INDIAN Horticulture
May–June 2021

Carambola
Some unique fruits for home garden

India has a rich and varied heritage of biodiversity, encompassing a wide spectrum of habitats from tropical rainforests to alpine vegetation and from temperate forests to coastal wetlands. Several fruit plant species have originated in Indian subcontinent. Apart from indigenous fruits, several fruits were introduced in India from South America, Africa, Europe, South East Asian countries during last four centuries. Some of the unique minor fruits which are suitable for the backyard garden in tropical and sub-tropical regions are described herewith.

Barbados cherry

Barbados cherry (Malpighia marginata syn. Malpighia glabra) belongs to family Malpighiaceae. It is native to South America and Central America. It is grown over all tropical regions of the world. It was introduced in India long back and found growing in most of the tropical and sub-tropical humid regions of the country. It is an evergreen, bushy shrub or small tree attaining up to 5 m height. It has very short stem and spreading/ dropping branches. The flowers are pink and sessile. The fruits are borne singly or in cluster of 2-3 in the leaf axils. Fruits are olate to round, cherry-like 1.25-2.5 cm diameter, bright-red coloured. The pulp is orange coloured, juicy and sour. The fruits are very rich in vitamin C (Table 1). There is no variety of Barbados cherry in India. The tree grows in well drained clay to loamy soil. It is generally propagated by seeds, air layering and cutting. The seed germination is about 50-60 per cent. About 300 g mixture of N.P.K (8-8-13) to young plant and 2 kg to adult plants may be given two times a year for better growth and yield. The flowering and fruiting start ripening in April-May and continue to produce successive small crops until December under Bengaluru conditions. A grown up shrub may yield 15-25 kg fruit /year. Slightly immature fruits may be harvested for processing. Barbados cherries are eaten mainly as fresh but can be used for making candies and fruit wines.

Bilimbi

Bilimbi, Averrhoa bilimbi L., (Oxalidaceae), is close relative of carambola. It is cultivated throughout South and South East Asia native region. In India, it is grown in tropical region, except higher hills. The tree is attractive, perennial which may grow up to 4-6 m height. It has a short trunk giving rise to several upright branches. The stem is smooth. The leaves are compound and leaflets are light green in colour. The tree starts flowering after 2-3 years of planting. The flowers are small, fragrant, yellowish-green or purplish, marked with dark-purple, are borne in small, hairy panicles emerging directly from the trunk and old branches. Fruit are borne in clusters. These are nearly cylindrical, smooth, 6-10 cm long and 2-3 cm in diameter. The fruit is crisp when unripe, turns from bright-green to yellowish-green when ripe. The fruit rind is glossy, thin, soft and tender, and pulp is greenish yellow, jelly-like, juicy and extremely acid. There are 5-7 seeds per fruit, wide, smooth and brown. It requires humid tropical conditions with good sunshine. Bilimbi grows best in rich, moist, well-drained soil. The tree is multiplied by seed and air-layering. The tree begins to flower in February – March and then blooms and fruits more or less continuously until December. The fruits are picked by hand, singly or in clusters. They need gentle
Some unique fruits for home garden
Prakash Chandra Tripathi

Our Guest Speaks

Seasonality chart of underutilized fruits found in the Eastern Himalayas
Thejangulie Angami and L Wangchu

Ascorbic acid for reducing foliage discoloration in cut chrysanthemum
Varun M Hiremath and Ritu Jain

High density planting system in apple using clonal rootstock: A profitable venture
Rajender Kumar, Himanshu Thakur, Sakshi Singh and Nidhi Sharma

Morphogenetic diversity in DBM-4 accession of jal brahmi
Parmeshwar L. Saran and Hiteksha I. Damor

Yamuna Purple-10 (G-404): A new promising garlic variety
B K Dubey and P K Gupta

Indigenous (traditional) vegetables as food and medicine in Adi community of East Siang (Pasighat), Arunachal Pradesh
Md. Ramjan and Kripa Shankar

Ziziphus jujube Miller – A fast vanishing minor fruit plant of Kashmir, India
Sheikh M Sultan, Susheel Kumar Raina, Suheel Ahmad and Sheeraz Salim Bhat

Microgreens: An ultimate superfood
Kalpana Yadav

Cultivating Garden pea in Punjab
Arti Verma

Livelihood security of small and marginal farmers through Ocimum cultivation
Priyanka Suryavanshi and Dipender Kumar

Pusa Gynoecious Cucumber Hybrid-18
A D Munshi, T K Behera, Amish K Sureja, B S Tomar, J Singh and S S Dey

Carambola (Star fruit) at a glance
T Janakiram

Attention readers: • All disputes are subject to the exclusive jurisdiction of competent courts and forums in Delhi/New Delhi only. • The Council does not assume any responsibility for opinions offered by the authors in the articles and no material in any form can be reproduced without permission of the Council. • The Council is not responsible for any delay, whatsoever, in publication/delivery of the periodicals to the subscribers due to unforeseen circumstances or postal delay. • Readers are recommended to make appropriate enquiries before sending money, incurring expenses or entering into commitments in relation to any advertisement appearing in this publication. The Council does not vouch for any claims made by the advertisers of products and services. The publisher and the editor of the publication shall not be held liable for any consequences in the event of such claims not being honoured by the advertisers.
The Covid-19 pandemic that has gripped the world in recent months constitutes a major challenge to food and nutrition security of vulnerable populations. Micro-nutrients especially zinc and vitamins boost the immunity of the Covid-19 sufferers. The Covid-19 pandemic should be seen as a wake-up call for humanity, to reflect, rethink and redesign dietary food systems that are safe, healthy, sustainable, and beneficial to all. It has rendered the consumers to contemplate and explore natural dietary food for improving their immunity levels. Root and tuber crops (RTC) are rich in dietary fibres, minerals and vitamins. They can help to improve household diet diversity and address minerals and vitamin deficiencies. The RTC based food can improve resilience of communities to withstand the challenge posed by pandemic in general, and Covid-19 in particular.

The RTC provide a substantial part of the world’s food supply. They contribute 6% of the average daily calorific intake of human beings. The RTC include sweet potato [Ipomoea batatas (L.) Lam.], cassava (Manihot esculenta Crantz.), yams (Dioscorea spp.), elephant foot yam (Amorphophallus paeoniifolius (Dennst.) Nicolson), taro (Colocasia esculenta (L.) Schott.), yam bean [Pachyrhizus erosus (L.) Urb.], arrowroot (Maranta arundinacea L.), etc.

Sweet potatoes have anti-inflammatory properties which are primarily due to the presence of β-carotene, anthocyanin, vitamin C and magnesium. Anthocyanin enriched sweet potato (Variety Bhu Krishna contains 95 mg anthocyanin per 100 g fresh tubers) may protect against colorectal cancer due to its anti-proliferative abilities. Vitamin A malnutrition is a major public health concern of the developing countries and is responsible for night blindness. The β-carotene is a precursor of vitamin A. The orange fleshed sweet potato variety Bhu Sona is having 14 mg β-carotene per 100 g of fresh tuber. Sweet potato is rich in dietary fibre; it promotes the digestive health, reduce the risk of ulcers and colon cancers. Cassava roots have bioactive compounds namely, cyanogenic glucosides such as linamarin and lotaustralin, noncyanogenic glucosides, hydroxycoumarins such as scopoletin, terpenoids and flavonoids. Cassava boosts energy level, ensures healthy weight gain, helps to prevent Alzheimer’s disease and cardiovascular diseases.

Yams are valuable source of carbohydrates, fibres and low level fat, which makes them a good dietary source. Yams stimulate the proliferation of gastric epithelial cells and enhance digestive enzyme activities in the small intestine. Diosgenin, a steroidal saponin of yam demonstrated antioxidative and hypolipidemic affects in vivo. Steroidal saponin of yam is used for drugs production such as dioscin, gracilin and prosapogenin. Elephant foot yam corms are a highly nutritious vegetable and contains calcium, phosphorous, iron and crude fibre. The corms contain glucose, galactose and rhamnose, flavonoids, phenols, coumarins, terpenoids, sterols, tannins, steroids and alkaloids. The corms are used traditionally for ailments like elephantiasis, tumors, hemorrhages, cough, bronchitis, asthma, amenorrhea, dysmenorrhea, seminal weakness, fatigue and anemia. Amblyone (a triterpenoid) and 3, 5-diacetylambulin (a flavonoid) has been isolated from its corms and have possible antibacterial, antifungal and cytotoxic activities. Taro leaves are rich in anti-oxidants and fibre, which makes them an excellent food to promote a healthy body weight. Regular consumption of taro leaf has been associated with reduction in risk of heart disease. Taro cormels contain starch, zinc, vitamin C, thiamine, riboflavin and niacin. Taro lowers risks of developing diabetes, reduces risks of lung and oral cancer.

The RTC are very high yielders. Cassava and elephant foot yam yields up to 60 tonnes/ha. The RTC have extensive agro-ecological adaptability and are capable enough to withstand biotic and abiotic stresses. Cassava and greater yam are resistant to drought and high temperature, and taro has flood tolerance. Sweet potato can tolerate flash floods and mid-season drought, and this crop is considered as ‘famine relief crop’. Hence, the RTC are not only treasure house of biomolecules, minerals and vitamins, but also climate smart food crops which can provide food and nutrition security to burgeoning population. Thus, RTC are aptly potential food crops for combating contagious pandemic diseases like Covid-19.
Nature in its generous abundance has bestowed the Eastern Himalayan region with a unique array of vegetation ranging from tropical and sub-tropical to temperate. The region has varied agro-climatic conditions supporting the growth of various plant species giving it a rich biological diversity. The article reports on the documentation of wild underutilized edible fruits species found in the entire region of North east India and its thorough observation on the time of flowering and fruit availability or fruit maturity which is paramount. A total of 44 underutilized fruit species represented by 21 families were listed and sampled from varied locations of the region in which Rosaceae family represented the highest with 6 species. Developing a seasonality chart or calendar will identify the timing of different seasons for locally available fruit species. The chart can also be used as a guide to explore different underutilized fruits throughout the year.

The Eastern Himalayan region of India stretching between 21°50’ and 29°34’ N latitude and 85°34’ and 97°50’ E longitude spreading over an area of 2,620,230 sq km comprises Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. It is a region geographically nestled in one of the most biodiversity rich regions of the world. The region is divinely blessed with diverse agro-climatic conditions, soil physiography and is endowed with wealthy plant genetic resources including several underutilized fruit species. The region is considered an abode and reservoir of numerous wild genetic resources specifically underutilized fruit crops growing wildly in the forest and in almost every homestead and backyard.

Underutilized or neglected fruit species are those fruit species which represent an enormous wealth of agrobiodiversity and have great potential for contributing to food security and nutrition, health (nutritional/medicinal), income generation, environmental services and combating the hidden hunger caused by micronutrient deficiencies. These fruit species are seen growing widely in forest and in almost every backyard without much care and attention that are neither grown commercially nor traded widely, lesser known to people, have less demand in the market and are less palatable. Further, whose distribution, cultivation and uses are poorly documented.

Underutilized fruits contribute significantly in improving human health by meeting their nutritional need, livelihood, household food security and ecological sustainability. Since yore, indigenous food resources constituted the bedrock of the diversity in traditional and indigenous food systems of communities in the north-eastern region of India and underutilized fruits constituted an integral part of traditional diets and contributed significantly in the livelihood security of several ethnic tribal communities of the region. The ethnic tribal till the present time have excellent knowledge in the use of almost all the fruit tree species found in the forests as a source of food, medicine and timber and they have been using such species since several generations without having anything in written.

The information on the period (month) of flowering and fruit availability of underutilized fruit species has not been given much attention and documented since the beginning, as compared to the major fruit species leading to dearth of knowledge and awareness on its time of availability. Therefore, underlining a seasonality chart or calendar will confirm and identify the timing of different seasons for locally available fruit species. The chart can also be used as a guide to explore different underutilized fruits throughout the year. It is obvious to state that the time of flowering and fruit maturity will vary depending on the region and growing seasons as it is normally determined by environmental factors such as photoperiod, temperature, availability of water, nutrients and stress as well as various endogenous genetic components. Fruits are normally at their best in terms of quality when they are harvested in their natural seasons as it contains all the vitamins and nutrients that our body needs in that particular season. This article documents the diversification of wild underutilized edible fruit species found in the entire region of North east India and thorough investigation on the time of fruit availability or fruit maturity. A total of 44 numbers of underutilized fruit species represented by 21 families were listed and collected of which Rosaceae family represented the highest with 6 species. Time of flowering and period of fruit availability differed for different fruit species as shown
**List of underutilized fruits found in the North-east region**

<table>
<thead>
<tr>
<th>Image of fruit</th>
<th>Name of the fruit species</th>
</tr>
</thead>
</table>
| Docynia indica Wall. | Common name: Crab apple  
Family: Rosaceae  
Vernacular name: Phukhoithi (Sumi Naga); Sohphoh (Khasi)  
**Time of flowering:** March – April  
**Period of fruit availability:** November – January |
| Pyrus pashia Hamilton ex D. Don | Common name: Wild Himalayan pear  
Family: Rosaceae  
Vernacular name: Piita ayhi (Apatani)  
**Time of flowering:** Feb. – March  
**Period of fruit availability:** September – October |
| Prunus nepalensis Serr. | Common name: Khasi cherry  
Family: Rosaceae  
Vernacular name: Sohiong (Khasi)  
**Time of flowering:** October – November  
**Period of fruit availability:** August – September |
| Flacourtia jangomas Lour. | Common name: Governor’s plum  
Family: Rosaceae  
Vernacular name: Poniol (Assamese)  
**Time of flowering:** February – March  
**Period of fruit availability:** July – August |
| Prunus cerasifera Ehrh. | Common name: Cherry plum  
Family: Rosaceae  
Vernacular name: Theikha (Kuki)  
**Time of flowering:** February  
**Period of fruit availability:** April – May |
| Rubus ellipticus Smith. | Common name: Yellow Himalayan raspberry  
Family: Rosaceae  
Vernacular name: Chilapoka nyigchi (Nyishi); Theimi (Kuki)  
**Time of flowering:** February – March  
**Period of fruit availability:** May – July |
| Rubus rosifolius Smith. | Common name: Roseleaf bramble  
Family: Rosaceae  
Vernacular name: Wachingwaring nyigchi (Nyishi)  
**Time of flowering:** March – April  
**Period of fruit availability:** June – July |
| Garcinia lanceifolia Roxb. | Family: Clusiaceae  
Vernacular name: Taktir (Galo); Rupohi-thekera (Assamese)  
**Time of flowering:** October – December  
**Period of fruit availability:** April – May |
| Garcinia pedunculata Roxb. | Family: Clusiaceae  
Vernacular name: Bor-thekera (Assamese); Thuphi (Kuki)  
**Time of flowering:** October – December  
**Period of fruit availability:** May – August |
| Garcinia xanthochymus Hook. f. | Common name: False mangosteen  
Family: Clusiaceae  
Vernacular name: Tepor-tenga (Assamese)  
**Time of flowering:** March – May  
**Period of fruit availability:** October – February |
| Garcinia morella (Gaertn.) Desr | Common name: Indian gamboge  
Family: Clusiaceae  
Vernacular name: Kuji-thekera (Assamese)  
**Time of flowering:** February – March  
**Period of fruit availability:** July – August |
| Garcinia paniculata Roxb. | Family: Clusiaceae  
Vernacular name: Kok (Kokborok)  
**Time of flowering:** December – February  
**Period of fruit availability:** May – July |
| Spondias pinnata L. | Common name: Indian hog plum  
Family: Anacardiaceae  
Vernacular name: Amora (Assamese); Medzisi (Angami Naga)  
**Time of flowering:** March – April  
**Period of fruit availability:** December – January |
| Spondias axillaris Roxb. | Common name: Nepali hog plum  
Family: Anacardiaceae  
Vernacular name: Lapsi (Nepali); Khulasi (Angami Naga)  
**Time of flowering:** April – May  
**Period of fruit availability:** December – February |
| Spondias cytherea Sonn. | Common name: Ambarella/Golden apple  
Family: Anacardiaceae  
Vernacular name: Amra (Bangla)  
**Time of flowering:** December – February  
**Period of fruit availability:** May – July |
| Rhus semialata Murr. | Common name: Nutgall  
Family: Anacardiaceae  
Vernacular name: Heimang (Meitei); Tsomhousi (Angami Naga)  
**Time of flowering:** September – November  
**Period of fruit availability:** December – January |
<table>
<thead>
<tr>
<th>Image of fruit</th>
<th>Name of the fruit species</th>
<th>Time of flowering</th>
<th>Period of fruit availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>Ficus racemosa Linn.</td>
<td>February – March</td>
<td>May – June</td>
</tr>
<tr>
<td>18</td>
<td>Ficus semicordata Buch.</td>
<td>February – March</td>
<td>June – August</td>
</tr>
<tr>
<td>19</td>
<td>Artocarpus lakoocha Roxb.</td>
<td>March – April</td>
<td>June – July</td>
</tr>
<tr>
<td>20</td>
<td>Streblus asper Lour.</td>
<td>March</td>
<td>May</td>
</tr>
<tr>
<td>21</td>
<td>Citrus medica L.</td>
<td>Feb. – March</td>
<td>December – January</td>
</tr>
<tr>
<td>22</td>
<td>Citrus macroptera Montr.</td>
<td>Feb. – March</td>
<td>December – January</td>
</tr>
<tr>
<td>23</td>
<td>Citrus indica Tanaka.</td>
<td>Sep. – January</td>
<td>October – February</td>
</tr>
<tr>
<td>24</td>
<td>Machilus edulis King. ex Hook.</td>
<td>February – March</td>
<td>September – October</td>
</tr>
<tr>
<td>25</td>
<td>Phoebe cooperiana U.N Kanjilal ex A. Das</td>
<td>September – October</td>
<td>April – June</td>
</tr>
<tr>
<td>26</td>
<td>Myrica esculenta Buch.-Ham. ex D. Don.</td>
<td>Feb. – March</td>
<td>April – June</td>
</tr>
<tr>
<td>27</td>
<td>Myrica nagi Thunb.</td>
<td>Feb. – March</td>
<td>April – June</td>
</tr>
<tr>
<td>28</td>
<td>Canarium strictum Roxb.</td>
<td>Feb. – March</td>
<td>December – January</td>
</tr>
<tr>
<td>29</td>
<td>Bursera serrata Wall. ex Colebr.</td>
<td>March – April</td>
<td>June – July</td>
</tr>
<tr>
<td>30</td>
<td>Elaeagnus latifolia L.</td>
<td>September – November</td>
<td>April – May</td>
</tr>
<tr>
<td>31</td>
<td>Elaeagnus umbellata Thunb.</td>
<td>September – November</td>
<td>April – May</td>
</tr>
<tr>
<td>32</td>
<td>Phyllanthus acidus (L.) Skeels</td>
<td>February – March</td>
<td>May – June</td>
</tr>
</tbody>
</table>

May–June 2021
in the seasonality chart figure. List of underutilized fruit species sampled from various locations of the region with vernacular names of various ethnic communities have been given to each species in the table along with photographs to elaborate the same.

