crop plant. It enables species to adapt to new agro-ecosystem and environments through natural and human selection.

Among temperate fruits, commercially grown are apple, pear, peach, apricot, plum, cherry, almond, walnut, pecan, hazelnut, chestnut, persimmon and Chinese gooseberry. These become cash crops for hill people. This biodiversity could be of different fruits species or of different verities of the same species or of various rootstocks. In case of apple approximately 2500 cultivars are existing all over the world but only 25 cultivars are commercially grown which mainly includes Delicious cultivars. It represents extremely narrow genetic base of cultivated apple. Similarly the entire North West Himalayas region possesses around 31 fruits genera. For example, there is a gradual trend for declining productivity in temperate fruit crops. The most urgent need today is to enhance the production, productivity and quality of nutritious food in an eco-friendly manner so as to improve farm income to ensure household food and nutritional security. Low-density standard plantations need to be converted to high-density plantations to reduce the juvenile period and increase productivity per unit area. Apple is the most important fruit of the temperate region and its cultivation is confined to 5 states in India. It is the high time to find out new rootstock and pollinizers for apple and temperate fruit crop improvement.

Wild fruit plants have been an important source of food for mankind since early times. As man developed through the ages so did the utility of these fruits. Valuable information was historically passed on from generation to generation until the dawn of the era of systematic documentation. The Himalayas are abundant in wild fruit species that are distinct from the tropical types found elsewhere in India.

Apple, the premier table fruit of the world, has been under cultivation since time immemorial. The selection of suitable rootstock of apples for a certain tract has been an important investigation. All successful apple rootstocks, either seedling or clonal, are of the genus *Malus*. In early days, French crab seedlings (*Malus sylvestris*) were widely used in the USA as rootstocks. Some of the Asiatic species of apples are apomictic and bred true from seeds even when pollinated by other species. These apomictic species have been used as rootstocks for commercial apple cultivars with the hope that they might be of value in controlling tree growth and age of fruiting. Thus, the crab apples can play a pivotal role for the improvement of apple through proper utilization of their potentiality. A number of crab apples have been found growing wild in the Himalayas. Botanically only two species of *Malus* have been identified *viz. Malus baccata and Malus sikkimensis*. However, this botanical classification does not clearly reflect the existing genetic variability. At the IARI Regional Station for Horticulture at Shimla, India seven types of *Malus baccata* and two types of *Malus sikkimensis* from different agro-climatic regions have been collected. Significant differences for their botanical and horticultural traits have been observed. The crab apples from Shillong and Srinagar exhibited a very good propagation potential, showed a high degree of resistance to powdery mildew and apple scab, while that from Shillong produces semi vigorous

trees and Srinagar produces very vigorous trees when used as rootstock. All the crab apples exhibited a considerably less chilling hour requirement as compared to the standard apple rootstocks M 9 and MM106. Thus, these crab apples are likely to improve the productivity of apple varieties in areas where the chilling requirement is not being fully met. The germplasm that holds promise for using rootstock *viz.*, *Malus baccata* (Shillong), *Malus baccata* (Srinagar) etc. or in breeding programme for disease resistance or as pollinizers has been identified for the improvement of apple. An ideal rootstock should posses uniformity in vigour, resistance to diseases and pests without impairing the productivity and quality. So, diversity among crops, species, varieties is now paramount important to cope up with the climatic change as well as monocrop failure due to unavoidable circumstances.

RESULTS

Superior edible types have gradually evolved through ages of conscious selection; this has often been at the cost of features such as resistances to diseases and pests or tolerance to adverse environmental conditions. Such characters were not of immediate concern, and hence got systematically discarded and are now facing extinction. The crab apples form the bulk of the germplasm available to mankind for affecting further improvements in the cultivated apples.

Crab Apples

Malus species growing in the wild are collectively called crab apples. Crab apple fruits are usually small sized, green or brightly coloured and sub-acidic sweet in taste. These plants have characters of immense significance for apple cultivation. Besides some of these are also of unique ornamental value. The crab apples have been classified into a number of *Malus* species:

Malus sikkimmensis, Malus floribunda, Malus zumi, Malus seiversii, Malus sylvestris, Malus baccata. The Malus baccata types available at our Research Farm are M. baccata [Srinagar], M. baccata [Shillong], M. baccata [Khrot], M. baccata [Rohru], M. baccata [Giabung], M. baccata [Dhack], M. baccata [Lahaul], M. sikkimmensis.

