

OLIVE CULTIVATION

Shiv Lal

Desh Beer Singh

Om Chand Sharma

Javid Iqbal Mir

Anil Sharma

Bilal Ahmed Padder



ICAR-Central Institute of Temperate Horticulture

K.D. Farm, Old Air Field, P.O. Rangreth-190007

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Javid Iqbal Mir, Anil Shrama
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Director

ICAR-Central Institute of Temperate Horticulture
K.D. Farm, Old Air Field, P.O. Rangreth, Srinagar-190007, J&K, India
Phone: 0194-2305044
Fax: 0194-2305045
Email: dircithsgr@icar.org.in
Website: cith.org.in

Compiled and Edited by

Dr. Shiv Lal
Dr. Desh Beer Singh
Dr. Om Chand Sharma
Dr. Javid Iqbal Mir
Dr. Anil Shrama
Dr. Bilal Ahmed Padder

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History

Olive believes to originated in Asia Minor and spread from Iran, Syria and Palestine to the rest of the Mediterranean basin about 6,000 years ago. It was being grown on Crete by 3,000 BC and may have been the source of the wealth of the Minoan kingdom. The Phoenicians spread the olive to the Mediterranean shores of Africa and Southern Europe. Olives have been found in Egyptian tombs from 2,000 years BC. The olive culture was spread to the early Greeks then Romans. As the Romans extended their domain they brought the olive with them. The Prophet of Islam, Muhammad, advised 1,400 years ago to his followers to apply olive oil to their bodies, and himself used oil on his head. Like the grape, the Christian missionaries brought the olive tree with them to California for food but also for ceremonial uses. Olive oil was used to anoint the early kings of the Greeks and Jews. The Greeks anointed winning athletes. Olive oil has also been used to anoint the dead in many cultures. The olive trees on the Mount of Olives in Jerusalem are reputed to be over 2000 years old, still relative newcomers considering the long domestication of the olive. We don't know the exact variety of the trees on the Mount. With the discovery of America in 1492 olive trees from Europe reached Antille and consequently the American continent. By the 16th century olives are already in Mexico, Peru, California, Chile and Argentina where it is possible to find famous Arauco's olive even today. Recently, olive has started to influence other areas of the World such as South Africa, Angola, Australia, China, and others. Its production extended even to a geographic area with monsoon characteristics that was considered unsuitable few years ago.

In pre-Himalaya regions of Northern Pakistan, Jammu & Kashmir, Himachal Pradesh (H.P.) and Uttar Pradesh of India, and Nepal, olive cultivation are being studied. Some significant results have been obtained for possibilities to exploit olive production. Olive is known as "Jaitoon" in Sanskrit, Arabic, Hindi, and Nepali. *Olea cuspidata* is a species locally known as "Lotto" in Dolpa and "Launtho" in Bajura districts of Nepal and "Kahu" in Himachal Pradesh, Jammu & Kashmir, and Uttarkhand states of India.

In Pakistan and India the cultivated olives (*Olea europaea* L.) were introduced in fifties as evidenced by the existing plantations in Mingora (SWAT), Rawalpindi, and Pinjore in India, where olive cultivation started 40 years ago. The first olive orchard was established at Jadhari in Solan District by the efforts of Maharaja Patiala's Family. In sixties and seventies, the H.P. government established olive plantations and launched a top-working programme of *Olea europaea* with *Olea cuspidata*. Technical Cooperation Programme of FAO/UNDP was launched to provide necessary technical support from 1975 for several years. With the Bilateral

Agreement between Indian and Italian Governments from 1984 to 1993, India has extended commercial olive plantation activities and olive oil industries in Himachal, Jammu and Uttarakhand (Bartolucci & Dhakal 1999) .

Introduction

Olive (*Olea europaea* L.) is undoubtedly one of the world's oldest cultivated crop originated from Asia Minor and has tremendous potential in India especially in mid hills and warm temperate regions of North Western Himalaya. It is a crop of Mediterranean region but grows well even under mild temperate conditions if chilling requirements are met. The tree is slow growing with very long life and attains a height of 3-15 meter or even more. The fruits are small to medium, drupe, 2-3 cm long and on ripening become blackish- purple while few cultivars are green when ripe and some turn to a shade of copper brown. Ninety percent of its fruits are mainly utilized for extraction of oil and on a limited scale they are used for table purpose and in making pickles and in salad.