Underutilized fruit species recreate an important role in mitigating hunger through diet diversification as they are reservoirs of minerals, vitamins, carbohydrates, proteins, antioxidants and also it can be considered as risk aversion and a resilient crop towards climate change owing to its wider phenological and soil adaptability in this difficult region. However, with rapid land transformation, growing connectivity, deforestation due to uncontrolled Jhum, wood felling, etc. regrettably, resulted in the decline and loss of these species, henceforth facing rarity. Several studies regarding these fruit species have been highlighted in different aspects nevertheless most of the studies were in bits and pieces. Therefore, a small effort on developing a seasonality chart will create a catalogue of wild underutilized fruits which need to be consumed during a certain season. Further, promoting the use of underutilized fruit species needs to be achieved by highlighting their importance in their current production and consumption as most of these fruit species are preferred in the region for their delightful taste, medicinal value and being a source of food and nutrition which betokens the natural essence of these wild underutilized fruit species.

For further interaction, please write to
Thejangulie Angami, (Scientist), ICAR, AP Centre, Basar, Arunachal Pradesh.*Corresponding author e-mail: thejaangami@yahoo.com

<table>
<thead>
<tr>
<th>Image of fruit</th>
<th>Name of the fruit species</th>
<th>Image of fruit</th>
<th>Name of the fruit species</th>
</tr>
</thead>
<tbody>
<tr>
<td>33</td>
<td>Antidesma bunius L. Spreng. Common name: Bignay Family: Euphorbiaceae Vernacular name: Heiyen (Meitei) <strong>Time of flowering:</strong> March – April <strong>Period of fruit availability:</strong> July – September</td>
<td>39</td>
<td>Syzygium jambos Alston. Common name: Myrtaceae Family: Rose apple Vernacular name: Bogi Jamu (Assamese) <strong>Time of flowering:</strong> Feb. – March <strong>Period of fruit availability:</strong> May – June</td>
</tr>
<tr>
<td>34</td>
<td>Baccaraea ramiflora Lour. Common name: Burmese grape Family: Phyllanthaceae Vernacular name: Bureng (Adi); Leteku (Assamese) <strong>Time of flowering:</strong> March <strong>Period of fruit availability:</strong> June – July</td>
<td>40</td>
<td>Nephelium lappaceum Linn. Common name: Wild rambutan Family: Sapindaceae Vernacular name: Tader (Adi) <strong>Time of flowering:</strong> February <strong>Period of fruit availability:</strong> April – May</td>
</tr>
<tr>
<td>35</td>
<td>Dillenia indica L. Common name: Elephant apple Family: Dilleniaceae Vernacular name: Outenga (Assamese) <strong>Time of flowering:</strong> May – August <strong>Period of fruit availability:</strong> September – February</td>
<td>41</td>
<td>Calamus tenuis Roxb. Common name: Cane fruit Family: Arecaceae Vernacular name: Jeying (Adi); Heiri (Meitei) <strong>Time of flowering:</strong> Dec. – January <strong>Period of fruit availability:</strong> April – May</td>
</tr>
<tr>
<td>36</td>
<td>Ziziphus mauritiana Lam. Common name: Ber Family: Rhamnaceae Vernacular name: Bogori (Assamese) <strong>Time of flowering:</strong> October – November <strong>Period of fruit availability:</strong> December – January</td>
<td>42</td>
<td>Haematocarpus validus (Miers.) Bakh. ex F. Forman Common name: Blood fruit Family: Menispermaceae Vernacular name: Theichhungsen (Mizo) <strong>Time of flowering:</strong> Dec. – January <strong>Period of fruit availability:</strong> June – August</td>
</tr>
<tr>
<td>37</td>
<td>Elaeocarpus floribundus Blume. Common name: Indian olive Family: Elaeocarpaceae Vernacular name: Jalphai (Assamese); Shekhuthi (Sumi Naga) <strong>Time of flowering:</strong> April – May <strong>Period of fruit availability:</strong> November – January</td>
<td>43</td>
<td>Viburnum foetidum Wall. Common name: Stinking viburnum Family: Caprifoliaceae Vernacular name: Yolyu (Apatani) <strong>Time of flowering:</strong> June – July <strong>Period of fruit availability:</strong> September – October</td>
</tr>
<tr>
<td>38</td>
<td>Terminalia chebula Retz. Common name: Chebulic myrobolan Family: Combretaceae Vernacular name: Silikha (Assamese) <strong>Time of flowering:</strong> March – April <strong>Period of fruit availability:</strong> November – January</td>
<td>44</td>
<td>Castanopsis hystrix J. D. Hooker &amp; Thomson ex A. de Candolle. Common name: Chest nut Family: Fagaceae Vernacular name: Amke (Adi) <strong>Time of flowering:</strong> October <strong>Period of fruit availability:</strong> August – September</td>
</tr>
</tbody>
</table>
Ascorbic acid for reducing foliage discoloration in cut chrysanthemum

Owing to the steady increase in demand of flowers, floriculture has become one of the important commercial businesses in horticulture. Chrysanthemum is one of the topmost cut flowers earning high domestic as well as export value. Post-harvest management of cut flowers is very important to enhance their vase life and keep them attractive for a longer time after consumers purchase. Early wilting and yellowing of leaves are major problem resulting in loss of quality in chrysanthemum. Studies have proved the application of ascorbic acid as chemical preservative against foliage discoloration and petal wilting in lily, red ginger, rose, carnation, etc. Yet, it is water soluble and cheaply available in market. In this regard, present study was carried out to study its influence on foliage discoloration and reported that the use of ascorbic acid as spray solution to reduce leaf yellowing and petal wilting in chrysanthemum. Ascorbic acid sprays will be helpful for consumers to keep the cut flowers fresh, turgid and attractive for longer time.

CHRYSANTHEMUM – one of the most popular flowers commercially grown for cut flower, loose flower and pot plant purpose–is the second largest cut flower cultivated and marketed all over the world. Japan is the leading producer of Chrysanthemum in the world and other top producing countries include Columbia, The Netherlands, Italy and United States. In India, it is cultivated in an area of 16.63 thousand hectare with a production of 179.37 MT.

Post-harvest management of cut flowers is very important to enhance their vase life and keep them attractive for a longer time after consumers purchase. Although chrysanthemum flowers have relatively higher vase life than other cut flowers, early wilting...
## Effect of ascorbic acid on leaf and petal senescence in chrysanthemum cv. Yellow Star

### Table 1. Influence of ascorbic acid on post-harvest foliage discoloration and vase life

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Pusa Centenary</th>
<th>Yellow Star</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Leaf wilting (%)</td>
<td>Leaf yellowing (%)</td>
</tr>
<tr>
<td>As spray solution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1 Distilled water</td>
<td>18.50</td>
<td>32.51</td>
</tr>
<tr>
<td>T2 Ascorbic acid 50 ppm</td>
<td>17.66</td>
<td>26.43</td>
</tr>
<tr>
<td>T3 Ascorbic acid 100 ppm</td>
<td>6.36</td>
<td>27.32</td>
</tr>
<tr>
<td>T4 Ascorbic acid 150 ppm</td>
<td>3.33</td>
<td>30.86</td>
</tr>
<tr>
<td>As vase solution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T5 Sucrose 4%</td>
<td>23.04</td>
<td>31.76</td>
</tr>
<tr>
<td>T6 Ascorbic acid 50 ppm + Sucrose 4%</td>
<td>53.65</td>
<td>25.94</td>
</tr>
<tr>
<td>T7 Ascorbic Acid 100ppm + Sucrose 4%</td>
<td>59.90</td>
<td>30.44</td>
</tr>
<tr>
<td>T8 Ascorbic acid 150ppm + Sucrose 4%</td>
<td>18.58</td>
<td>28.88</td>
</tr>
</tbody>
</table>

Ascorbic acid is a potential antioxidant which can delay leaf and petal senescence in chrysanthemum. It is also interesting to know that the endogenous level of ascorbic acid has recently been suggested to be important in the regulation of developmental senescence and plant defense against pathogens. Its use as preservative has also been documented in Rose, Carnation, Gladiolus, Tuberose, Lilium, Red Ginger, etc. Besides functional role, ascorbic acid is cheap, easily available and can be dissolved easily in distilled water for its use in vase solutions.

Keeping these points in view, a study has been conducted at Division of Floriculture and Landscaping of ICAR-IARI, New Delhi to investigate effect of exogenous ascorbic acid on leaf and petal senescence through spray as well as vase solutions. Cut stems of standard chrysanthemum cv. Pusa Centenary and cv. Yellow Star were harvested during morning hours from the research farm at fully open stage before anthesis. Harvested stems...
were immediately placed in a bucket containing clean water for rehydration and were brought to the laboratory. These stems were cut back to the uniform length of 60 cm and the leaves from the lower 1/3rd portion of the stem were removed and flowers were kept in distilled water. The basal portion of the cut stems (2 cm) was recut under water and cut stems were kept in test tubes containing distilled water or different vase solutions as per different treatments (Table 1). Freshly prepared ascorbic acid (L-ascorbic acid, lab grade chemical) solutions were uniformly sprayed alternate day onto petals and leaves of chrysanthemum cv. Pusa Centenary and cv. Yellow Star according to treatments and their effect on leaf wilting, leaf yellowing and vase life was studied (Table 1).

It was concluded from the study that the spraying of flowers of Pusa Centenary with 100 ppm and Yellow Star with 50 ppm concentration of ascorbic acid delayed foliage discoloration (leaf yellowing, wilting, browning), petal senescence and also enhanced the vase life of cut stems. These findings were also evident from involvement of antioxidant enzymes in regulation of foliage discoloration and petal wilting after 14 days after treatment. It is attributed to the fact that the ascorbic acid is absorbed directly through the leaves, thereby preserving the chlorophyll content and also enhanced endogenous ascorbic acid level.

Ascorbic acid spray was helpful for keeping the cut flowers fresh, turgid and attractive for longer time. However, since foliage discoloration has been found cultivar specific, there is a need to standardize the ascorbic acid levels for each chrysanthemum cultivar. It is also essential to validate efficacy of ascorbic acid in other important ethylene insensitive flowers.

---

**For further interaction, please write to:**

**Ritu Jain**, Division of Floriculture and Landscaping, ICAR-IARI, New Delhi 110 012. *Corresponding author e-mail: ritujain.unif@gmail.com*

---

**Textbook of Field Crops Production – Foodgrain Crops**

The first edition of Textbook of Field Crops Production was published in 2002 and there has been a heavy demand for the book. This book is now being brought out in two volumes. The chapters cover emerging trends in crop production such as System of Rice Intensification (SRI), export quality assurance in the production technology of commodities like Basmati rice, organic farming, resource conservation technologies, herbicide management etc. Good agronomic practices must judiciously inter-mix the applications of soil and plant sciences to produce food, feed, fuel, fibre, and of late nutraceuticals while ensuring sustainability of the system in as much possible environment and eco-friendly manner. The advent of hydroponics, precision farming, bio-sensors, fertigation, landscaping, application of ICT, GPS and GIS tools, micro-irrigation etc. is in the horizon. The textbook covers both the fundamentals of the subject and at the same time inspire and prepare both teachers and students for the emerging frontiers.

---

**TECHNICAL SPECIFICATIONS**

<table>
<thead>
<tr>
<th>No. of pages</th>
<th>Price</th>
<th>Postage</th>
<th>ISBN No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>i-xii + 396</td>
<td>₹ 700</td>
<td>₹ 100</td>
<td>978-81-7164-116-1</td>
</tr>
</tbody>
</table>

*For obtaining copies, please contact:*

**Business Manager**

Directorate of Knowledge Management in Agriculture

Krishi Anusandhan Bhavan-I, Pusa, New Delhi 110 012

Tel : 011-25843657, Fax 91-11-25841282; e-mail : bmicar@gmail.com*
HIGH-DENSITY planting refers to the planting of a higher number of plants per unit area than the conventional system of plantings. Conventionally, standard apple plants raised on seedling rootstocks are planted at a spacing of 7.5 × 7.5 m and spur varieties at a spacing of 5.0 × 5.0 m with a planting density of 178 and 400 trees/ha respectively. The average productivity of these orchards is approximately 6-8 metric tonnes/ha, which is much below the productivity obtained in high-density orchards (40-60 metric tonnes per hectare) where the density of plant will be approximately 500 to 600 trees/acre. High-density orcharding can be done on flat and fertile lands with assured irrigation using dwarf/semi- dwarf clonal rootstocks which can be trained to modern methods of canopy management, viz. Tall Spindle, Vertical Axis and Slender Spindle, etc. This technology is helpful in best utilization of land and other required resources and ease in orchard inter-culture operations, plant protection as well as harvesting and to obtain export quality of the produce. High-density systems will be productive and profitable if it is managed very well with several very specific considerations as discussed here stepwise.

**Selection of variety**

When high chill varieties like Royal and Red Delicious are grown on lower altitude, they do not develop colour which is the major challenge for their commercial exploitation at intermediate or mid hill region. Varieties having chilling requirement of 700-900 hours like Jeromine, Red Velox, Red Cap Valtod can be grown at medium altitude of 1200-1800 m.

<table>
<thead>
<tr>
<th>Altitude (m)</th>
<th>Variety recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>1200-1800</td>
<td>Early Red One, Gale Gala, Jeromine, Red Velox, Red Cap Valtod, Scarlet Spur II, Redlum Gala, Super Chief</td>
</tr>
<tr>
<td>1800-2200</td>
<td>Auvil Early Fuji, Oregon Spur II, Vance Delicious</td>
</tr>
<tr>
<td>2200-2400</td>
<td>Fuji, Red Chief, Royal Delicious, Top Red</td>
</tr>
</tbody>
</table>

**Highly feathered nursery trees:** If procuring nursery trees, ideally it should have 10-15 feathers/tree. Transplant shock caused by a high top to root ratio helps to keep trees within this tight spacing. It also contributes to significant fruit bud differentiation at the year of planting.

**Selection of pollinator variety**

As in traditional system, we are using Golden Delicious and Red Gold as pollinizer, which do not fetch good price in market. New pollinizer variety like Gale Gala, Redlum Gala and Auvil Early Fuji are getting good market price and they can also be planted in the 33-40% ratio to increase the fruit set percentage and overall productivity. One of the major advantage of these pollinizing varieties is the synchronization of their flowering pattern with commercial variety. Auvil early Fuji is also a good pollinizing variety which is recommended for higher elevation as it does not develop colour at lower elevation.
Use of dwarfing rootstock

The other important consideration is the use of appropriate dwarfing rootstocks which is the key component of high density planting system. The most successful high density orchards established to date have been on M.9 and B.9 rootstock. The yield efficiency and precocity of the Geneva rootstock are also being stated positive where fire blight is a concern. More vigorous rootstocks than these should only be used with the weakest growing varieties such as Spur Delicious. Malling 9 is an excellent rootstock for this system as are G.41, G.11, G.16, V2 and V3. Malling 26 rootstock should only be used for weaker growing varieties. The base of the tree where the rootstock has been planted should be approximately six inches above the soil.

Planting distance

It depends on the vigour of variety and rootstock and also on the soil strength. In high density orchards the density of plant should be approximately 500 to 600 trees/acre. The maximum spacing between trees should be 4-6 feet and 8-12 feet between rows depending on the elevation and the terrain of the land.

Training system

In high density orcharding, trees should be trained to modern methods of canopy management, viz. Tall Spindle, Vertical Axis and Slender Spindle, etc.

Tall Spindle: In tall spindle system of training, our target should be to grow a tall narrow tree with a straight leader up to the top wire and a fruited area well exposed to the sun. For it the ideal nursery tree should be at least 5 feet tall and preferably 6-7 feet. This tree should have an abundance of healthy roots and a dominant straight leader. It should have 8-12 feathers that are 15-30 cm long and they should be distributed at regular intervals along the leader. The maximum spacing between trees should be 4 feet and 12 feet between rows depending upon the vigour of rootstock and variety. The optimum Tall Spindle spacing for an average vigour variety and soil is 3 feet by 11 feet. While planting the lowest feather should at least be 60 cm above the soil and rootstock should be 10-15 cm above ground level. Pruning the new tree is discouraged therefore tying and training are more useful to encourage the healthy growth and to produce fruitful feathers.

This is very different from planting conventional orchards system where new trees are planted as whips and severely pruned to encourage strong growth. During the 1st year of tree training the leader is not cut and after bud break, competing side shoots near leader along with broken or damaged branches are removed. Any feathers lower than 50 cm are also removed. The feathers having diameter more than 50-66% of leader diameter should also be removed. This is very critical as we need to maintain the dominance of the leader. These branches whose diameter is exceeding the diameter of leader should be cut with bevel cut which will encourage the new growth from below the cut.

Tying down of feathers below horizontal is the most important aspect of tall spindle. Then the support system is installed at planting and trees are attached to it. Our goal during first year should be to let the leader grow as tall as possible so that it should be reaching top in the 2nd or 3rd year itself. In the initial 1-2 years the trees energy is directed to growth towards the top wire and producing many feathers that will crop early.