There are two species of *Malus* indigenous to the Himalayas *viz. M. baccata* var. *himalaica* and *M. sikkimmensis*. However, a number of distinct biotypes of both these species have been observed growing wild in different agro-climatic regions of the Himalayas. Studies on these at the IARI Regional Station (Horticulture), Shimla indicate their entitlement to a separate taxonomic status for these biotypes. Six biotypes *M. baccata* and two biotypes of *M. sikkimmensis* have been identified. Some of the noteworthy features of these are given below.

Malus baccata var. *himalaica* (Maxim.) Schneid

It was collected from Himachal Pradesh from an altitude of 3000 m ASL (Randhawa, 1987). It is also found growing wild in the hills of Meghalaya (1303 m ASL) and Utranchal Pradesh (Srivastava *et al.*, 1977). It has been found to be partially resistant to collar rot (c.o. *Phytophthora cactorum*), root rot (c.o. *Dematophora necatrix*) and to the woolly aphid (*Eriosoma lanigerum*). Field resistance to apple scab (c.o. *Venturia inaequalis*) in this species has also been observed. Leaf stomata count indicates that it may more dwarfing than the M 9 rootstock of apple (Table 1). Its chilling requirement is very less indicating its usefulness in breeding programmes or for use as rootstock in comparatively warmer areas (Randhawa and Kishore, 1987; Kishore and Randhawa, 1987). This species did not propagate clonally through mound layers.

Malus baccata (Linn.) Borkh (Shillong)

It was collected from Shillong (Meghalaya), where it is locally known as *Soh-sheur*. It was found growing wild at an altitude of 1300 m ASL (Randhawa, 1987). In the wild it grows as a small low branching tree producing small scarlet red fruits. Leaf stomata counts indicate that it may be as dwarfing as the M 9 apple rootstock (Table 1). However, overall growth

Table 1
Horticulture Traits of Himalayan Crab apples

Species	*Propagation on Potential*	*Vigour*	*Reaction to Wooly Aphid*	*Reaction to Powdery Mildew*	*Reaction Apple to Scab*
MM 106	G	SV	R	S	S
M 9	P	D	S	S	S
M baccata (Shillong)	VG	SV	R	R	R
M. baccata (Khrot)	VG	D	S	S	R
M baccata (Giabung)	G	D	S	S	–
M. baccata (Dhak)	VP	D	S	S	S
M. baccata (Srinagar)	VG	V	S	R	R
M. baccata (Lahaul)	VP	VD	S	S	–
M. baccata (Rohru)	VP	VD	S	–	–
M. sikkimmensis	P	D	R	–	R

of apple scions (cvs Golden Delicious and Spur Types of Red Delicious) on this rootstock is more than that on M 9, but less than that on MM 106. Development of root rot (c.o. *Dematophora necatrix)* and powdery mildew (*Podosphora leuchotricha*) significantly delayed. It has shown field resistance to apple scab (c.o. *Venturia inaequalis*) and is completely resistant to woolly aphid (*Eriosoma lanigerum*) (Plate-1). It has a very good propagation potential. The chilling requirement of this species is less than that of M 9 and MM106 (Table 1).

Malus baccata (Linn.) Borkh (Dhak)

It was collected from Dhak in Himachal Pradesh at an altitude of 2060 m ASL. Locally it is known as *Bambtu.* In the wild the trees are tall and spreading. The fruits are red on a yellow background and are the largest (3.1 cm diameter) of all the Malus *baccata* biotypes collected from the Himalayas. Growth of apple grafts on this species showed it to be semi vigorous although its leaf stomata count was more akin to that of M 9. For satisfactory propagation through mound layers the shoots have to be blanched at the bases and treated with growth regulators. Its chilling requirement is less than M 9 and MM 106. This species is highly susceptible to woolly aphid (Plate 1), powdery mildew and apple scab.