Vertical axis: This system of training is also similar to tall spindle besides here the branches are maintained just horizontal unlike tall spindle where they are managed below horizontal. This system also relies on high density, dwarfing rootstocks, minimal pruning, limb renewal, and an effective support system. The major disadvantage is that it is a tall system that requires working off the ground. Maintaining sufficient vigour in the bottoms and controlling excess vigour in the tops is a challenge in some varieties.

Slender spindle: This system is bit difficult to develop as compared to above discussed systems. After one year of the development of initial basic system the leader is bended and then new branches will develop on that side and at the end of year then the leader will be
bended in opposite direction of first bend and it will also bear branches on alternate side and top canopy will look like S-shape. This system is generally preferred by those growers who wish to work exclusively from the ground level only and are not confident in building the wire support systems. In this system, each tree is supported with a wooden stake 8 feet long and 3 inches in diameter. The tree is pruned to develop a narrow conical shape and excess vigour of the tree top is controlled by annually cutting of 2-year old wood to remove the top most 2 or 3 limbs, which are generally too vigorous. The side limb is tied to the post which will result in a zigzag shape. There are 4 or 5 permanent limbs in the lower part of the tree and young temporary limbs in the top half of the tree.

Use of support system

As the rooting system of M 9 rootstock is brittle and shallow and need support system to maintain the sturdiness of plant, inadequate support system cannot support the weight of the tree and the fruit especially if we get heavy winds and snow storms then the entire system will collapse. Depending upon the training system, different support system can be used. We can use 8 to 10 foot long angle iron, and bamboo pole. The objective is to support the tree and the fruit load within the second or third year. Many times a multiple wires system having wires at 2, 4, 6, 8 and 10 feet interval are tied especially for M 9 rootstock.

Irrigation and fertilizer application

Another key criterion with high-density systems is an efficient irrigation system where we can use micro sprinklers and drip irrigation system. Fertigation can also be done where soluble fertilizer are being added to the irrigation water and are applied straight-away with irrigation water. Water soluble fertilizer like urea, MOP or 19:19:19 (contains 19% Nitrogen, 19% Phosphorus and 19% Potassium) can be applied with irrigation water as fertigation. Non water soluble fertilizer like single superphosphate should be applied as basal dose. Deficiency of micronutrients like B, Zn, Mn and Cu should be corrected through foliar application of boric acid (0.1%), zinc sulphate (0.5%), manganese sulphate (0.3%), and copper sulphate (0.3%) respectively. One important care need to be taken that manganese sulphate and copper sulphate should be applied by mixing with lime (0.5%).

Special pruning techniques

Special pruning techniques such as pinching, notching, clicking and bending need to be done to maintain the balance between the vegetative and reproductive growth and to have more branches at desired place. The use of plant growth regulator like 6-BA (6-benzyladenine) is very effective in stimulating buds to break. Promalin is also applied to buds where lateral shoot growth is desired. All of these methods can provide a better alternative than using a heading cut for inducing branching on the leader.

Minimal pruning at planting: For HDF system of planting very little growth is needed to fill the available space. Pruning is limited to only the removal of a few larger branches along the leader. Generally, those branches which are more than ½-2/3rd the diameter of the leader at the insertion point are removed. Pruning in subsequent years is limited to complete limb renewal by removing all dominant limbs.

Bending of branch: Bending is done in tall spindle system of training to reduce the vigour of a branch. Branch weights, rubber bands, or tying can be done for bending. Bending of branch will check the vegetative vigour and will keep the trees within allotted space, and encourages the production of fruit buds for the following growing season.

Limb renewal: All scaffolds are renewed by complete removal if they become too large for the available space and become out of balance within the tree. Renewal cuts
are made using the standard method of using a “bevel cut” which encourages new shoots to form as replacement fruiting limbs. Tall Spindle differs from most other systems in that there are no permanent limbs within the tree.

**Girdling and notching:** In notching, partial ringing of a branch above a dormant lateral bud is done to increase the flowering shoots and to induce spur from bud. In girdling, the 2-3 mm strip of bark is removed. Apples produce auxin—a plant growth hormone, in their growing apical meristems and shoot tips. It flows down inhibiting bud break for a distance below the growing shoot tip. A shallow cut into the cambium and phloem interrupts the flow of auxins to the dormant buds and these buds will start to grow. The best time to girdle or notch is in late February to the beginning of March when the sap is starting to flow. These are very effective methods to reduce the tendency towards blind wood. Girdling should be done approximately every foot of the trunk on second year trees.

**Summer pruning and pinching:** This technique can be used to remove shoots that are growing too much. It can be performed by pinching the shoot apex to reduce shoot elongation. Pinching of shoots at 8-10 cm growth is also carried out to develop the fruiting spurs and to check the growth of branches.

**Clicking:** Clicking is a method of tipping the branches of one-year-old wood where we will remove 3-5 cm tip portion of such branch. This helps to minimize blind wood. In some varieties bending tends to result in 2-3 more nodes of blind wood. This blind wood not only reduces fruiting potential but also exposes the branch to sun and sunburn due to the fruit orientation and then clicking type pruning methods should be used to counter it.

**Spur pruning:** It is a good way to rejuvenate trees that are heavy spur bearers such as Red Delicious and Empire. A tree will produce its highest quality fruit on spurs that are 2-5 years old. Any spur that is older than 5 years reduces quality fruit and should be removed. Some spur removal with pruning should be done every year on trees older than five years. The age of a spur can be determined by its size. Spurs on the bottom of limbs should be removed, as they will never produce high quality fruit. Spur pruning initiates new shoot growth to produce new fruiting wood.

**Thinning of flower:** As an average, one spur bear 5 flowers, retain only 1-2 fruit after fruit set so that fruit could attain good size and quality.

For further interaction, please write to:
Rajender Kumar, Department of Horticulture, GBPUA&T, Pantnagar 263 145, Uttarakhand. *Corresponding author e-mail: rajenderkumargbpuat@gmail.com*
Morphogenetic diversity in DBM-4 accession of jal brahmi

Successful restoration of overexploited species depends upon variability, conservation and cultivation. Elite accessions were characterized for quantitative and qualitative traits for sustainable cultivation and industrial uses. The evaluated accessions were having sufficient variability in morphology, herbage yield and chemical content. The accession DBM-5 was showing maximum dry herbage yield (19.88 t h⁻¹ y⁻¹) and DBM-4 rich in bacoside-A3 and bacopaside-II. Overall, economic and/or industrial yield was found maximum in accessions DBM-4, therefore, they may be further used in crop improvement program as valuable selection.

MORPHOLOGICAL variation in vegetative traits is a key determinant in unraveling phenotypic diversity of any plant population. Diversity in plant genetic resource provides opportunity for breeders to develop new and improved cultivars with desirable characteristics, which include both farmer-preferred traits (yield potential), and very important consumer preferred traits (superior quality). In addition to this, characterization of herbage morphology is a classical approach which is well suited for analysis of genetic diversity in regards of plant resources conservation and utilization. Herbal medications are receiving widespread acclaim globally in more than 80% of the world population, due to their higher biosafety profile over the allopathic or synthetic medications. Medicinal plant like jal brahmi utilization and conservation have allured global attention due to their overexploitation these days. The increasing demand has placed B. monnieri as the second most priority species among the most important Indian medicinal plants and is identified among the seven important medicinal plants recommended for immediate attention and included in the list of highly endangered medicinal plants of India by NMPB and Technology Information Forecasting and Assessment Council (TIFSAC), Department of Science and Technology, GOI, India.

Bacopa monnieri (L.) Penn. commonly known as ‘Neera-Brahmi’ of family Scrophulariaceae is a perennial, prostrate and creeping herb which is identified in habitat including wetlands and muddy shores. Jal brahmi, a nootropic herb being used as a promising agent in modern Ayurveda system owing to its antioxidant, cholinergic, anti-beta amyloid property; also, has been used as a traditional Ayurvedic medicine to enhance memory and to prepare popular ayurvedic preparations like ‘Brahmirasayanam’ and ‘Brahmighritam’. Bacoside A is the major active compounds of jal brahmi.

The diversity of different B. monnieri accessions collected from different parts of country were evaluated for horticultural traits. The leaves of herb are oblanceolate, relatively thick, succulent and arranged oppositely on the stem/stolon. At the same time larger leaf size or leaf area (ranging from 0.57-0.81 cm²) was observed in DBM-5 and DBM-2. However, DBM-10 had a very tiny leaf size (0.39-0.46 cm²). Small, actinomorphic flowers are borne in leaf axils, which are whitish, blue to medium purple in colour with various sizes of flower-stalk length. At the same time elite accession DBM-9 exhibited maximum stolon length (95-122 cm). Variation was observed in flower pedicel length and pedicle diameter. Higher pedicel length (1.57 cm) and pedicle diameter (0.52-0.91 m) was exhibited by
DBM-4. Flower colour was purple to purplish white in most of the genotype but whitish purple flower colour was also observed.

Table 1. Jal brahmi accessions with distinct morphological characters

<table>
<thead>
<tr>
<th>Accession</th>
<th>Distinct characters</th>
</tr>
</thead>
<tbody>
<tr>
<td>DBM-2</td>
<td>Maximum stolen leaf length, light green colour and twisty top leaves</td>
</tr>
<tr>
<td>DBM-4</td>
<td>Maximum pedicel length and high total bacoside content especially bacoside-A₃ and bacopaside-II</td>
</tr>
<tr>
<td>DBM-5</td>
<td>Maximum herbage yields, leaf size and number of leaves</td>
</tr>
<tr>
<td>DBM-9</td>
<td>Maximum inter nodal length and stolon thickness</td>
</tr>
<tr>
<td>DBM-10</td>
<td>Smaller leaf size/area</td>
</tr>
</tbody>
</table>

Crop exhibited very good plant growth round the year even under polyhouse conditions and harvested three to four times in a year. Maximum dry herbage yield was observed under open field condition as compared to polyhouse. The morphometric traits like stolon length, thickness and leaf size might be helpful for contribution in higher herbage yield. The highest fresh herbage yielding accession was DBM-5 (13.5 kg m²) followed by DBM-9 (10.1 kg m²) and DBM-4 (7.9 kg m²). On an average dry herbage yield was observed maximum in DBM-5 (19.88 t h⁻¹y⁻¹) followed by DBM-4 (18.84 t h⁻¹y⁻¹) as compared to check (17.29 t h⁻¹y⁻¹).

The whole plant is used in indigenous system of medicine as a nerve tonic and for epilepsy and insanity due to richness in Bacosides which are a class of chemical compounds, that are dammarane-type triterpenoid saponins. Elite DBM-4 observed for having maximum average bacoside-A₃ (1.13 % W/W) and bacopaside-II (2.52 % W/W) content on dry weight basis. It developed through selection and is a trait specific elite accession which produce quality herbage rich in saponins. Among the evaluated accessions, DBM-5, DBM-9, DBM-2 exhibited high herbage yield whereas DBM-4 was also containing maximum bacoside-A₃ and bacopaside-II. The accession DBM-4 and DBM-5 is rich in quality as well as herbage yield, respectively. Therefore, it can be used further in crop improvement and commercial cultivation as a new selection.

For further details please contact at below address:
Parmeshwar L. Saran, Principal Scientist (Horticulture), ICAR-Directorate of Medicinal and Aromatic Plant Research, Boriavi, Anand-387 310. *Corresponding author e-mail: plsdehradun@gmail.com

Movable screens in rose production

- Use movable screen, an important tool for rose cultivation.
- It can help growers manipulate environment conditions — lowers temperature, changes humidity and influences production numbers.
- The movable screens can be used year-round and in a variety of climates — from the Netherlands to India.
Yamuna Purple-10 (G-404): A new promising garlic variety

The new variety of garlic Yamuna Purple-10 was tested at different locations and found superior at Jammu, Karnal, Kalyanpur, Chiplima, Jabalpur, Durgapura, Akola, Junagarh, Rajigurunagar, Coimbatore and Dharwad. It has also been identified for cultivation at National level and accordingly notified by the Government of India vide notification No. SO 4272 (E) dated 26 Nov. 2019 and recommended for cultivation in Zone-II (Jammu, Ludhiana, Delhi, Haryana and Rajasthan) and Zone-IV (Madhya Pradesh, Chhattisgarh, Karnataka, Maharashtra). It is recommended for planting by the second fortnight of October and becomes ready for harvesting in about 165-175 days. Average bulb yield is 18-20 tonne per hectare.

Garlic (Allium sativum L.) is one of the most important and versatile of horticultural commodities consumed in various ways for culinary, medicinal and antimicrobial purposes. Garlic is rich source of various nutrients, vitamins, fibers and has tremendous medicinal values. Its medicinal value has been realized by the medical community, especially Unani and Ayurvedic systems of medicine for disorders of digestive system, cholesterol, sterility, cough, etc. Its antibacterial action by virtue of allicin has also been found to have potential in organic farming for treatment of plant diseases. In India it is grown in 3.17 lakh ha area with the production of 16.10 lakh. The average productivity is 5.08 tonne/ha, which can be improved by adoption of high yielding garlic varieties, suitable cultural operations, pest management practices and post-harvest management.

Yamuna Purple-10

The new garlic variety Yamuna Purple-10 (G-404), IC No. 0597827 has been identified at the national level for release during the 10th Annual Group Meeting of ICAR All India Network Research Project on onion and garlic (AINRPOG) held at IARI, New Delhi during 31 May to 2 June, 2019. It has been recommended for zone II (Jammu, Ludhiana, Delhi, Haryana and Rajasthan) and zone IV (Madhya Pradesh, Chhattisgarh, Karnataka, Maharashtra and Rajasthan). It’s a high yielding variety developed through clonal selection by National Horticultural Research and Development Foundation, R. R. S., Karnal to meet out the domestic as well as the export requirements. The variety was tested across the country under ICAR-AINRPOG in different climatic zones and found superior in performance over check. Recommended for commercial cultivation during rabi season the variety was notified by the Government of India, wide notification No. S.O. 4272(E) dated 26 November, 2019.

Production technology

The plant has dark green, broad and erect leaves, plant height 90 to 95 cm and number of leaves 8 to 10 per plant. Bulbs of this variety are compact, globular in shape and purplish or purple white in colour. They are large in size with 4.8-5.5 cm diameter. Cloves are bold with 1.0-1.4 cm equatorial diameter and 2.5-3.5 cm polar diameter. The number of cloves is 24-28 per bulb. Total soluble solids and dry matter content in bulb are 40-41%B and 41-42%, respectively. Bulbs contain 34.61 micro mol/g pyruvic acid. The other nutritional
constituents are 0.21 mg Copper, 0.61 mg Iron, 0.27 mg Manganese, 0.90 mg Zinc, 0.30 mg Sulphur, 27.84 mg Calcium, 12.72 mg Magnesium, 369.90 mg Potash, 9.90 mg Sodium, 1.68 mg Nitrogen and 150.30 mg Phosphorus per 100 g. Twenty bulbs of the variety weigh 650 g to 750 g. It is recommended for planting by 15-30 October. The variety becomes ready for harvesting in about 165-175 days after planting. Average bulb yield is approximately 18-20 t/ha and keeping quality is good. It is suitable for table and processing purposes. It is highly tolerant to major diseases of garlic like purple blotch, Stemphylium blight and other environmental stresses.

A spacing of 15×10 cm is recommended for obtaining optimum yield of good quality bulbs. Well rotten FYM may be applied @ 20 tonnes/ha or 5 tonnes/ha vermicompost at the time of field preparation and mixed well in the soil. In addition, 120 kg N, 50-80 kg P₂O₅, 50-60 kg K₂O/ha and 30 kg/ha Sulphur need to be applied through chemical fertilizers. The foliar applications at the rate of 1% of 19N:19P:19K at 30, 45 and 60 days after planting and 13N:46P at 75, 90 and 105 days after planting improves the yield and quality of the garlic bulbs. Use of Zinc, Boron and Sulphur also helps to improve yield as well as quality. Garlic being a shallow rooted crop (5-8 cm), the use of drip and sprinkler irrigation on raised bed is very much successful for increasing yield and quality of bulbs. Application of weedicide viz. Oxyfluorfen @ 0.25 kg a.i. per hectare + 1 hand weeding at 45 days after planting has been recommended to control the broad leafy weeds. The crop gets matured for harvesting when top of plants turns yellowish or brownish and 50% neck fall occurs. Drying and curing is most important post-harvest activity to improve the shelf life of bulbs during storage.

**SUMMARY**

NHRDF Purple-10 is a new addition to the list of promising garlic varieties. It is purple in colour with medium maturity and high yielding (180-200 q/ha) variety. For further interaction, please write to P K Gupta, (Director), National Horticultural Research and Development Foundation, Vill. Solaru, Post- Darar, Distt- Karnal-132 001, Haryana. *Corresponding author e-mail: drpkgupta11@gmail.com*

---

**Gardening provides you…**

- Feeling of peace and tranquility, reduces stress, and offers a sense of self-esteem and mastery of environment
- Horticultural therapy, which is utilized in psychiatric hospitals, general hospitals, physical rehabilitation centres, homes for elderly, prisons and schools
- This therapy helps the individual to overcome the diagnosed problems or cope with the problem much better while developing relationship with plants and landscaping.
- The patients can achieve higher level of personal development and satisfaction.
Indigenous (traditional) vegetables as food and medicine in Adi community of East Siang (Pasighat), Arunachal Pradesh

Arunachal Pradesh is popularly known as land of the rising Sun (latitude 26° 30’ N and 29° 30’ N and longitude 91° 30’ E and 97° E). It is a picturesque state in the remote north eastern part of India with 83,743 sq. kms area. It stretches from snow-capped mountains in the north to the plains of Brahmaputra valley in the south. The climate of Arunachal Pradesh varies with elevation; areas that are at a very high elevation in the upper Himalayas, close to the Tibetan border have an alpine or tundra climate whereas in the middle Himalayas, people experience a temperate climate. Areas at the sub-Himalayan and sea level elevation generally experience humid, sub-tropical climate with hot summers and mild winters.