Plate 1: Differential reaction to wooly aphid exhibited by *M. baccata* (Dhak) and *M. baccata* (Shillong)

Malus baccata (Linn.) Borkh (Rohru)

In its natural habitat (Rohru, Himachal Pradesh, and 2100 m ASL) it is a small bushy tree. Based on its leaf stomata count it appears to be more dwarfing than the M 9 apple rootstock (Randhawa and Kishore, 1987). It is susceptible to woolly aphid but only moderately resistant to powdery mildew under field conditions (Table 1). Like *M. baccata* var *himalaica* it exhibits the least chilling requirement amongst all the Himalayan crab apples (Table 1).

Malus baccata (Linn.) Borkh (Khrot)

In the wild the plants are low and spreading (Randhawa, 1987) producing small yellow fruits overlaid with red stripes. Known as 'banphal' locally its seedlings are being used as rootstock for apple. Leaf stomata count indicates its vigour to be similar to M 9 apple rootstock. It is easy to propagate clonally through mound layering, exhibits good graft compatibility with apple cultivars and has comparatively less chilling requirement than *Malus baccata* (Shillong). However, it is highly susceptible to woolly aphid and powdery mildew though it has shown field resistance to apple scab (c.o. *Venturia inaequalis*).

Malus baccata (Linn.) Borkh (Giabung)

This was collected from Giabung (Himachal Pradesh, 2900 m ASL). Locally known as 'Lead' the tree is small with slender branches producing small scarlet fruits that are depressed at the apex. It gives a fair rate of success by mound layering. Though the leaf stomata count is similar to M 9, but actual growth of grafts of cv. Golden Delicious on this stock has been found to be significantly lesser (Kishore 1989). It is susceptible to woolly aphid and powdery mildew.

Malus baccata (Linn.) Borkh (Srinagar)

It was collected fro Srinagar (Jammu and Kashmir) at an altitude of 1390 m ASL (Randhawa 1987). In natural habitat, the trees are not very large and produce small yellow coloured fruits. On the basis of leaf stomata count it was categorized as being similar in vigour to MM 106, but actual growth of grafts has been found to be more vigorous. Its chilling requirement is similar to that of the biotype from Shillong *i.e.* appreciably lower than that of M 9 and MM 106. It is resistant to powdery mildew and apple scab but is susceptible to woolly aphid.

Malus sikkimmensis (Hook. f.) Kochneex Schneider

It thrives in Lachen Valley in Sikkim (altitude 1970 m ASL), where it is locally called 'Tipsi'. It is used as rootstock for apple in Sikkim (Randhawa, 1987). The tree is moderate in size producing small cherry-like pointed dull red fruits. The fruits are borne in bunches of 3-5. Two biotypes collected from Darjeeling and Gangtok have been identified. The one from Gangtok has bolder fruits, leaves and shoots (Plate 2). In terms of vigour it is close to M 9 apple rootstock (Table 1, Randhawa and Kishore, 1987). Preliminary evaluation indicates it is resistant to collar rot (Randhawa and Ram, 1977) and powdery mildew (Ram and Randhawa 1979). It has been reported (Brown 1975) to be highly sensitive to latent viruses present in the scion wood. Since virus-free bud sticks are not readily available in India, it would not be advisable to use it as a rootstock

In India wild germplasm of temperate fruits and nuts appears to be introduced over the long past and have undergone eco-geographical modification/ changes in plant and fruits characteristics. In genus, Malus, there are two indigenous species *viz.* M. baccata var. Himalaica and M. sikkemensis. However, M. baccata (shillong), M. baccata (Khrot), M. baccata (Giabung), M. baccata (Dhak), M. baccata (Rohru), M. baccata (Srinagar), and M. deerangenesis from Aunachal Pradesh. Similarly, in genus Pyrus, several ecotypes are identified like P. pashia var. Kumaonii, P. pyrifolia (Burm.F), Nakai var. Culta Nakai (P. serotina Rend), P. vulgaris, P. jacquimontiana and P. Polycarpa.