The state of Arunachal Pradesh falls under the Himalaya Biodiversity hotspot and harbor a rich diversity of flora and fauna. The native inhabitants of the state include 26 major tribes and 110 sub-tribes. Most of the tribal people still depend primarily on the plant resources for their life support and livelihood. As the state harbor multi-ethnic diversity, it has a great potential for ethnobotanical studies.

Arunachal Pradesh receives heavy rainfall of 80 to 160 inches (2,000 to 4,100 mm) annually, mainly during May-September. The mountains slopes and hills are covered with alpine, temperate, and sub-tropical forests. Pasighat (East Siang) is one of the districts which are dominated by the Adi tribe. In the tribal society the use of plants as vegetable in daily diet with medicinal values is well known since early days. They used different plant species in the treatment of various diseases using the various parts of the vegetables like, roots, stems leaves, flowers, fruits, tuber, etc. of the plant.

The state has 17 districts, out of which six districts are inhabited by the Adi community, namely East Siang, Upper Siang, West Siang, Lower Dibang valley, Lohit and Upper Subansiri. Adi is one of the major tribes and consists of 14 sub-tribes, namely Ashing, Bori, Bokar, Karko, Komkar, Minyong, Millang, Pasi, Padam, Panggi, Pailibo, Ramo, Shimong and Tangam. The Adi language spoken by the people belongs to Tibeto-Burman language family. Adi people celebrate different festivals which are essential parts of their socio-cultural life. Festivals reflect the traditions, costumes and life style of the people. The festivals are mainly celebrated for feasts, good harvest of crop, merriment and for narrating the myths, legends, folklores and mythologies.

The Adi people have the tradition of eating raw leaves, young inflorescences, tender stalks and other plant parts as vegetable in their diet since time immemorial. These plants are thought of having medicinal properties. Raw plant parts are used with their indigenous preparation along with meat and fish. This tradition of eating raw plant parts is handed down from generation to generation and believed that they get direct medicinal benefit by this way of eating. Besides the parts used in raw form of eating, other parts are also used in cooking. These plants are used as medicine in other forms such as juice, supernatant, after boiling, crushing, direct application, etc. Plants are used as medicine from time immemorial; as many as 1,200 plants are mentioned in ancient text.

The present survey was carried out at College of Horticulture and Forestry, Central Agricultural University, Pasighat, Arunachal Pradesh. The different species of plants were found to be used by the Adi people as vegetable (Table 1). Plants belonging to different families were used as raw or in cooked form. Solanaceae and rubiaceae is found to be most widely used family followed by asteraceae, piperaceae, zingiberaceae, actinidiaceae, apiaceae, lamiaceae, and caryophyllaceae. They used various parts of the plants such as leaves, young inflorescence, tender stalks, tuber, fruits and other plant parts in this mode of eating. The belief behind this mode of eating is that it is good for health and acts as a remedy for various ailments. This could be attributed due to the presence of phytochemical composition in these plants that enhance the power of immunity of human body. Raw plant foods are considered to be rich in nutrition composition and energy; and low in calories. These are further rich in various vitamins like, vitamin C, vitamin A, vitamin B, vitamin E, carotenoids, folate as well as various minerals like calcium, magnesium, selenium, phosphorus, zink, boron, fiber, etc.

Further proper documentation and domestication is needed to assess the scientific and medicinal properties of these plants. It may be hypothesized that the longevity
<table>
<thead>
<tr>
<th>Botanical name</th>
<th>Local name</th>
<th>Family</th>
<th>Habit</th>
<th>Parts used</th>
<th>Traditional Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diplazium esculentum</td>
<td>Takang</td>
<td>Athyriaceae</td>
<td>Herb</td>
<td>Tender leaves &amp; shoots</td>
<td>Boiled young shoots and leaves are taken with boiled rice as vegetable for lactative</td>
</tr>
<tr>
<td>Centella asiatica</td>
<td>Kipum</td>
<td>Apiaceae</td>
<td>Herb</td>
<td>Whole plant</td>
<td>Fresh whole plant extract is taken 2-3 times a day as stomachic</td>
</tr>
<tr>
<td>Begonia josephii</td>
<td>Sisi baying</td>
<td>Begoniaceae</td>
<td>Herb</td>
<td>Shoots &amp; leaves</td>
<td>Paste of shoots and leaves is given 2-3 times a day for antidysentric</td>
</tr>
<tr>
<td>Chenopodium album</td>
<td>Gilimili</td>
<td>Chenopodiaceae</td>
<td>Herb</td>
<td>Leaves &amp; young shoots</td>
<td>The leaves and young shoots may be eaten as a leafy vegetable, either steamed in its entirely, or cooked like spinach</td>
</tr>
<tr>
<td>Clerodendrum colebrokiamum</td>
<td>Ongin</td>
<td>Verbanaceae</td>
<td>Shrub</td>
<td>Leaves</td>
<td>Tender leaves are taken as vegetable to check blood pressure</td>
</tr>
<tr>
<td>Eryngium foetidum</td>
<td>Adiori</td>
<td>Apiaceae</td>
<td>Herb</td>
<td>Leaves</td>
<td>Leaves are taken as chutney (condiments) believed to be appetizer. Paste from stem and leaf is applied together on forehead as a remedy for headache</td>
</tr>
<tr>
<td>Houttuynia cordata</td>
<td>Roram</td>
<td>Saurururaceae</td>
<td>Herb</td>
<td>Shoots</td>
<td>Extract of tender shoot is given for stomach ache. Warmed leaves are packed in banana leaf for snuff or massage to get from sinusities</td>
</tr>
<tr>
<td>Mussaenda roxburghii</td>
<td>Akshap</td>
<td>Rubiaceae</td>
<td>Shrub</td>
<td>Leaves</td>
<td>Leaves are cooked and served as vegetable</td>
</tr>
<tr>
<td>Physalis minima</td>
<td>Bodopatti</td>
<td>Solanaceae</td>
<td>Herb</td>
<td>Fruit</td>
<td>Fruit extract is administrated for gastric problem</td>
</tr>
<tr>
<td>Portulaca oleracea</td>
<td>Guber oying</td>
<td>Portulaceae</td>
<td>Herb</td>
<td>Stem &amp; leaves</td>
<td>Stem and leaves are taken as vegetable with boiled rice for stomachic</td>
</tr>
<tr>
<td>Solanum nigrum</td>
<td>Kopir</td>
<td>Solanaceae</td>
<td>Herb</td>
<td>Stem, leaves &amp; berries</td>
<td>Stem and leaves are used for vegetable and considered digestive and liver tonic. Berries are eaten raw or cooked</td>
</tr>
<tr>
<td>Solanum torvum</td>
<td>Kopir</td>
<td>Solanaceae</td>
<td>Shrub</td>
<td>Fruit</td>
<td>Berry is taken as raw as well as in cooked form. Good for cough and tonsilitis.</td>
</tr>
<tr>
<td>Solanum spirale</td>
<td>Okobang</td>
<td>Solanaceae</td>
<td>Shrub</td>
<td>Leaves &amp; fruit</td>
<td>Tender leaves used for stomach disorder, warm decoction of fruits is used in stomach ache and also as vegetable, chutney and salad</td>
</tr>
<tr>
<td>Solanum xanthocarpum</td>
<td>kopir</td>
<td>Solanaceae</td>
<td>Shrub</td>
<td>Fruit</td>
<td>Expectorant, tooth-ache, cough, cold, respiratory problems</td>
</tr>
<tr>
<td>Spilanthus acmella</td>
<td>Marshang</td>
<td>Compositae</td>
<td>Herb</td>
<td>Leaves &amp; flowers</td>
<td>Flower are chewed to cure tooth-ache</td>
</tr>
<tr>
<td>Zanthoxylum armatum</td>
<td>Ombe</td>
<td>Rutaceae</td>
<td>Tree</td>
<td>Leaves &amp; fruits</td>
<td>Fruits are crushed, made into paste solution to prevent malaria</td>
</tr>
<tr>
<td>Zanthoxylum rhetsa</td>
<td>Onger</td>
<td>Rutaceae</td>
<td>Tree</td>
<td>Leaves</td>
<td>Tender leaves are used as vegetable. Infusion of seed mixed with Allium sativum and little salt is prescribed in case of stomach bloating and used as hair cleaning agent</td>
</tr>
<tr>
<td>Sida acuta</td>
<td>Holap</td>
<td>Malvaceae</td>
<td>Herb</td>
<td>Tender leaves</td>
<td>Tender leaves are cooked and eaten as vegetable</td>
</tr>
<tr>
<td>Pouzolzia viminea</td>
<td>Oyik (small leaf)</td>
<td>Urticaceae</td>
<td>Herb</td>
<td>Leaves</td>
<td>Is eaten as vegetable and it is considered by Adi tribe to increase lactation in women</td>
</tr>
<tr>
<td>Pouzolzia hirta</td>
<td>Oyik (big leaf)</td>
<td>Urticaceae</td>
<td>Herb</td>
<td>Leaves</td>
<td>Is eaten as vegetable and it is considered by Adi tribe to increase lactation in women</td>
</tr>
<tr>
<td>Oxalis corneculata</td>
<td>Phakep</td>
<td>Oxalidaceae</td>
<td>Herb</td>
<td>Whole plant</td>
<td>Whole plant is taken as vegetable, as anti dysentinic and to relieve intoxication from wine</td>
</tr>
<tr>
<td>Alocasia macorrhiza</td>
<td>Engee</td>
<td>Araceae</td>
<td>Shrub</td>
<td>Rhizome</td>
<td>Pain reliever from insect bite</td>
</tr>
<tr>
<td>Alpina malaccensis</td>
<td>Pupure</td>
<td>Zingiberae</td>
<td>Shrub</td>
<td>Rhizome</td>
<td>A piece of fresh rhizome is taken as anthelmentic</td>
</tr>
<tr>
<td>Calamus erectus</td>
<td>Tara</td>
<td>Arecaceae</td>
<td>Tree</td>
<td>Seed &amp; tender shoot</td>
<td>Fresh seed are taken for dyspepsia. Tender shoot are taken as vegetable and anthelmentic</td>
</tr>
<tr>
<td>Drymaria cordata</td>
<td>Tayitoar</td>
<td>Caryophyllaceae</td>
<td>Herb</td>
<td>Whole plant</td>
<td>Fresh whole plant mixed with Psidium guajava fruit is taken in gastritis</td>
</tr>
</tbody>
</table>
of life in rural and forest dwelling people are more as compared to the urban and city dwellers owing to the daily physical work combined with all these medicinal doses they faced everyday as vegetables. The daily intake of herbal medicine in the form of vegetables might be one of the important reasons for the life longevity and less occurrence of the developed world killer ailments like cancer, diabetes, heart diseases.

The traditional knowledge of eating raw plants by adi tribe of pasighat (East Siang) Arunachal Pradesh as medicinal/nutritional supplement in their diet is an age-old practice in this region of the state.

To conserve the above mentioned traditional knowledge, there is a need for scientific research and documentation in particular. Thus, collaborative research and integrated efforts are necessary to preserve the knowledge of indigenous people in traditional healthcare. Mass awareness programmes on usefulness of plants will be a basic tool for conservation and sustainable utilization of these natural resources. These efforts may help in upliftment of the rural economy as well as long-term biodiversity conservation and security of the traditional healthcare system.

SUMMARY

The present investigation revealed only a fraction of traditional knowledge of plants used by the Adis of pasighat East Siang. An elaborate and long term study is required for understanding and documentation of traditional knowledge possessed by the Adi community and its cultural connection. It is also important to conserve the language and the traditional lifestyle to foster the ethnic knowledge for the next generation.

For further interaction, please write to:
Md. Ramjan, College of Horticulture and Forestry, Central Agricultural University, Pasighat, Arunachal Pradesh 791 102, India.*Corresponding author e-mail: mohammadramjan165@gmail.com
**Prospects**

**Ziziphus jujube** Miller – A fast vanishing minor fruit plant of Kashmir, India

In the Indian union territory of Jammu and Kashmir, *Ziziphus jujube* is found growing at different places in Kashmir province with temperate climate mainly in wild form and at very few places is cultivated for fruits while *Ziziphus mauritiana* is cultivated in Jammu province with tropical or sub tropical climate. Of the two subspecies of *Ziziphus jujube* occurring in Kashmir, *Ziziphus jujuba* ssp. *spinosa* grows wild at many places with thorny, often shrubby plants bearing smaller fruits; the other one viz, *Ziziphus jujuba* ssp. *jujube* with thorn less trees bearing larger and tastier fruits is cultivated at few places. The fruits especially of later subspecies are consumed by locals and are of medicinal importance. During our recent exploration and germplasm collection programme, we have collected eight accessions of *Ziziphus jujuba* ssp. *spinosa* and only two of *Ziziphus jujuba* ssp. *jujube* from various parts of Kashmir. Variability in fruit size, shape, color and taste was recorded in these collections. A unique accession of *Ziziphus jujuba* ssp. *spinosa* has been collected from Ganderbal area having moderately thorny plants bearing bigger, brown, shining and tasty fruits almost equivalent to the fruits of *Ziziphus jujuba* ssp. *jujube*. Such accessions can be suggested to be possible progenitor of later subspecies. Earlier both these subspecies of *Ziziphus jujube* were more common in Kashmir and unfortunately are now fast vanishing from the region. Therefore, more concerted efforts should be made for their conservation both *ex situ* and *in situ* for our future generations. We firmly believe that under the prevailing uncertain climatic conditions, these wonderful and multipurpose minor fruit plants being highly drought tolerant and capable of growing on dry wastelands hold a great promise in the region.

*Ziziphus* Mill. is a very important genus of buckthorn family Rhamnaceae native to South Asia and comprising about 100 species of trees, shrubs, climbers, and a herb distributed mostly in the tropical and sub-tropical regions of the world, mainly Asia and America, although few of these extend in the Pacific Islands and Australia. Some of these occur in the temperate regions as well. About 17 species have been reported in India, 12 in China, 13 in Pakistan, 7 in Bhutan, 8 in Nepal and 6 in Bangladesh. *Ziziphus* trees and shrubs inhabit arid environments on every continent due to their versatility in being able to adapt to drought stress. The fleshy drupes of some species are rich in sugars and vitamins, and this fact has made *Ziziphus* species important fruit trees for many centuries. The highly nutritious fruits provide a valuable source of energy, vitamins and also income when sold in local markets. The leaves provide fodder for livestock; the hard wood is used for turning, making agricultural implements, fuel and high quality charcoal. More importantly, extract from fruits, seeds, leaves, roots and bark of this plant is used in many traditional medicines to alleviate the effects of insomnia, skin diseases, inflammatory conditions and fever. In many regions, *Ziziphus* is grown as a hedge; with its spines creating effective live-fencing besides their strong root system stabilizes the soil preventing soil erosion. Some species, like *Ziziphus mauritiana* and *Ziziphus jujuba* are found on nearly every continent, whereas other species are restricted in their distribution. These two are major domesticated *Ziziphus* species for fruit production. In India as well as in China, *Ziziphus* trees have a long tradition of selection and cultivation, as result a these two species occurring in these countries are better known and more widely researched than those in other regions. *Ziziphus mauritiana* is commonly cultivated in India, while *Ziziphus jujube* is predominantly cultivated in China.

*Ziziphus mauritiana* Lamk. (Ber, Indian Jujube, Chinese date, Indian cherry, Indian plum) is highly drought resistant plant, thus considered as an ideal fruit tree for arid and semi-arid regions in tropical and subtropical climates where most of the fruit crops cannot be grown either due to lack of irrigation facilities or adverse climatic and soil conditions. It is found growing wild as well as in cultivated forms throughout the warmer regions up to an altitude of 1500 m above mean sea level. In India, the major ber growing states are Rajasthan, Haryana, Uttar Pradesh, Gujarat, Madhya Pradesh, Bihar, Maharashtra, Andhra Pradesh and Tamil Nadu. Its plants are large shrubs or trees, may be evergreen and up to 15 meter tall. Drupe fruits are eaten fresh and also processed to prepare delicious murraba and candies. Fruits can also be used for preparation of jam and wine. These contain high amount of vitamin C (85 - 95 mg per 100 g), more vitamin C has been found in the fruit flesh near the seed rather than near the skin of the fruit. Drupes are 1.0 - 1.2 × 1.0 cm. in size, globose, oblong or ovoid, orange yellow, turning deep red, pulpy, with persistent tube at base; stones irregularly furrowed with a hard, thick, boney shell enclosing 1 - 2 red-brown shiny seeds 6 - 7 × 5 - 6 mm. in size. Fruits are produced from September to January.

*Ziziphus jujuba* Mill. (Jujube, Chinese ber, Red date and Chinese date) is small deciduous tree, rarely shrub up to 10 m tall, spinose or unarmred. Drupe red at maturity, turning red-purple, oblong or narrowly ovoid, 2.0 - 3.5 cm. in size, globose, turning deep red, with persistent tube at base, stones irregularly furrowed with a hard, thick, boney shell enclosing 1 - 2 red-brown shiny seeds 6 - 7 × 5 - 6 mm. in size. Fruits are produced from September to January.
Fruiting shrub (a), heavy bearing late maturing plant with bigger green fruits (b) and a small tree of *Ziziphus jujube* subsp. *spinosa* (c), a huge tree (d), fruiting branch (e) of *Ziziphus jujube* subsp. *jujube*, and local community initiative for protection of trees in Shopian area (f).

cm. long, 1.5 - 2 cm in diameter; mesocarp fleshy, thick, sweet or sour-tasting; stone acute or obtuse at both ends, 2-loculed, 1 - 2-seeded; fruiting pedicel 2 - 5 mm or longer. Seeds compressed to orbicular, 1 × 0.8 cm in size. Flowering from May to July and fruiting from August to October. Three accessions of Chinese ber namely Ta-Yan-Jhao (EC27715-A), Ta-Yan-Tsou (EC36768) and Moneyung (EC280769) were introduced from Russia and Korea, they are established in the field gene bank of ICAR-NBPGR Regional Station, Shimla and have been distributed to several places in north eastern India. The plants are thorn less bushy, spreading, or upright, 5-10 m tall. Leaf shape is ovate, broad elliptic and elliptic with serrate margin. Chinese ber requires a small amount of chilling during winter to set the fruits however, it can withstand wide range of temperature (below freezing to 34°C). Fruits are borne solitary or in clusters, with smooth surface, obtuse fruit apex and base. Pulp color greenish-white, less sweet in taste with moderate pulp aroma. Fruit length varies from 1.8 - 4.3 cm and diameter 1.2 - 3.3 cm. Stone shape oval to spindle. Average fruit varies 8 - 18 g in weight with 16 - 21% total soluble solids and pulp to stone ratio varying from 1.2 - 1.9.

In the Indian Union Territory of Jammu and Kashmir, *Ziziphus mauritiana* has been reported to be grown on 790 thousand hectares with a production of 13.20 thousand metric tonnes in Jammu province with tropical to subtropical climate while in temperate Kashmir province, *Ziziphus jujube* is the species found growing at different places mainly in wild form and at very few places it is being cultivated rather maintained for fruits. While revising genus *Ziziphus* in the Kashmir Himalaya have collected many plant specimens growing in the wild which were identified as *Ziziphus jujuba* Mill. subsp. *spinosa* (Bunge) Peng, Li & Li, a new addition to the flora of the Indian subcontinent from the Kashmir Himalayas. This wild subspecies of *Ziziphus jujube* was earlier known as *Ziziphus acidojujuba* Cheng & Liu and is widely distributed and considered an important honey plant in North China for its fragrant flowers rich in nectar. In Kashmir, *Ziziphus jujuba* ssp. *spinosa* occurs as thorny shrub often bearing less tasty smaller fruits which upon maturity form a cavum, completely hollow mesocarp. Another subspecies found growing in Kashmir is *Ziziphus jujuba* ssp. *jujube* which is cultivated for its bigger and tastier fruits and is characterized by taller thorn less trees not forming a cavum upon drying. This species could have been introduced in Kashmir through the famous Silk Route.

Characteristics and germplasm collection

*Ziziphus jujuba* ssp. *spinosa* occurs wild in Kashmir and locally called as ‘Bar-e-Kund’ grows on dry areas like *Karewa* lands, slopes near foot hills, fencing of orchards at some places at an altitude of 1600 - 2300 m. We have observed small populations of this plant growing in Trai area of Pulwama district and at various places in Ganderbal district during our recent exploration and germplasm collection programme of wild fruits from various areas of Kashmir. It is a thorny deciduous shrub 1 - 3 m tall mostly with spreading habit. However, at few places we have seen small upright trees of this species with solid branched trunk more than 5 m in height. We have also observed some plants moderately and some heavily armed with spines but we have not been so far able to
locate spineless plants of this species. The fruits mature from September to October. During our exploration programme we have collected eight diverse accessions of this species varying in fruit shape, size, color and taste from an altitudinal range of 1671 - 1779 m. Fruits shape may be globose, oblong or ellipsoid. Color varies from light brown, dark brown to tan. We have recorded fruit length of 0.9 - 2.1 cm, breadth of 0.8 - 1.9 cm, fruit weight of 0.775 - 4.057 g and stone weight of 0.071 - 0.408 g in this species. Stone globose to ellipsoid, obtuse or sometimes acute as well, superficially tuberculate, often with two locules each with single smooth surfaced, brown, compressed, orbicular seed. One heavy bearing late maturing bush type accession with fruit size of 1.8 x 1.6 cm, fruit weight of 2.923 g and stone weight of 0.343 g has been collected from Tral area. However, fruits of this accession form a cavum upon maturity and drying; besides its fresh fruits are almost tasteless. On the other hand one unique accession with shrubby plants has been collected from Lar Ganderbal area with fruit size of 2.1 x 1.9 cm, fruit weight of 4.057 g and stone weight of 0.371 g. The accession is unique in being moderately thorny, bearing very tasty, brown shining crispy fruits with thin epicarp, and comparatively thicker mesocarp, besides not forming cavum upon maturity. These characteristics bring it closer to Ziziphus jujuba ssp. jujube and thus can be suggested to be its possible progenitor. This accession has a potential to be exploited as a minor fruit crop in the region. Ziziphus jujuba ssp. jujube is now rare in Kashmir and we have collected its two accessions only, one from Pampore area at an elevation of 1630 m and another from Shopian area at an elevation of 1930 m. Three very huge plants believed to be around a century old were observed in Pampore area with fruits maturing in the month of September while in Raqshama village of Shopian almost a dozen comparatively smaller trees were found to be growing. The fruits here mature late in October. Mature fresh fruits of Ziziphus jujuba ssp. jujube are brownish, tasty, and narrowly ovoid, on an average 2.7 in length, 2.4 in breadth, fruit weight 6.473 g and stone weight of 0.238 g, stone acute at both ends, 2-loculed, 1or 2-seeded, seeds orbicular and compressed.

**Utilization**

The fruits are eaten fresh or in dried form. Various functional compounds such as vitamin C, amino acids, triterpene acids, polysaccharides, and polyphenols have been reported in the Ziziphus. In Unani system of medicine, it is known as ‘Unnab’ and its sherbet is believed to have a sort of ‘cooling effect’ on the body. Traditionally, species belonging to the genus Ziziphus have been largely used as medicine to treat many diseases and body disorders, such as chest and respiratory problems, scabies, pimples and the inflammation of mouth and gums. It is reported to be a good blood purifier and stomachic. The fruits are useful in the treatment of asthma, bronchitis, diabetes, eye diseases, inflammatory skin conditions, liver disorders, ulcers and wounds. In Uri areas of Kashmir, Ziziphus jujuba ssp. jujube is locally called as ‘Singli’ and
a decoction prepared by grinding its seeds in salty water is taken orally two spoons thrice a day for two months as a cure for jaundice. In Kashmir, the leaves especially of Ziziphus jujuba ssp. jujube are added to boiling water used for taking bath to cure various skin ailments. The foliage is used as fodder for livestock at many places.

Need for conservation

Four or five decades back Ziziphus jujuba ssp. jujube was more commonly grown in Kashmir and its trees were seen in countless number of villages and people fondly consumed its fruits especially for medicinal purposes. However, unfortunately over these years this potential minor fruit has fast vanished and now-a-days is growing at very limited places across Kashmir. Even Ziziphus jujuba ssp. spinosa growing wild at various places throughout Kashmir is greatly threatened due to merciless cutting and habitat loss. Therefore, efforts should be made for their conservation both ex situ and in situ. During the exploration programme, the authors while interacting with local people at village Raqhama of Shopian, lauded their efforts in protecting about a dozen Ziziphus jujuba ssp. jujube trees by wire fencings as a local community initiative. Root suckers of these protected plants are being carefully maintained and groomed for propagation purpose. The village community is eager to distribute these juvenile plants among interested people for revival of this valuable plant genetic resource. The village is interestingly and correctly known as ‘Bre Baag’ meaning a ‘Ber Orchard’. As mentioned earlier we have collected a total of 10 accessions of both these subspecies for conservation. The authors firmly believe that under the prevailing uncertain climatic conditions, Ziziphus jujuba holds a great promise as a multipurpose minor fruit crop in the region being highly drought tolerant and capable of growing on dry wastelands. Therefore, more concerted efforts should be made for their conservation both ex situ and in situ for our future generations.

For further interaction, please write to: Sheikh M Sultan, ICAR-NBPGR, Regional Station, Srinagar, Jammu and Kashmir 191 132. *Corresponding author e-mail: mohmmad.sheikh@icar.gov.in

---

**HANDBOOK OF AGRICULTURAL ENGINEERING**

Agricultural Engineering interventions have led to significant improvement in agricultural productivity by timeliness of operations, reduction in drudgery, prevention of post-harvest losses and achieving higher cultivation intensity. Timely farm operations with efficient use of inputs, post-harvest processing and value addition to agricultural produce and conservation and sustainable use of natural resources are essential for ensuring higher returns to the cultivators. This is the maiden attempt of the Indian Council of Agricultural Research to publish the *Handbook of Agricultural Engineering*. The handbook comprises 50 chapters under four sections, namely Farm Machinery and Power, Soil and Water Engineering, Energy in Agriculture and Agro-Process Engineering. This publication would be useful to farmers, students, researchers, extension workers, policy makers, entrepreneurs and other stakeholders.

**TECHNICAL SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Size</th>
<th>Royal Octavo (16 cm x 24 cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of pages</td>
<td>i-viii + 808</td>
</tr>
<tr>
<td>Price</td>
<td>₹ 1500</td>
</tr>
<tr>
<td>Postage</td>
<td>₹ 100</td>
</tr>
</tbody>
</table>

For obtaining copies, please contact:

**Business Manager**

Directorate of Knowledge Management in Agriculture
Krishi Anusandhan Bhavan I, Pusa, New Delhi 110012
Telefax: 011-2584 3657; E-mail: bmicar@gmail.com
Microgreens: An ultimate superfood

Microgreens are new generation smart food products whose popularity is increasing with time. Microgreens are tiny edible greens obtained from different kinds of vegetables, herbs, and plants. Microgreens are popularizing as new culinary ingredients. Microgreens have a higher content of vitamins, minerals, and many bioactive compounds and more nutritious than their mature plant parts. Microgreens do not require specific nutrients for growth and can be grown throughout the year.

Prospects

The lifestyle changes associated with the improved standard of living in terms of social, economic, and cultural standards have led to the major lifestyle associated problems including diseases and nutritional deficiencies. The non-availability of fresh and pesticide residue-free vegetables for consumption is a big problem in the future. The urban populations are mainly dependent on long food chains that begin in distant rural areas limits the availability of produce that has short shelf-life and poor shipping ability. As a result of that, many urban populations reside in areas classified as ‘food deserts’, where people do not have ready access to fresh agricultural products like fruits and vegetables and also lacking complete package of essential nutrients and depend mainly on processed and packaged foods. Increased health consciousness associated with lifestyle changes has created a vast demand for functional food globally. Microgreens are considered ‘practical nourishments’ which are food items that have explicit wellbeing advancing and infection forestalling properties, that are extra to their typical healthy benefits. These are additionally named a decent wellspring of minerals in the human eating regimen. Microgreens are an arising class that can tackle practically all the medical conditions identified with wholesome lack. The culinary value of microgreens rose high in the past decades owing to its high nutrient content, versatility, flavor profile, and crisp texture imparted to the dish.

What are microgreens?

Microgreens are young and tiny seedlings of vegetables and herbs, harvested when cotyledons (seed leaves) are fully expanded and the first pair of true leaves are emerging or partially expanded. The size of these microgreens is ranges from 1-3 inches (2.5−7.6 cm) in height which usually occurs within 7–14 days after germination, which varies from crop to crop and variety to variety and other environmental conditions. It has three basic parts; a central stem, two cotyledon leaves, and typically the first pair of very young true leaves.

The commonly cultivated microgreens are spinach, mustard, buckwheat, arugula, bull's blood beet, celery, cilantro, amaranth, golden pea, basil, spinach, mizuna, pepper cress, popcorn shoots, red mustard, red beet, red cabbage, red orach, sorrel, red sorrel, wasabi, cabbage, broccoli, radish, lettuce, kale, rapini, etc. Microgreens are cut along with the stem and attached cotyledons/seed leaves with the help of scissors. If left for a longer time, they will begin to rapidly elongate and lose color and flavor.

It is different from sprouts in the sense that sprouts are the germinated seeds that are consumed with the embryonic root and the seeds. Microgreens are different from baby greens in their size and much smaller than baby greens. Their status remains in between sprouting and baby greens. It is also known as vegetable confetti.

Nutritional composition

Microgreens are richer sources of several micronutrients particularly vitamins and minerals. Microgreens are higher in nutritional content than their mature parts. The composition of vitamin A, C, E, K, enzymes, and carotenoid differs according to types of microgreens, growing medium, amount of sunlight and temperature, and the time of harvesting. Bright colored microgreens are found to be more nourishing than light ones. Microgreens have a higher content of α-carotene,
β-carotene, violaxanthin, lutein, and neoxanthin in comparison to sprouts. They have more protein, iron, and Zn content than sprouts. It is interesting to know that antinutritional factors like nitrate ($\text{NO}_{3}^{-}$) and nitrite ($\text{NO}_{2}^{-}$) content are also very low in microgreens.

Growing microgreens: Indoors vs outdoors

The absolute first choice a microgreens farmer should make is to decide, regardless of whether to develop their harvest inside or outside. As indicated by my developing experiences with microgreens, an indoor arrangement is a superior alternative since it permits more prominent command over the developing climate. Microgreens are most flourishing in the same temperature range, so a farmer can use any spare room in their home or garage and by creating a perfect and controlled environment, they can grow their greens very easily. Outdoor setups have their own pros and cons. One advantage of growing microgreens outdoors is that it does not need any artificial light source, but outdoor farming requires the appropriate environmental conditions. There are many drawbacks to growing microgreens outdoors. Apart from this time frame, it is not possible to grow microgreens without supplemental heat due to the threat of extreme temperature fluctuations and frost. A greenhouse can be a better option for the outdoor cultivation of microgreens, but it can be very expensive for a farmer.

How to grow microgreens?

Microgreens can be grown in different mediums like soil, tissue paper, hydroponics, etc. But generally, a mixture of Coco-peat, vermiculite, and perlite can be used for growing microgreens in a 5:2:1 ratio respectively. The release of macro-and micronutrients present in this medium is very slow; hence, a farmer can reuse the same media several times for the growth of their young greens. Microgreens seeds generally do not require extra nutrition for germination but require only ideal conditions (environmental and proper water moisture conditions for imbibition) for germination up to the microgreen stage which makes the production of microgreens easy and cost-effective. Treatment of seeds by various chemicals is also not suitable for farming of microgreens and the use of hybrid seeds may not be economical for you.

Sowing time

Seeds can be sown around the year as per the consumer’s requirement. During the reuse of previous sowing media, roots and other remaining parts of preceding crops should be completely removed from the trays/container. Dry the media properly by exposing it to sunlight and then fill the trays/container. Any living place like rooms or any type of mini-greenhouse can be used to keep your greens to maintain optimum temperature, humidity, and light intensity. Microgreens grown in an environment with high light conditions, low humidity and good air circulation will result in a better harvest.

Growing microgreens: Indoors vs outdoors

The absolute first choice a microgreens farmer should make is to decide, regardless of whether to develop their harvest inside or outside. As indicated by my developing experiences with microgreens, an indoor arrangement is a superior alternative since it permits more prominent command over the developing climate. Microgreens are most flourishing in the same temperature range, so a farmer can use any spare room in their home or garage and by creating a perfect and controlled environment, they can grow their greens very easily. Outdoor setups have their own pros and cons. One advantage of growing microgreens outdoors is that it does not need any artificial light source, but outdoor farming requires the appropriate environmental conditions. There are many drawbacks to growing microgreens outdoors. Apart from this time frame, it is not possible to grow microgreens without supplemental heat due to the threat of extreme temperature fluctuations and frost. A greenhouse can be a better option for the outdoor cultivation of microgreens, but it can be very expensive for a farmer.

How to grow microgreens?

Microgreens can be grown in different mediums like soil, tissue paper, hydroponics, etc. But generally, a mixture of Coco-peat, vermiculite, and perlite can be used for growing microgreens in a 5:2:1 ratio respectively. The release of macro-and micronutrients present in this medium is very slow; hence, a farmer can reuse the same media several times for the growth of their young greens. Microgreens seeds generally do not require extra nutrition for germination but require only ideal conditions (environmental and proper water moisture conditions for imbibition) for germination up to the microgreen stage which makes the production of microgreens easy and cost-effective. Treatment of seeds by various chemicals is also not suitable for farming of microgreens and the use of hybrid seeds may not be economical for you.

Benefits of growing microgreens as a business

The benefits of integrating leafy greens and microgreens into their diet are gradually being understood by people worldwide, ensuring that demand continues to grow. And we are also seeing more and more problems and crop failure of vegetables grown outdoors, so there is an indoor future for agriculture.

Low start-up costs - Farmers may start their business with very low investment by simply supplying one restaurant with their greens or producing enough microgreens to sell at a farmer’s market once a week and rising production according to customer demand.

Quick turnaround time - Microgreens from seed to harvest take around 7-14 days. A farmer doesn’t have to wait for a whole season or more to harvest.

Year-round growing - Microgreens can be grown round the year and a farmer can use microgreens to earn extra money and diversify their business for more profit.

Higher nutrition - Microgreens are ‘functional foods’. They are a complete pack of different vitamins and nutrients.
**High-value crop** - A farmer can sell their microgreens to top restaurants and food stores to get higher prices and as a local producer they can also charge a premium for their microgreens.

**SUMMARY**

Microgreens are the immature form of green leafy vegetables and can be harvested within 7-14 days including stem and leaves. They have an appealing appearance, soft texture, and powerful flavor, and supply a full pack of essential nutrients. Microgreens are usually more nutrient-rich than their mature counterparts. Concerning flavor acceptability, microgreens also have strong market acceptability. By exposing them to low temperatures with modified atmospheric packaging, consistency and quality can be preserved.

---

For further interaction, please write to: **Kalpana Yadav**, Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana. *Corresponding author e-mail: yadavkp37@gmail.com*
Pea (Pisum sativum) is a rich source of digestible proteins, vitamins and minerals like iron, magnesium, phosphorus and zinc. Its green beans are very common in Indian cuisine. Pea has a global value as food source for millions of people and is extensively cultivated as pulse and vegetable crop. Being leguminous crop, it fixes the atmospheric nitrogen through a symbiotic relation with root nodule bacteria. In India, during 2019-2020, garden pea is grown over an area of 5,63,000 ha with the annual production of 57,03,000 metric tonnes. However, in Punjab, pea is cultivated in about 43,860 ha area with the production of 4,60,450 tonnes mainly in Amritsar, Hoshiarpur and Nawanshahr districts. Besides Punjab, Karnataka, Madhya Pradesh, Rajasthan, West Bengal, Haryana, Himachal Pradesh and Bihar are major pea growing states. We can also preserve the green pods/tender seeds for a long time by drying, canning or freezing in order to fetch higher prices during the offseason. Pea is easy to grow, but have a very limited growing season. Therefore, its cultivation as per recommendation of Punjab Agricultural University is of utmost importance.