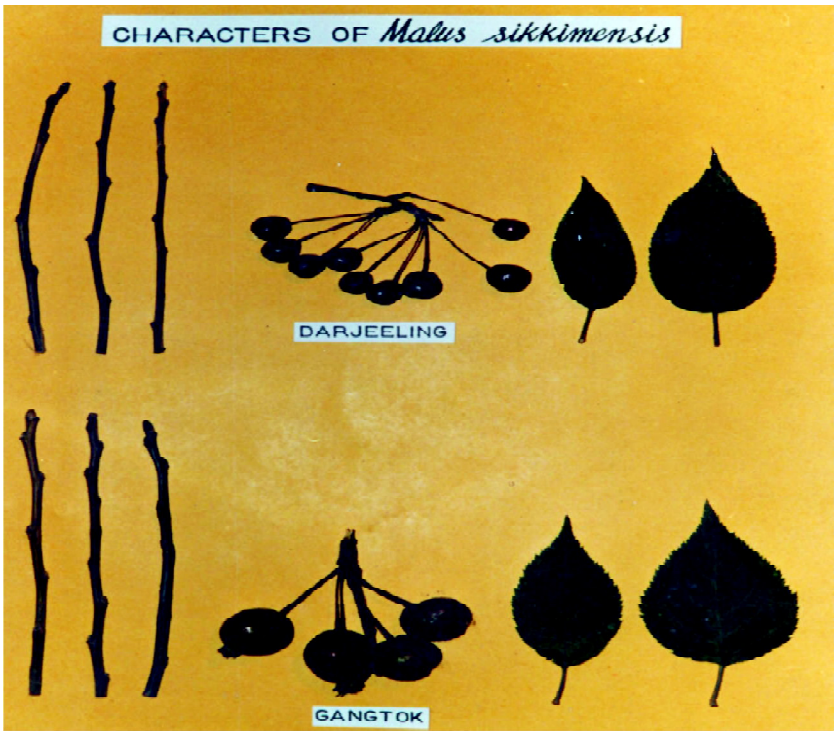

Plate 2: Two types of *M.sikkimmensis*

The wild sources are important source for resistant/elite traits and are used for crop improvement programmes. Biodiversity played important role in the evolution of fruits crop plants and act as genetic reservoir for breeding purposes.

FUTURE STRATEGIES AND RECOMMENDATIONS

Minor Temperate Fruit and Nuts

- This group has been relatively ignored because of low commercial value.
- However, these crops can be of crucial economic importance in marginal areas; where commercialization and diversification is key to successful agriculture.
- Conservation, characterization and utilization of these species is an important objective.

The North-West Himalaya is bestowed with rich genetic diversity of minor temperate fruits representing the genera *viz. Malus, Prunus, Pyrus, Rubus, Ribes, Sorbus, Cotoneaster, Myrica, Corylus, Crataegus, Punica, Hippophae, Elaeagnus, Viburnum, Vitis, Ficus, Citrus, Ziziphus, Morus,, Olea,* etc. These species are known for their hardiness, adaptability to wastelands and tolerance to biotic and abiotic stresses. Apart from their easy availability, they assure some sustained yield and make our diet more diverse. Some indigenous species having potential for diversifying temperate fruit production are *Pyrus pyrifolia, Diospyros lotus, Rubus ellipticus, R. lasiocarpus, Corylus colurna, Citrus pseudolimon, Hippophae rhamnoides* and *Pinus gerardiana*. Some of the exotic temperate fruits *viz.* pineapple guava (*Feijoa sellowiana*), Chinese ber (*Ziziphus jujuba*), Japanese persimmon (*Diospyros kaki*), *Rubus* spp., *Ribes* spp, quince (*Cydonia oblonga*), medlar (*Mespilus* spp.), pecan nut (*Carya illinoensis*), hazelnut (*Corylus avellana*),and husk tomato (*Physalis* spp.) have shown good performance.

Some general bottlenecks for their popularization include size of the fruit, less pulp-to-seed ratio, undesirable sugar-to-acid ratio, perishable nature of fruit, less productivity, presence of protective

structures (spines, prickles), long juvenile period and lack of awareness about their potentiality. Hence, concerted effort on collection of variability existing within the species along with domestication and improvement through hybridization, development of agronomic practices including their adaptation in existing land use system, creating awareness among the dwellers about their importance through extension personnel and mass media, etc. may form the need of the hour.