Pea, being a cool season crop, requires frost-free weather especially at flowering and pod formation stage though vegetative growth is not affected by the frost. The optimum temperature for its germination is about 20-25°C. Though, its seeds can germinate at 4-5°C but under severe frost condition, its flowers and young pods may be damaged. High temperature reduces the pod quality as sugars in the seeds changes to hemicellulose and starch. A temperature above 27°C shortens its growing period but adversely affects pollination process.

Sowing time and seed rate play crucial role not only in crop production but also in escape of several insect-pests and diseases. Likewise, a healthy pea crop can be possible only if sown between mid-October to mid-November (for rabi season crop). Avoid early sowing of crop in September to get rid of pea wilt to some extent. The optimum seed rate is 45 kg/acre for early maturing varieties, while 30 kg/acre for main season varieties. The sowing should be done in line, with the spacing of 30 cm × 7.5 cm and 30 cm × 10 cm (row × plant) for early and main season varieties, respectively. Farmers may also make use of seed-cum-fertilizer pea drill having a sowing capacity of one acre in an hour. Seed treatment prior to sowing with Rhizobium leguminosarum culture is the simplest way to increase pea production and quality as it helps in quick nodulation on the roots which in turn fix atmospheric nitrogen. Farmers can get this culture from the Department of Microbiology, Punjab Agricultural University, Ludhiana. Culture should be mixed thoroughly in half litre of water and the suspension is rubbed gently on all the four sides of the seeds. Let the treated seed shade dry well before sowing. One packet of culture is sufficient for one acre seed.

Nutrients application, irrigation and their timing are the major prerequisite for growing healthy crop. Go for refined annual soil testing to know the nutrient status of the field and based on soil test report follow proper manuring and fertilization of the crop. Farmyard manure @ 8 tonnes should be properly incorporated at the time of land preparation. Generally, pea crop has low nitrogen
Plant protection

Major insects infesting pea crop and their management

<table>
<thead>
<tr>
<th>Insect</th>
<th>Symptoms</th>
<th>Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaf miner (Chromatomyia horticola)</td>
<td>The greenish larvae make serpentine tunnel in the leaves and feed on it. The infested leaves wither and dry. Flowering and pod formation are drastically affected.</td>
<td></td>
</tr>
<tr>
<td>Pea thrip (Thrips indicus)</td>
<td>Nymphs and adults of thrip cause severe damage to the young crop by sucking the cell sap from leaves and flowers.</td>
<td></td>
</tr>
</tbody>
</table>
| Pea-stem fly (Ophiomyia phaseoli) | The maggots of fly bore inside the stem leading to withering and ultimate drying of the affected shoots. The adults also cause damage by puncturing the leaves, and the injured parts turn yellow. The damage is more severe on seedlings than on the grown up plants | a) At the time of sowing, apply 10 kg Furadan 3G (carbofuran) granules per acre.  
b) Sow the crop in the second fortnight of October to escape the damage of this pest. |

Major disease of pea and their management

<table>
<thead>
<tr>
<th>Disease</th>
<th>Symptoms</th>
<th>Management</th>
</tr>
</thead>
</table>
| Powdery mildew (Erysiphe pisi)      | First symptoms appear on the upper surface of the leaves as very small and discoloured spots which soon give rise to enlarge white powdery areas on leaves, stem and pod. Multiple infections may cover the whole plant. | Sulfex @ 600 g in 200 litres of water per acre should be sprayed on the appearance of symptoms.  
2 - 3 sprays may be given at 10 days interval. |
| Wilt, root rot and collar rot (Fusarium oxysporum and Rhizoctonia solani) | Wilt attacks young plants. The affected plants show yellow-orange internal discolouration in the lower internodes. Diseased plants appear unthrifty, variously dwarfed depending upon the severity of infection, and may wilt and die. | Seed treatment with Talc based formulation of Pseudomonas fluorescens @ 15 g per kg seed before sowing is effective.  
Avoid early sowing in infested areas. |
| Rust (Uromyces vicieae fabae)        | During December-January, yellow and reddish brown coloured raised pustules appeared on the ventral leaf surface. Rust is more serious in the late sown crop. | Remove and destroy weed host plants of this disease (especially Rewari).  
For controlling powdery mildew and rust together, Sulfex @ 200 g can be sprayed in combination with Indofil M-45 @ 400 g per acre. |
| White rot (Sclerotinia sclerotiorum) | Irregular water soaked spots on leaves, stem and pods appear. Symptoms are more frequent on pods which turn papery brown in colour in the later stage. White mycelial growth appears on the infected portion under wet and cool weather. Black hard sclerotal bodies embedded in mycelium are formed within the pods. The disease is high at flowering and pod formation stage. | Avoid pea crop sowing in fields where susceptible crops like brinjal, cauliflower, carrot are sown.  
Go for crop rotation with non-host crops like tomato and chilli. This will help in reducing the disease spread. All left over crop debris should be collected and burnt. |

requirement. Therefore, full dose of nitrogen 20 kg (45 kg urea), phosphorus 25 kg (155 kg superphosphate) per acre should be applied before sowing. A pre-sowing irrigation is essential for proper seed germination. For the production of peas, first irrigation should be done after 15 days of sowing. Irrigations at flowering and pod formation stage are necessary. This crop can also be grown under rainfed conditions provided with sufficient moisture at the time of sowing. A total of 3-4 irrigations are required depending upon soil type and weather conditions. Two hoeings are necessary after 4th and 8th week of germination to keep the field free from weeds. Hoeing helps in weed removal and pulverizes the soil for proper aeration. However, it is difficult to control the weeds manually, if the crop is sown in rows in closed spacing.

Well developed and green pods (with tender seeds) should be harvested always. Number of pickings depends upon the maturity group of peas. Picking should be done either early in the morning or late in the afternoon. Picking during mid day deteriorates the quality of pea pod due to heat stress.

**Improved varieties**

Varieties on the basis of period of maturity:

**Early maturing varieties:** AP-3, Matar Ageta-7, Matar Ageta-6 and Arkel.

**Main season varieties:** Punjab-89 and Mithi Phali

**Important precautions**

a) Avoid spraying the crop with hazardous insecticides/ fungicides at least 20 days before the picking of pods.

b) Avoid direct contact with chemicals while treating the seeds with insecticide/ fungicide.

c) Always use rubber gloves for application of granules/ insecticides.

d) Keep the insecticides / fungicides in a store far from living area.

For further interaction, please write to:

Arti Verma, PAU, Krishi Vigyan Kendra, Langrova, Punjab 144 516. *Corresponding author e-mail: artiverma@pau.edu*
Livelihood security of small and marginal farmers through Ocimum cultivation

In view of achieving the target of doubling farmers income by March 2022, there is a need to identify crops and varieties that may suit resource poor farmers. Introduction, adaption and acceptance of new crops, varieties and latest technical knowhow for crop production can potentially strengthen farmers’ cropping systems by increasing yields, improving drought resilience and also by capturing new market opportunities. In this context, ocimum cultivation may be adopted by small and marginal farmers of India. It is a miracle plant which is valued for its medicinal properties. It has been harvested for use in Ayurveda treatments for 5,000 years and is known as the ‘Queen of Herbs’. Essential oil of ocimum is widely used in perfumery, cosmetics, pharmaceuticals and confectionary industries. Farmers may adopt ocimum cultivation in rainfed areas in Kharif season as it requires lower input and gives better returns, thus it has the potential of enhancing farmers income.

The aromatic plants belonging to genus Ocimum is popularly known by the name Basil. Basil was derived from greek word ‘Basilica’ which means royal plant. Basil is an excellent shrub and known as the ‘queen of herbs’. It belongs to the family of ‘Lamiacea’. In India, Basil is cultivated over an area of 25,000 ha and it accounts for annual production of about 250-300 tonnes of oil. The annual export of dry leaves herb, its products, essential oil, and its derivatives/chemical constituents of Ocimum are worth 5,000 tonnes.

Tulsi leaves contain a bright yellow volatile oil which is useful against insects and bacterial. The principle constituents of this oil are eugenol, eugenol methyl ether and carvacrol. The oil is reported to possess anti-bacterial and antiviral properties. Drugs obtained from tulsi are used to cure fever, decreases inflammation and increases stamina. It is used in treating coughs, bronchitis, skin diseases, and diarrhea. These preparations are considered to be prophylactic against epidemics including cholera, influenza and malaria. The tulsi seeds, taken mixed in water, juice or cow’s milk, are antioxidant, nourishing, mucilaginous and demulcent. They are used in treating low energy, ulcers, vomiting and diarrhea or as an overall tonic. The herb improves resistance to stress and has

Field view of Ocimum crop at maturity stage
a normalizing influence on blood pressure and blood sugar imbalances. The plant is also richly endowed with bioavailable antioxidants, vitamins A and C and calcium. It has marked insecticidal activity against mosquitoes. The oil is used as antiperspirant and as fly and mosquito repellent. CSIR-CIMAP is actively involved in both genetic enhancement of the Ocimum species as well as developing various cultivation practices for increasing yield of herb and oil yield. Commercial farming of genus Ocimum can be grouped in cultivation of these two species.

**Indian basil (Ocimum basilicum)**

Indian basil (*Ocimum basilicum*) is a short-duration crop and is cultivated in India for its essential oil used extensively in flavour, fragrance, food, oral health, etc. The crop thrives well on moderate fertile and well-drained sandy loam oil. It can be grown in subtropical and tropical climate conditions. Temperate climate is not suitable for this crop. CSIR-CIMAP has developed high-yielding varieties with chemical variability, namely, CIM-Saumya, CIM-Snigdha and CIM-Surabhi. The crop is propagated by seeds/seedlings during months of June and July, and it can yield about 80 kg oil giving a net profit of ₹ 35,000–40,000 per ha in about 3 months.

**Varieties**

*CIM-Saumya*: The variety is a short-duration crop of 3 months and has the potential to produce about 80–100 kg/ha oil rich in methyl chavicol (62%) and linalool (25%).

*CIM-Snigdha*: This variety developed by CSIR-CIMAP is distinct in leaf morphology and has unique aroma. The variety matures in 80–90 days yielding essential oil rich in methyl cinnamate content (78.7%).

*CIM-Surabhi*: The essential oil of sweet basil with linalool, linalool acetate in desired combinations is used in various cosmetic and perfumery products. This high oil-yielding variety (100–120 kg/ha) is developed with a unique chemical composition having 70–75% linalool with 99% purity. The linalool obtained from this variety is superior to that obtained from lavender and will be a cheaper source of linalool for the industry.

**Holy Tulsi (Ocimum sanctum)**

Tulsi is well known for its traditional medicinal values due to its antioxidant and anti-ageing properties. The decoction of leaves is effective for relief from seasonal cold and cough and stomach disorders. The crop is cultivated by a large number of farmers which can give a net profit of about ₹ 70–80,000 per ha.

*CIM-Ayu*: The variety CIM-Ayu developed by CSIR-CIMAP has the potential to produce 16 q dry leaf yield or 110 kg/ha oil rich in eugenol (83%) even in rainy season. The variety is being cultivated as annual crop in around 4000 ha in Mathura, Uttar Pradesh, Gujarat, Karnataka and Maharashtra states of India for its leaf oil and dry leaves for use in herbal tea.

*CIM-Anga*: The plant morphology is distinct by having greyish purple stem with green leaves, which turn purplish in winter season. The variety is producing dry leaf herb yield (14 q/ha) or 90 kg/ha essential oil yield containing eugenol (40%) and germacrene-D (16%).

**Improved agronomic practices for basil cultivation**

**Soil**

Ocimum cultivation is avoided in highly saline, alkaline or water logged conditions as these are not good for its yield. It gives best result when grown under well drained soil with good organic matter. Well drained soil ranging from pH 5.5-7 suits best for its growth.

**Seed and sowing**

About 500 g seeds are enough to raise the seedlings for transplanting in one hectare of land. Seed beds of 4.5 × 1.0 × 0.2 m size are prepared. Before sowing, to protect crop from soil borne disease and pests, seeds are treated...
with Mancozeb @ 5 gm/kg of seeds. The seeds are very small and hence it should be mixed with sand and sown to a depth of 2 cm. After sowing, the seeds in the nursery, a mixture of farm yard manure and soil should be spread in a thin layer over the seeds and irrigate with a sprinkler hose. The seeds germinate in 8-12 days and the seedlings are ready for transplanting in about 25-30 days time. A spray of 2% urea solution on the nursery plants at 15 to 20 days before transplanting helps in getting healthy seedlings for transplanting.

Transplanting

Seedlings of six weeks old and having 4-5 leaves are transplanted in July at a spacing of 45 × 30 cm to get high herbage and oil yield. Water seedling beds 24 hours before transplanting so that seedlings can be easily uprooted and remain turgid at transplanting time. The plots are irrigated immediately after transplanting. The seedlings will establish well by the time of second irrigation. At this stage, gap filling and replacement of the poor plants are also done so that uniform plant stand is achieved.

Crop nutrition

As Tulsi is grown for its herbage, it is necessary to frequently replenish the soil. Farm yard manure / compost are to be applied at 10-15 t/ha before planting. Ensure that FYM / compost is well decomposed before use. The optimum fertilizer dose recommended for this crop is 80 kg N, 40 kg of P₂O₅, and 40 kg K₂O per hectare. One third dose of N and the entire dose of P₂O₅ and K₂O should be given as a basal dose, whereas, the remaining N is applied in two split doses after first and second cuttings. Application of 1-1.5 kg farm yard manure/m² in nursery is recommended for obtaining healthy seedling.

Irrigation

In summer, apply 3 irrigation per month and in rainy season, no irrigation is required. About 12-15 irrigations should be given in one year. First irrigation should be given after transplanting and then second irrigation is given during seedling establishment. Apply mulch to conserve soil moisture. However, before harvesting, irrigation should be discontinued.

Intercultural operation

Weeds have to be managed before they start competing with the main crop for nutrients and light. First weeding is done one month after planting and the second 4 weeks later. One hoeing and earthing up operation is required at two months after planting. Use mulch to maintain soil moisture and to inhibit growth of weeds. Do not use chemical herbicides to eradicate weeds and do not keep weeds till flowering as this will increase weed pressure in coming years.

Harvesting

Harvesting is usually done in bright sunny days for good oil yield and quality. The crop is harvested at 90-95 days after planting in a stage when the plant is in full bloom and the lower leaves start turning yellowish. The whole plant is harvested after leaving about 15 cm from the ground level for regeneration of the crop. The harvested produce will be allowed to wilt in the field for 4-5 hours so as to reduce the moisture and also the bulkiness.

Post-harvest processing

Post-harvest processing is usually the most critical stage in determining the end quality of the aromatic plant material. After harvesting, drying of leaves is done. Then steam distillation is done to obtain Basil oil. The oil should be stored in sealed amber coloured glass bottles, containers made of stainless steel, galvanised tanks, aluminium containers in a cool and dry place. For transportation, it is packed in airtight bags. Leaves should be stored in dry places. From herb, several products like Panch Tulsi oil, Tulsi Ginger, Tulsi Powder, Tulsi Tea and Tulsi Capsules are made after processing. Extraction of oil through steam distillation is better than hydro-distillation as it takes less time and improves the oil recovery.

Expected returns

An average yield of 20 tonnes of green herbage and 100-120 kg/ha from whole herb will be obtained. Tulsi farming involves an average cost of cultivation ₹ 45,000/ha and gross returns of ₹ 1,00,000/ha after selling the herb, thus leading to a net return of ₹ 55,000/ha.
Carambola

Carambola (star fruit; *Averrhoa carambola* L.) belongs to family oxalidaceae. It is believed to have originated in Ceylon and the Moluccas but it has been cultivated in southeast Asia for many centuries. The carambola tree is slow growing, short-trunked with a much-branched, bushy, rounded crown which may reach 6-9 m height. The leaves are compound and spirally arranged. The flowers are borne in small clusters and are red-stalked, lilac, purple streaked coloured. The fruits are waxy, orange-yellow, oblong, longitudinally angled, 6-15 cm long and up to 7-9 cm wide. The fruit has a more or less pronounced oxalic acid odour and the flavour ranges from very sour to mildly sweetish. There are two distinct type of carambola—the smaller, very sour type and the larger and sweet type. The carambola is found growing in tropical and sub-tropical regions. Carambola grows well on sand, heavy clay or limestone, but loamy soil is best. It cannot stand water logging. Carambola is usually multiplied by seed, air-layering and Inarching. The tree required humid tropical and sub-tropical climate and sunny place. It is generally planted at 6 × 6 m distance. Half kg mixture of N, P, K, Mg (6-6-6-3) may be given 3 to 4 times per year for good growth and yield. It requires light irrigation in dry seasons. Carambola fruits mature in August–September and February–March. The fruits fall at ripening. A tree may yield 40 to 90 kg fruits. Carambola fruits are eaten fresh and served in salads. They are also cooked to prepare jam, chutney and curries.

Bilimbi

Handling because of the thin skin. They cannot be stored for more than a few days. The bilimbi is generally regarded as too acidic for eating raw. The fruits are used to make chutney, salad etc.

Natal plum

*Natal plum* (*Carissa macrocarpa*) is a close relative of Karonda. It is native to South Africa. It is small to moderate size, thorny shrub which can tolerate salinity and salty winds and is good crop for coastal areas. The...
Fruiting shoot of natal plum (a) and ripe fruits (b)

plant is short, compact with shiny, deep green leaves. It requires hot humid sub-tropical climate but can tolerate low temperature (up to -5°C). It is also drought resistant, grows well in full sun as well as shade. It can be grown in any soil such as limestone, heavy clay, sandy having good drainage. Natal plum is easy to multiply by seeds and vegetative means. Its seeds germinate two to four weeks after sowing. It can be easily multiplied by stem cutting and air layering. Vegetatively propagated plants produce fruits within two years while seedling takes 4-5 years to fruits. Natal plum can be planted as hedge like karonda. Regular pruning is required to restrain the size of plant and increase yield. It usually flowers in April–May and September–October in Bengaluru conditions but few flowers may be seen around the year. The flowers are snowy white, scented and larger than karonda. Regular pruning is required to restrain the size of plant and increase yield. It usually flowers in April–May and September–October in Bengaluru conditions but few flowers may be seen around the year. The flowers are snowy white, scented and larger than karonda. Fruits are plumpy, oblong - round, 2-3 cm long and 1-2 cm wide, crimson red coloured and sweet. The fruit are rich in carbohydrates, vitamins and minerals (Table 1). The fruit can be eaten fresh or used to prepare jams, jellies, and sauces. The fruit has potential to improve nutrition, boost food security and support sustainable land development.

Kumquat
Hongkong kumquat (Fortunella hindsii Swingle syn. Citrus hinds), belongs to the sub-family Aurantioideae of the Rutaceae. It is slow-growing, shrubby, compact, 2-4 m tall tree. The branches are light-green and angled when young, with a few spines. The fruit is oval-oblong or round, 1.6-4 cm wide. The fruit rind is golden-yellow to reddish-orange and edible. The pulp is acid to subacid and contains small seeds. Kumquats are believed to be native to China. The various kumquats are distinguished as botanical species rather than as cultivars. Kumquat requires moderate temperature ranging from 26 to 37°C, but could withstand frost. Kumquats are rarely grown from seed as they do not do well on their own roots. They are usually grafted onto the trifoliate orange. Kumquats are planted at 1.5-2 m distance. For pot culture, they can not be allowed to become pot-bound, and need sufficient watering and nutrition. Fresh kumquats can be eaten raw and preserved whole in sugar syrup. Kumquats are excellent for making marmalade. The fruit may be pickled by merely packing in jars of water, vinegar, and salt.

Hog plum
Hog plum (Spondias mombin L.) is medium sized tree which belongs to family Anacardiaceae. It is native to southern Mexico to Peru and Brazil and common in moist lowland forests. The leaves are deciduous, alternate, pinnate, 20-45 cm long with 5-15 cm long leaflets. The flowers are small, fragrant, whitish, borne in panicles of 15-30 cm long and attract lot of bees. The fruits are borne in clusters aromatic, ovoid or oblong, 3-4 cm long and up to 2.5 cm wide. The fruits are golden-yellow coloured with thin, tough skin, very juicy pulp, very acidic. It is grown to a limited extent in India. It is well-adapted to
Fruiting twig of hog plum (a) and mature fruits (b)

Indian Horticulture

Fruiting twig of sour karonda (a) and mature fruits (b)

Fruiting twig of hog plum (a) and mature fruits (b)

Fruiting twig of sour karonda (a) and mature fruits (b)

Karonda (Carissa carandas) belongs to Apocynaceae family. It is an evergreen medium-sized, thorny shrub or short stature tree. It grows naturally all over the country particularly lower Himalayas and Western Ghats. It is a well suited to arid climate and grown well at higher temperature and used for making hedge for orchards. It produces berry-sized fruits bright red to Reddish black in colour. Karonda fruit is a rich source of iron and contains a fair amount of Vitamin C (Table 1). It is a very hardy, drought-tolerant plant that thrives well in a wide range of soils. It can be grown successfully in tropical and subtropical climate. Plant growth is affected in high rainfall and waterlogged areas. Karonda is grown successfully on a wide range of soil types, viz. sandy loams, laterite, alluvial sand, and calcareous soil but good growth and higher yield can be obtained in alluvial sandy loam soils with good drainage. There are several released cultivars of Karonda. Pant Manohar, Pant Sudarshan, Pant Suvarna which are pink red coloured pickle type varieties while Konkan bold, CHES K-II-7 and CHESK-35 are dark black coloured, bold size and table purpose varieties. Karonda is propagated through seed and vegetative methods such as cutting, layering and budding. It is planted at 3×3 m distance in orchards or at 0.6 m distance as hedge. One-year old plant should be provided 5 kg of FYM and 100 gm mixture of Nitrogen, Phosphorus and Potash. This dose should be increased proportionately up to 3 years. Training of plant in the initial stage is essential to provide the required framework. Pruning is required every year to maintain the size of the plant and yield. Karonda plant starts yielding after 3 years. In Western Ghats, flowering takes place from December to March and fruit mature in the month of April to June. All fruits generally do not matures at one time therefore harvesting is generally done 3-4 times. A plant may yield 4-5 kg fruits. The fruits are used as fresh fruit or pickle making. It is also used for jam, jelly, squash, syrup, chutney, etc.

Miracle fruit

Miracle fruit is native of Africa. The fruits are not sweet but they contain a glycoprotein named miraculin which binds to receptors on the taste buds resulting in acidic foods to taste sweet. This effect lasts from a half hour to two hours. It is an evergreen, dense shrub, which usually may grow up to 3 m height. The leaf is simple,
5-8 cm long, 2-3 cm wide. These forms cluster at the tip of branchlets. The plant starts bearing after 3-4 years of planting. The plant grows well in acidic soil (4.5-5.8 pH). They require tropical climate with high humidity. The plants perform good under partial shade but can tolerate drought and bright sunshine. It is multiplied through seeds. The seeds germinate in 15-20 day. The seedling became ready for planting in one year. Planting can be done at 4-m distance. The plant starts fruiting after 3-4 years. There are two fruiting season September -October and February -March. The flowers are small and white. The fruit are bright red coloured and 2-3 cm long. The fruit contains one seed. The fruits can be used as food additive. The fruit extract can be used as a low-calorie or noncaloric sweetener. The leaves are sometimes infested by leaf eating caterpillars and fruits are infested by fruit fly.

**Passion fruit**

Passion fruit (*Passiflora edulis* Sims) is a native of Brazil. It belongs to the family Passifloraceae. It is grown mostly in tropical and sub-tropical parts of the world. In India, passion fruit was introduced in early part of 20th century in Southern India. It is a perennial, vigorous, climbing, woody vine which produces round or ovoid fruits. Fruits have a tough, smooth, waxy dark purple/yellow coloured rind and orange coloured pulpy juice. The fruits are generally processed to make fruit juice, concentrate, etc. Fruits are rich in Vitamin A, Vitamin C and minerals (Table 1). Passion fruit is used for urinary infections and as a mild diuretic, digestive stimulant and health tonic. Passion fruit is grown on many soil types but light to heavy sandy loams, of medium texture are most suitable. It is propagated through seed, stem cutting, grafting and serpentine-layering technique. Passion fruit has three types, yellow and purple and their hybrids. The yellow passion is more acidic and less starchy while the purple are less acidic and more starchy but both types are cultivated. In India, there is no released variety of both yellow and purple types. The local lines of Purple types and yellow types are cultivated by the growers. A hybrid of yellow and purple form named ‘Kaveri’ has been developed at IIHR RS, Chettalli which is popular throughout the country. Passion fruit is planted at a spacing of 3 × 2 m distance. The vines are trained on a frame of wires and poles for commercial cultivation but for backyard gardens these may be trained on the tree or over fence. Passion fruit requires regular irrigation. A fertilizer dose of 110 g N, 60 g P₂O₅ and 110 g K₂O per vine per year is recommended for 4 years. Passion fruit bears flowers around the year under tropical humid conditions, but there are two main flowering periods March–April and August–September. About 60-70 days are required from fruit set to the harvest of fruit. Harvesting is done when fruit turns slightly coloured. A vine may yield 10-12 kg fruit.

**Phalsa**

Phalsa (*Grawia subinaequalis* DC) is fruit of Indian origin which belongs to Tiliaceae family. The phalsa is a medium shrub, which may attain a height of 4 m. It is cultivated on a commercial scale mainly in the northern and western states of India. Phalsa fruits contain high carbohydrate, vitamin A and antioxidant value (Table 1). The phalsa fruits are rich in potassium, which plays important role in energy metabolism and normalizing blood pressure. Phalsa is a sub-tropical fruit plant but can be grown in wide climatic conditions. Phalsa plant grows vigorously and produces satisfactorily under variable soil types including fine sand, clay or even limestone. But loamy soil is best for the growth and productivity. It is propagated by various methods such as seed, cutting, grafting and layering but seed and stem cuttings are most popular methods of multiplication. There is no recognized variety of phalsa, but local varieties such as tall, dwarf, Local and Sharbati, etc. are grown in different growing regions. It is planted at 2.5 to 4 m distance. Planting can be done in July –August. It needs regular annual pruning to cut the old growth and to enhance the new growth and yield. Phalsa is a drought tolerant plant and does not require frequent irrigation. The phalsa plant shows good response to nitrogen applications. Phalsa plant starts
fruits after 15 to 18 months of planting but the good yield is obtained only after three years of planting. The flowering starts in the month of February–March and continue for almost one month. The flowers are small 1 to 2 cm diameter and bright orange-yellow in colour. The fruits are very small (1-2 cm diameter), round, purple to crimson red in colour when ripe. The fruit are harvested in April and May. The average fruit yield is 5 to 10 kg per plant. The average fruit weight is 1.0 to 2.0 g. Fruits ripe 45 to 55 days after flowering. The fruits are sweet acid in taste with mild pleasant flavour. Phalsa fruit has a short shelf life suitable only for local marketing. The phalsa is used for preparation of Phalsa juice (sorbet) and squash.

Star gooseberry

Star gooseberry (*Phyllanthus acidus*) is a small tree with dense and bushy crown. It prefers hot, humid tropical conditions with a short dry season. Star gooseberry is found throughout sub-tropical and tropical Asia, Central and south America. It is considered that it originated in Madagascar and south Asia. It can be multiplied by seed and vegetative means. The seeds germinate easily and are main method of propagation. The soft wood and semi-hard wood cutting and air layering may also be used for multiplication. The plant grows rapidly and starts bearing at the age of 2-3 years. It usually flowers two time in a

Table 1. Nutritional value of fruits (per 100 g edible portion)

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Barbados cherry</th>
<th>Bilambi</th>
<th>Carambola</th>
<th>Hog plum</th>
<th>Natal plum</th>
<th>Karonda</th>
<th>Surinam cherry</th>
<th>Star gooseberry</th>
<th>Purple passion fruit</th>
<th>Miracle fruit</th>
<th>Phalsa</th>
<th>Kamquat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (kcal)</td>
<td>32</td>
<td>-</td>
<td>31</td>
<td>48</td>
<td>62</td>
<td>42</td>
<td>43-51</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>274</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>92.0</td>
<td>94.2</td>
<td>92.0</td>
<td>90</td>
<td>84.1</td>
<td>91</td>
<td>90.7</td>
<td>91.7</td>
<td>85.6</td>
<td>59.5</td>
<td>80.8</td>
<td></td>
</tr>
<tr>
<td>Carbohydrate (%)</td>
<td>7.69</td>
<td>6.73</td>
<td>4.6</td>
<td>13.63</td>
<td>2.9</td>
<td>7.93-12.5</td>
<td>6.4</td>
<td>13.6</td>
<td>18.8</td>
<td>21.1</td>
<td>72.1</td>
<td></td>
</tr>
<tr>
<td>Protein (%)</td>
<td>0.4</td>
<td>0.61</td>
<td>1.04</td>
<td>0.7</td>
<td>0.5</td>
<td>1.1</td>
<td>0.92</td>
<td>0.71</td>
<td>0.9</td>
<td>7.7</td>
<td>1.5</td>
<td>-</td>
</tr>
<tr>
<td>Fat (%)</td>
<td>0.3</td>
<td>0.6</td>
<td>0.33</td>
<td>0.4</td>
<td>1.3</td>
<td>2.9</td>
<td>0.64</td>
<td>0.52</td>
<td>0.1</td>
<td>3.4</td>
<td>0.9</td>
<td>3.8</td>
</tr>
<tr>
<td>Fibre (%)</td>
<td>1.1</td>
<td>2.80 g</td>
<td>1.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.48</td>
<td>0.7</td>
<td>4.4</td>
<td>1.2</td>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td>Vitamin A (mg)</td>
<td>38ug</td>
<td>0.035</td>
<td>61 IU</td>
<td>270 ug</td>
<td>-</td>
<td>-</td>
<td>1600IU</td>
<td>7171U</td>
<td>0.04mg</td>
<td>419ug</td>
<td>2530</td>
<td></td>
</tr>
<tr>
<td>Vitamin B1 (mg)</td>
<td>0.02</td>
<td>0.010</td>
<td>0.014</td>
<td>0.02</td>
<td>0.04</td>
<td>-</td>
<td>0.03</td>
<td>0.05</td>
<td>Trace</td>
<td>-</td>
<td>-</td>
<td>0.35</td>
</tr>
<tr>
<td>Vitamin B2 (mg)</td>
<td>0.06</td>
<td>0.026</td>
<td>0.016</td>
<td>0.2</td>
<td>0.06</td>
<td>-</td>
<td>0.04</td>
<td>0.01</td>
<td>0.1</td>
<td>-</td>
<td>-</td>
<td>0.40</td>
</tr>
<tr>
<td>Vitamin B3 (mg)</td>
<td>0.4</td>
<td>0.302</td>
<td>-</td>
<td>0.3</td>
<td>0.2</td>
<td>-</td>
<td>0.03</td>
<td>1.5</td>
<td>-</td>
<td>0.3</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Vitamin C (mg)</td>
<td>1677.6</td>
<td>15.5</td>
<td>34.4</td>
<td>21</td>
<td>38</td>
<td>220-200</td>
<td>20-30</td>
<td>8</td>
<td>30</td>
<td>22.7</td>
<td>22</td>
<td>151</td>
</tr>
<tr>
<td>Calcium (mg)</td>
<td>12</td>
<td>3.4</td>
<td>3</td>
<td>36</td>
<td>11</td>
<td>21</td>
<td>9</td>
<td>5</td>
<td>3.6</td>
<td>1</td>
<td>129</td>
<td>266</td>
</tr>
<tr>
<td>Phosphorus (mg)</td>
<td>11</td>
<td>11.1</td>
<td>12</td>
<td>11</td>
<td>7</td>
<td>28</td>
<td>11</td>
<td>23</td>
<td>12.5</td>
<td>-</td>
<td>39</td>
<td>97</td>
</tr>
<tr>
<td>Potassium (mg)</td>
<td>146</td>
<td>-</td>
<td>133</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>375</td>
<td>-</td>
<td>995</td>
</tr>
<tr>
<td>Iron (mg)</td>
<td>0.02</td>
<td>1.01</td>
<td>0.08</td>
<td>3.9</td>
<td>1.13</td>
<td>-</td>
<td>0.2</td>
<td>0.4</td>
<td>0.2</td>
<td>0.24</td>
<td>3.1</td>
<td>1.7</td>
</tr>
<tr>
<td>Magnesium (mg)</td>
<td>18</td>
<td>-</td>
<td>10</td>
<td>-</td>
<td>16</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sodium(mg)</td>
<td>7</td>
<td>-</td>
<td>0.016</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Zinc(mg)</td>
<td>-</td>
<td>-</td>
<td>0.12</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.09</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
year in moist humid area in February–March and August–September. Flowers are formed at leafless parts of the main branches, at the upper part of the tree. These are borne in clusters composed of male, female or hermaphrodite flowers. The flowers are small and pinkish and appear in clusters in 5 to 12.5 cm long panicles at leafless parts of the main branches, at the upper part of the tree. The fruit is ripe between 90-100 days. The fruits are numerous, oblate, with 6 to 8 ribs, and are densely clustered. They are pale yellow or white, waxy, crisp, juicy and very sour. The fruits mature in May and October–November. A mature tree may yield 5-7 kg fruits. The raw or ripe fruits are used for making chutneys or souring agents. The pulp is rich in carbohydrates, minerals and vitamins (Table 1).

**Surinam cherry**

Surinam cherry (*Eugenia uniflora* L.) is a shrub with spreading branches. It is native of Surinam, Guyana and French Guiana to southern Brazil. It was introduced in India by Portuguese voyagers long back. The leaves are ovate to ovate-lanceolate. The flowers are white, borne singly or in cluster of 2-4 in leaf axils. The fruits are ribbed, oblate, 2-4 cm diameter, bright-red to deep-scarlet coloured at ripening. The fruit pulp is orange-red, juicy, acid - sweet with 1 to 3 smaller seeds. Surinam cherry is adapted to tropical and sub-tropical regions. Young plants are damaged by low temperature. The plant requires full sunshine. It requires only moderate rainfall and being deep-rooted, can stand a long dry season. The Surinam cherry grows in almost in all type of soils, But it is intolerant to salt. Seeds are common mean of propagation. They remain viable for around one month and fresh seeds germinate in 3 to 4 weeks. Layering has been successful. Regular fertilizer application promotes fruiting. The fruits develop and ripen quickly, only 3 weeks after the flowers open. The plants bloom in May–June and fruits ripe within a month, they bloom again in October and November. The fruits should be picked only when they are so ripe as to fall into the hand at the lightest touch. The pruned bushes may yield 2-3 kg per plant. The fruits can be eaten fresh. The syrumped fruits are excellent for fruit cups, salads and pudding, ice cream. They are often used to make jam, jelly, or pickles.

For further interaction, please write to: Prakash Chandra Tripathi, (Principal Scientist), Division of Fruit Crops, ICAR-Indian Institute of Horticultural Research, Hessaraghatta Lake Post, Bengaluru 560 089. *Corresponding author e-mail: prakaashtripathi2000@yahoo.co.in*
The cucumber (Cucumis sativus L.), known as Khira in Hindi is a very popular and important vegetable grown in hills and plains of India. It is used as salad, pickle and also as cooked vegetable. Apart from being used as salad, it is also used for pickling and rayata preparation. Due to good taste and low energy content, they are regarded as refreshing condiment. In north Indian plains, generally two crops are taken in a year viz. spring-summer and kharif season crops. The consumer preference in India is long cylindrical type, medium thick indigenous (desi) hybrid of cucumber with earliness and high yielding ability. Keeping in view these facts, a gynoecious cucumber hybrid Pusa Gynoecious Cucumber Hybrid-18 was developed by Division of Vegetable Science IARI, New Delhi and recommended by AICRP (vegetable crops) for cultivation in Zone I [Humid Western Himalayan Region i.e. Jammu & Kashmir (J&K), Himachal Pradesh and Uttarakhand] during spring-summer and kharif season and subsequently notified by central sub-committee on crop standards, notification and release of varieties of horticultural crops during the year 2021.