Most of the North-Western Himalayan region is entirely mountainous and in elevation ranges from the foot hills to high snow covered mountains. These areas are highly suitable for cultivation of various temperate fruits, namely pome, stone fruits, strawberry, olive and number of other crops. Varied plant genetic resources are recognized as the future building blocks. In quest for new genetic resources both the botanists and the horticulturists have recognized the significance of genetic diversity present both in the cultivated and related wild species. Introduction and acclimatization of new genetic resources from abroad to augment the gaps in local germplasm and to broaden the genetic base for there present and future use is very essential. The department of Fruit Breeding and Genetic Resources is actively involved in the collection, evaluation and maintenance of various temperate fruit crops with the objectives of

(i) Identification of varieties suitable for direct cultivation

(ii) Identification of donor cultivars for use in future breeding programmes

(iii) Assessment of different genetic resources for use as rootstocks.

Some very useful genotypes of apples, pear, strawberry with specific traits like low chill, early flowering and ripening, later flowering, heavy and regular bearer etc. in each fruit crop have been identified and some are being used as donor parents in breeding programmes.

Uttarakhand government has identified horticulture particularly in hilly regions as a thrust segment for over all development of the state with the view to create the new avenue for Income and employment opportunities through vertical and horizontal expansion of Production and post harvest management.

Unfortunately, the prevailing constraints such as non availability of elite planting material; lack of technical know how; dry land horticulture; high cost of Production, lack of credit awareness and availability; small and fragmented land holding; old and senile orchard; lack transport and communication facilities; poor mechanization; Lack of efficient marketing system and post harvest infrastructure does not allow the farmer to take advantage of the emerging opportunities in temperate fruit production. Development of appropriate institutional arrangement for

(i) providing elite/frontier Planting material,

(ii) establishment of 'Single Window System' and 'information Cell'

(iii) technology package and

(iv) integration of various line departments for production, Marketing and post harvest management are important to harness the potential of temperate fruits.

Besides, there is a need to provide' policy package' for temperate fruits and appropriate steps to be taken for consolidation of land.

Indian Himalaya that comprised the states of Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, Arunachal Pradesh, and parts of Meghalaya, Assam, Manipur, Mizoram, Nagaland, Darjeeling district of West Bengal and Nilgiri hills supports wide range of native and introduced temperate horticultural crops. In the present context, horticultural crops have special significance when we have attained self-sufficiency in food grain production and now aiming

at nutritional security. Thus, the cultivation of horticultural crops has a vast potential and is a step toward enhanced food and nutritional security, employment, poverty alleviation, diversification of agriculture and sustainable development. Effective utilization of the vast range of horticultural genetic resources thus require their proper deployment which may include

(i) use as a breeding material and/or rootstocks,

(ii) directly as variety through introduction or after selection, and

(iii) as new crop through domestication.

The management of horticultural genetic resources which include collection, characterization, evaluation, conservation and utilization is a gigantic task. In fact, management of horticultural genetic resources is more complex as compared to the field crops and requires different management strategies. Keeping in view the enormity and diversity of the task and the difficulties involved therein, essentially a networking approach is required. The development and adoption of improved varieties, which are generally uniform and many times genetically related, has led to the replacement of innumerable local varieties and landraces.

For example, the three varieties Starking Delicious, Red Delicious and Richard Delicious occupying about 83% of the total area under apple in HP. Therefore, conservation requires complementary strategies involving both *in situ* (including on-farm) and *ex situ* conservation. Emphasis needs to be given to the conservation of the endemic wild relatives and rare and endangered species that are rapidly disappearing from their niches. The future management strategy should not only focus on the already commercialized crop species but also on many relatively neglected minor vegetables and temperate fruits which are considered low-income crops and have received a very little attention.

So, diversity among crops, species, varieties is now paramount important to cope up with the climatic change as well as monocrop failure due to unavoidable circumstances.

REFERENCES

Anonymous. (1962), The Wealth of India : Raw Materials. CSIR, New Delhi. VI : 234-49

Anonymous. (1969), Prunus. In The Wealth of India: Raw Materials, vol VIII, CSIR, New Delhi.

Bailey, L.H. (1953), Standard Encyclopedia of Horticulture. Macmillan Co, New York.

Brown, A.G. (1975), Apples. In Advances in Fruit Breeding (Moore and Janick, Eds.). Purdue University Press, USA. P. 3-38.

Dastur, J.F. (1964), Useful Plants of India and Pakistan. D.B. Taraporewala and co. Pvt Ltd. Bombay.

Hayes, W.B. (1944), Fruit Growing in India. Kitabistan, Allahabad.