Pusa Gynoecious Cucumber Hybrid-18 (DGCH-18) is a gynoecy based hybrid which becomes ready for first harvesting in 40-45 days after sowing during spring-summer and kharif season. Fruits are attractive green in colour with mild whitish green stripes originating from the blossom end and brownish green blotchy patches present near the stem end; 18-20 cm long having soft skin, crispy and tender flesh with average fruit weight 200 g. Average yield in AICRP (VC) trials at six Centres over 3 years is 24.52 t/ha, which is 31.44% higher than National check PCUCH-3.

Performance of Pusa Gynoecious Cucumber Hybrid-18

Pusa Gynoecious Cucumber Hybrid-18 (DGCH-18) has been tested in yield trial at several centers throughout India in AICRP (vegetable crops) trials from 2016-17 to 2018-19 along with check PCUCH-3. The results indicated that Pusa Gynoecious Cucumber Hybrid-18 yielded 24.52 t/ha which was 31.44% higher than check PCUCH-3 (Table 1). At multilocation testing DGCH-18 has fruit length of 18.36 cm (Table 2) and average fruit weight 212.88 g (Table 3).

Cultivation

It can be grown successfully on all type of soils but prefers well-drained loam and sandy loam soils rich in organic matter. The seed rate is 1.5-2.0 kg per hectare. Seed should be treated with 2 g Captan/Thiram per Kg of seed. As a spring-summer crop, it is sown from mid February to February end and as kharif season crop in June-end. The seeds are sown in the hills 45-60 cm apart on the slope of channels prepared at a distance of 2.0 m. The spacing between channels is increased to 2.5 m when sowing is done on both the sides.
Subscription Form for ICAR Magazines/Journals

I am/We are interested to become a subscriber to the following ICAR Magazine(s) / Journal(s) for the period ...........

...to................................. My old subscription no. (if any) is .................................................

for the year ..........................................................

Name of the Magazines                                      Annual Subscription in
                                                          (₹)     (US$)*

• Indian Farming (English Monthly) 300                  50
• Indian Horticulture (English Bi-Monthly) 150          30
• Kheti (Hindi Monthly) 300
• Phal Phool (Hindi Bi-Monthly) 150

Research Journals
• The Indian Journal of Agricultural Sciences (English monthly) ₹ 1,000  US$ 160
• The Indian Journal of Animal Sciences (English monthly) ₹ 1,000  US$ 160

Please accept my subscription amount of Rupees (₹)/US Dollar ($) ....................................... for the Magazine(s)/Journal(s) tick (√) marked above.

Name ................................................................................ Address ...........................................................................
.............................................................................................................................................. Pin ................................
Phone/Mobile No. ............................................................. Email .................................................................................
NEFT/RTGS/Demand Draft No. ......................................................... Dated ............................
Amount Rs. ................................................ Bank name & branch code ......................................................

TERMS AND CONDITIONS

While placing order, the name and address with email, may be given in block letter. The Post Office, District, State and PIN code may also be indicated. When bulk order are to be executed through railway parcels the name of the Railway Station & name of road transport company may also be given.

A. Payment should be made through Bank Draft or Net Banking. The remittance may be drawn in favour of the "Business Manager, ICAR, New Delhi".
B. Payment through online (RTGS/NEFT).

RTGS/NEFT Payment Details:

<table>
<thead>
<tr>
<th>Journals/Magazines</th>
<th>Project Director, DKMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name and Address of the Organization</td>
<td>Canara Bank</td>
</tr>
<tr>
<td>Bank Address</td>
<td>Krishi Anusandhan Bhawan-I, Pusa, New Delhi 110012</td>
</tr>
<tr>
<td>IFSC Code</td>
<td>CNRB0012413</td>
</tr>
<tr>
<td>MICR No.</td>
<td>110015500</td>
</tr>
<tr>
<td>Current Account No.</td>
<td>241330500000040</td>
</tr>
</tbody>
</table>

PFMS Unique Code: DLND00001925 (for Govt. Department & ICAR Institutes)

*Foreign price mentioned are inclusive of postal and forwarding charges by Air Mail.

Note: Please furnish the details of the payment with your name & address, NEFT/RTGS number, date, amount in ₹/US$, Bank name and address alongwith details of your order of Books and Magazines/Journals subscription to the E-mail: businessuniticar@gmail.com

Contact:
Business Manager, Directorate of Knowledge Management in Agriculture
Indian Council of Agricultural Research
Krishi Anusandhan Bhawan-I, Pusa, New Delhi 110012
Telephone: 011-25843657 (D) 011-25841993 (Ext. 657 & 220)
Website: www.icar.org.in
GUIDELINES TO AUTHORS

Visit us at http://epubs.icar.org.in/ejournal/index.php/IndHort

Online submissions of article:
• Already have a Username/Password for Indian Horticulture?
  GO TO LOGIN
• Need a Username/Password?
  GO TO REGISTRATION
• Registration and login are required to submit items on-line and to check the status of current submissions.

Author Guidelines

Title of the article: Catchy, short and attractive; Compel the readers to read the article; Time-oriented; Serve the purpose of audience – means it should be audience-oriented, and News-oriented.

Intro/Introductory Paragraph: It has gist of the article; Preferably give answers of all 4 Ws and 1 H; Ws stands for: what, where, why and when, H stands for: how; and Intro paragraph should convey the complete message so that reader is satisfied.

Introduction: The very first paragraph of the article is known as Introduction; It is an introduction for the article; It shows the need of writing article. For example, we write an article on a new hybrid. We have to write its importance that it is better in such and such regards, and It should be of one paragraph or two paragraphs, if the subject is broader.

Text of article: Remaining text should be in a descending order of importance; Emphasize on your own findings; Follow proper heading scheme; Use key words in headings; Follow central heading, side heading, subheading, inset heading etc.

General guidelines: Follow guidelines strictly. In popular articles, number of authors should not be more than 3. Stick to number of words required (2,500 words); Do not exceed page limit; Write captions separately; Give 1-2 tables or graphs (avoid repetition); Name(s) of author(s), Complete postal address(es) of affiliations (place where work was conducted). Complete correspondence address including e-mail address of authors should be provided (these are given as footnote on first page).

Units in metric system: Full forms of all abbreviations used in table; source of data should be given in detail. Units of measurement, symbols and standard abbreviations should conform to those recommended by the International Union of Biochemistry (IUB) and the International Union of Pure and Applied Chemistry (IUPAC). Metric measurements are preferred, and dosages should be expressed entirely in metric units (SI units). In exceptional circumstances, others may be used, provided they are consistent.

Figures: Author is required to submit high-resolution (2 MB) images, preferably with the initial submission but no later than revision stage. Electronic (2 MB) images (figures and schemes) must be at a minimum resolution of 600 d.p.i. for line-drawings (black and white) and 300 d.p.i. for colour or gray-scale. Colour figures must be supplied in CMYK not RGB colors. Please ensure that the prepared electronic image files print at a legible size (with lettering of at least 2 mm). A number of file formats are acceptable, including: PowerPoint (.ppt), Tagged Image File Format (.tif), Encapsulated PostScript (.eps), Joint Photographic Experts Group (.jpg), Graphics Interchange Format (.gif), Adobe Illustrator (.ai) (please save your files in Illustrator’s EPS format), Portable Network Graphics (.png), Microsoft Word (.doc), Rich Text Format (.rtf), and Excel (.xls) but not Portable Document Format (PDF). Type in 1.5- space everywhere.

Rewrite Your article

Language: Use simple words; Use short sentences in a logical order; Use active voice; Avoid passive voice; Relate all sentences with each other; Maintain coherence; Paragraphs should be short and readable; Short paragraphs give pause to readers; Give human touch to your article to make it interesting, and Give practical information

Writing for success stories: Who has got success in; Introducing new technology/methodology etc.; Diversification of any farming system in a particular area for more return; How he/she is inspiration to other farmer; What is cost:benefit ratio of the farm produce?; What are the prospects of that farm commodity?; Show the difference in adoption of that particular technique, variety, seed, tool etc.

Summary: Summary of article should be provided at the end of article under the heading “Summary”. Papers should be composed in MS Word, and double spaced throughout (including references and tables). Article (including illustrations) should be uploaded on Indian Horticulture site (as given on top), after a careful check up of typographical errors.

Submission preparation checklist
✔ As part of the submission process, authors are required to check off their submission’s compliance with all of the following items, and submissions may be returned to authors that do not adhere to these guidelines.
✔ The submission has not been previously published, nor is it before another journal for consideration (or an explanation has been provided in Comments to the Editor); and submission file should be in Microsoft Word file format.
✔ The text is 1.5-spaced; uses a 12-point font; employs italics, rather than underlining (except with URL addresses); and all illustrations, figures, and tables are placed within the text at the appropriate points, rather than at the end. Data is correct, authentic and updated.
✔ If submitting to a peer-reviewed section of the Indian Horticulture, the instructions in Ensuring a Blind Review have been followed.
✔ Article is based on recent experiments or practical experience of the author.
✔ Article should not be based on compiled matter or on some survey, report or record of extension education.
✔ Article should not be of theoretical nature or only of local relevance. Article text gives complete relevant details of practical utility to the farmer in clear and simple English.
Two to three seeds are sown 2 cm deep in each hill. Bower or trellis system of training is preferred during kharif season to obtain high yield and disease free crop.

Apply 15-20 tonnes of well-rotten organic manure per hectare before field preparation and 100 kg urea, 200 kg single super phosphate and 80 kg muriate of potash at the time of last ploughing. Another dose of 50 kg urea should be top-dressed at 8-10 leaf stage. Spray 1 % urea if crop growth is poor. When seedlings become 8-10 cm tall, thinning should be done to keep 1 or 2 seedlings per hill.

Weeds are controlled by 2-3 hoeing and hand weeding in the channels and between the channel. Crop needs earthing up twice at one month interval to facilitate good root development and to reduce the weeds. Care should be taken that fruits should not touch the wet ground surface by providing some support under the fruit at the time of maturity to avoid rotting especially during kharif season.

Irrigation is given in the channels. Frequent irrigations during summer crop and light irrigations during rainy season crop depending upon the weather conditions. It is ready for first harvesting in 40-45 days and 50-55 days after sowing during kharif and spring-summer season, respectively. Drenching with ridomil @ 2 g/litre and blitox @ 3g/litre of water is necessary to prevent the seedlings from damping off and other root borne diseases. Downy mildew and virus are the major problem during kharif season. A need based spray of Imidachlorpid @ 0.3 ml/litre or acetamiprid @ 0.3 gm/litre of water followed by Dimecron @ 2ml/liter of water at two to three weeks interval should be applied judiciously to prevent the crop from Tomato Leaf Curl New Delhi Virus and important sucking pests like aphid and whitefly.

**SUMMARY**

Pusa Gynoecious Cucumber Hybrid-18 is a gynoecy based hybrid of cucumber with earliness and desirable horticultural traits for spring summer and kharif season cultivation in Zone IV (Sub-humid Sutlej-Ganga Alluvial Plains i.e. Punjab, Uttar Pradesh, Bihar and Jharkhand). Apart from superior quality characters, it showed 31.44% higher yield over the National check hybrid PCUCH-3.

For further interaction, please write to:
**Amish K Sureja,** (Principal Scientist), Division of Vegetable Science, ICAR-Indian Agricultural Research Institute, New Delhi 110 012. *Corresponding author e-mail: aksureja@gmail.com

---

**Table 1. Mean performance of Pusa Gynoecious Cucumber Hybrid-18 (DGCH-18) in AICRP (VC) from 2016-17 to 2018-19**

<table>
<thead>
<tr>
<th>Entry</th>
<th>IET (2016-17)</th>
<th>AVT-I (2017-18)</th>
<th>AVT-II (2018-19)</th>
<th>Average yield (t/ha)</th>
<th>% increase over check</th>
</tr>
</thead>
<tbody>
<tr>
<td>DGCH-18</td>
<td>24.65</td>
<td>24.51</td>
<td>24.40</td>
<td>24.52</td>
<td>31.44</td>
</tr>
<tr>
<td>PCUCH-3 (Check)</td>
<td>20.94</td>
<td>17.40</td>
<td>17.63</td>
<td>18.65</td>
<td></td>
</tr>
</tbody>
</table>

**Table 2. Average fruit length (cm) of Pusa Gynoecious Cucumber Hybrid-18 (DGCH-18) in AICRP (VC) from 2016-17 to 2018-19**

<table>
<thead>
<tr>
<th>Entry</th>
<th>IET (2016-17)</th>
<th>AVT-I (2017-18)</th>
<th>AVT-II (2018-19)</th>
<th>Average fruit length (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DGCH-18</td>
<td>16.55</td>
<td>18.69</td>
<td>19.83</td>
<td>18.36</td>
</tr>
<tr>
<td>PCUCH-3 (Check)</td>
<td>17.28</td>
<td>17.77</td>
<td>18.55</td>
<td>17.87</td>
</tr>
</tbody>
</table>

**Table 3. Average fruit weight (g) of Pusa Gynoecious Cucumber Hybrid-18 (DGCH-18) in AICRP (VC) from 2016-17 to 2018-19**

<table>
<thead>
<tr>
<th>Entry</th>
<th>IET (2016-17)</th>
<th>AVT-I (2017-18)</th>
<th>AVT-II (2018-19)</th>
<th>Average fruit weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DGCH-18</td>
<td>214.70</td>
<td>217.45</td>
<td>206.49</td>
<td>212.88</td>
</tr>
<tr>
<td>PCUCH-3 (Check)</td>
<td>225.40</td>
<td>184.33</td>
<td>188.92</td>
<td>199.55</td>
</tr>
</tbody>
</table>

---

*Flowers always make people better, happier, and more helpful; they are sunshine, food and medicine for the soul.*

– Luther Burbank
Carambola (Star fruit) at a glance

**Carambola**

Believed to be originated in Sri Lanka and the Moluccas, cultivated in southeast Asia and Malaysia for many centuries. Very sour type, richly flavoured with more oxalic acid; the larger, sweet type, mild-flavoured with less oxalic acid.

**Botanical name**  
*Averrhoa carambola* L.

**Family**  
Oxalidaceae

**Economic part**  
Fruit

**Propagation techniques**  
Seed, Cleft-grafting, Air-layering

**Nursery period**  
10-12 months

**Multiplication time**  
July-September

**Spacing**  
6 m x 6 m

**Climate and soil requirements**  
Tropical and sub-tropical, thrives up to an elevation of 4,000 ft (1,200 m) with evenly distributed rainfall throughout year

**Leaf**  
Compound, spirally arranged, alternate leaves, 20-25 cm long, with 5-11 nearly opposite, ovate-oblong leaflets 3 to 8 cm in length.

**Growth form**  
Perennial, vigorous

**Flowering period**  
February-March, July-August

**Pollination**  
Cross pollination

**Pollinating agents**  
Insects

**Economic yield**  
After 6 years

**Yield**  
30-40 kg/tree

**First harvest**  
3 years

**Harvesting method**  
Fruit manually

**Harvesting period**  
July-September, November-December

**Pests**  
Fruit fly, fruit moths and fruit spotting bugs

**Diseases**  
Brown spot, Root rot

**Shelf life**  
5-7 days

**Shelf life in cold storage**  
2 weeks at 10°C

**Nutritional value of Averrhoa carambola L. (Per 100 g of edible portion)**

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Quantity</th>
<th>Nutrient</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>31 Kcal</td>
<td>Riboflavin</td>
<td>0.016 mg</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>6.73 g</td>
<td>Sodium</td>
<td>2 mg</td>
</tr>
<tr>
<td>Protein</td>
<td>1.04 g</td>
<td>Potassium</td>
<td>133 mg</td>
</tr>
<tr>
<td>Total Fat</td>
<td>0.33 g</td>
<td>Calcium</td>
<td>3 mg</td>
</tr>
<tr>
<td>Dietary Fiber</td>
<td>2.80 g</td>
<td>Iron</td>
<td>0.08 mg</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>61 IU</td>
<td>Magnesium</td>
<td>10 mg</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>34.4 mg</td>
<td>Potassium</td>
<td>12 mg</td>
</tr>
<tr>
<td>Thiamin</td>
<td>0.014 mg</td>
<td>Zinc</td>
<td>0.12 mg</td>
</tr>
</tbody>
</table>

For further details, please contact or write to:  
Dr. P.C. Tripathi  
ICAR-Indian Institute of Horticultural Research,  
Bengaluru, Karnataka 560 089
HANDBOOK OF HORTICULTURE

Volume 1 & 2

The Indian Council of Agricultural Research has brought out the Second enlarged and revised edition of the Handbook of Horticulture. Horticultural crops are gaining more and more importance as they have been instrumental in improving the economic condition of the farmer and contributing significantly to the national GDP. This new revised edition has been divided into 2 volumes – Volume 1 contains General Horticulture and Production Technologies (Fruit, Vegetable and Tuber crops) and Volume 2 has Production Technologies (Flower, Plantation, Spices crops and Medicinal and aromatic plants), Plant Protection and Post-harvest Management. The earlier chapters have been thoroughly revised and new chapters have been added. It is hoped that the readers will find this Second edition more useful and informative.

Technical Specifications

Pages: i-xxiv + 1-682 (Vol. 1)
      i-xxxiii + 683-1218 (Vol. 2)
Price: ₹ 2000/- (Vol. 1 & 2) Postage ₹ 200/-

Copies available from:
Business Manager
Directorate of Knowledge Management in Agriculture (DKMA)
Indian Council of Agricultural Research
Krishi Anusandhan Bhavan, Pusa, New Delhi 110012
Tel: 011-25843657; e-mail: bnicar@icar.org.in, businessuniticar@gmail.com