Hooker, J.D. (1879), The Flora of British India II. L. Reeve and Co. Ltd. NR Ashford Kent, England.

Jindal, K.K. and Gautam, D.R. (Eds), (2001), Compendium of winter school on "productivity of temperate fruits-Isuues and strategies" published by Department of pomology, Dr. Y.S.Parmar University of Horticulture and Frorestry, Nauni, Solan (H.P) 498 Pp.

Kishore, D.K. (1988), Annual Research Report for 1987. IARI Regional Station (Hort.), Shimla.

Kishore, D.K. (1989), Annual Research Report for 1987. IARI Regional Station (Hort.), Shimla.

Kishore, D.K. and Randhawa, S.S. (1983a), Annual Research Report for 1982. IARI Regional Station (Hort.).

Kishore, D.K. and Randhawa, S.S. (1983b), A note on the graft compatibility of native wild species. II. Plum. Scientia Horticulture, **19**: 251-55.

Kishore, D.K. and Randhawa, S.S. (1987), Comparitive chilling requirement of Malus species. In Advances in Research on Temperate Fruits (Chashna, T.R., Ed.). Dr, Y.S. Parmar University of Horticulture and Forestry, Solan. P. 95-98.

Nasacheva, E.P., Anisimova, K.L. and Shterinbook, S.D., (1973), Restitel. Nye Resursy, **9**: 257.

Parmar, C. and Kaushal, M.K. (1982), Wild Fruits. Kalyani Publishers, Ludhiyana.

Randhawa, S.S. and Kishore, D.K. (1981), A note on graft compatibility of native wild species-1 apple and pear. J. Horti. Sci., **56**: 369-71.

Randhawa, S.S. and Kishore, D.K. (1983), Propagation of Kainth (Pyrus pashia Bunch.) by root cuttings. Indian J. Horti., **40**: 213-14.

Randhawa, S.S., (1987), Wild Germplasm of pome and stone fruits, IARI, New Delhi-110012.

Randhawa, S.S. and Kishore, D.K. (1987), Preliminary evaluation of native Malus baccata types as rootstocks. In Advances in Research on Temperate Fruits (Chadha, T.R., Ed.). Dr. Y.S.Parmar University of Horticulture and Forestry; solan. P. 85-93.

Randhawa, S.S. and Ram, R.D. (1976), Collection, maintenance and evaluation of germplasm. All India Coordinated Fruit Improvement Project, Tech. Doc. **9**: 7-12.

Randhawa, S.S. and Ram, R.D. (1977), Potentiality of the indigenous germplasm in the improvement of pome and stone fruits. In Fruit Breeding in India (Nijjar, G.S., Ed.). Oxford and IBH Publishing Co., New Delhi. P. 131-38.

Ram, R.D. and Randhawa, S.S (1979), Resistance of different species of pome and stone fruits to powdery mildew incited by podosphaera leucotricha. Sci Cult., **45**: 256.

Sharma, B.D., Rana, J.C. and Yadav, S.K. (Eds) (2001), A profile NBPGR Regional Station, Shimla. Published by NBPGR, New Delhi-12.

Singh, R.N., Randhawa, S.S. and Gupta, P.N. (1971), Rootstock performance of two wild species of Cherry (Prunus cerasoides and Prunus cornuta) in the nursery. Indian J. Hort., **23**: 196-198.

Srivastava, R.P. (1966), Research on horticultural crops at Chaubattia. Indian Hort., **10**: 9-11.

Sofi, A.A. and M.K.Verma, (2004), Final project report on "Clonal selection and quality planting material production of almonds and walnut (NATP)". CITH. Srinagar, J&K 38 Pp.

Sofi, A.A. and M.K.Verma, (2003),Technical project report from 1999-2003 project on "sustainable management of plant biodiversity (NATP)". CITH. Srinagar, J&K 38Pp.

Srivastava, R.P., Pathak, R.K., Bana, D.S. and Pandey V.S. (1977), Utilization of some important fruit trees growing wild in the Himalayan region. In Fruit Breeding in India (Nijjar, G.S., Ed.). Oxford and IBH Publishing Co, New Delhi. P. 1-8.

Young, E and Werner, D.S. (1985), Chill unit and growing degree hour requirements for vegetative bud break in six apple rootstocks. J. Amer. Soc. Hort. Sci., **110**: 411-13.