Olive is member of family *Oleaceae* and *Olea europaea* is only species which produces edible fruits. *Olea cuspidata* also known as Indian olive are found in the Himalaya from Kashmir to Kumaon upto 2400 m altitude and this species is closely related to *Olea europaea* which is mostly used as root stock. The other species are *Olea crysophylla*, *Olea verrucosa* and *Olea laperrini* all are native to Africa but bear no edible fruits.

The place, time and immediate ancestry of the cultivated olive are unknown. It is assumed that *Olea europaea* may have arisen from *O. chrysophylla* in northern tropical Africa and that it was introduced into the countries of the Mediterranean Basin via Egypt and then Crete or the Levant, Syria and Asia Minor. Fossil Olea pollen has been found in Macedonia, Greece, and other places around the Mediterranean, indicating that this genus is an original element of the Mediterranean flora. Fossilized leaves of Olea were found in the palaeosols of the volcanic Greek island of Santorini (Thera) and were dated about 37,000 Before Present (BP). Imprints of larvae of olive whitefly *Aleurolobus (Aleurodes) olivinus* were found on the leaves. The same insect is commonly found today on olive leaves, showing that the plant-animal co-evolutionary relations have not changed since that time.

Botany

Inflorescence

A mature olive (*Olea europaea* L.) tree produces about 500,000 flowers but only 1–2% of them set fruit reach to maturity. Olive flowers are borne on inflorescences which called as panicles. The inflorescences are mostly developed at leaf axils and

have a central axis which is terminated by a flower. The primary branches arise from the central axis and may also have secondary branches. In some cultivars, tertiary branches are also found. The number of flowers and their distribution on the inflorescence are specific for each cultivar but can change from year to year (Lavee, 1996).



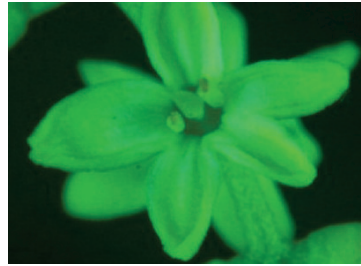
Flowering branch

Flower

The olive bears small and white flower. It comprised of four fused green sepals, four white petals, two stamens each with a large yellow anther and two carpels each with two ovules. Flowers are either perfect (hermaphrodite) or staminate (male). Perfect flowers characterized by a plump green pistil with a short, thick style and a large stigma. Staminate flowers do not have pistil or only a tiny, yellow aborted one. The proportion of perfect and staminate flowers varied according to genetic, climatic conditions, and the level of fruit production in the last year; therefore, it may vary from season to season, from tree to tree, from branch to branch, and from inflorescence to inflorescence. The viable pollen grains are produced by both perfect and staminate flowers but only the perfect flowers set fruit.



Flower buds



Hermaphrodite flower

Fruit

The fruit of the olive tree is a drupe which comprised of the epicarp or epidermis, the mesocarp or flesh and the endocarp or pit which consists of a woody shell enclosing one or, rarely, two almonds (seeds). However, it differ from all others drupes in their chemical composition as its fruits have low concentration of sugars, 2-5% versus around 12%, a high oil content, 20-30% versus 1-2%, and in their characteristic strong bitter taste. The strong bitter taste is due to the presence in the olive of the glucoside, oleuropein, which does not occur in any other fruit or tissue in the plant kingdom.



Fruiting

Seed

The olive seed developed by in various stages. The fruits of olive horticulturally mature in Indian condition in the month of mid September to mid October as well as November and physiologically in the month of November. The mature seed is covered with a thin coat that covers the scratch-filled endosperm. The latter surrounds the tapering, flat, leaf like cotyledons, short radical (root) and plumule (stem). Seed size and absolute shape vary greatly according to cultivars.



Seeds

Root system

The root system of olive is featured by shallow root systems. This allows olive roots to collect water from soil that have an attributes of drying fast. The shallow root system ensures the tree gets enough moisture to stay hydrated. While shallow root systems get water faster, they can also become exposed more easily. There is always possibility of damage from the elements and from landscaping tools such as lawn mowers and weed trimmers.

Leaves

In olive (*Olea europaea* L.) leaf is simple, subsessile, thick, coriaceous, lanceolate to obovate, more or less pointed at the apex. The margins are entire and folded abaxially. Nervation of the leaf is reticular. The upper surface is dark-green, glabrous and shiny, the lower surface shimmering silver and tomentous (densely pilous).



Leaves

Main branches

The branches originate at a height of 1.2 m in the classical olive grove and at 20-40 cm in the modern dense olive plantings. The number of branches is three or more. The main branches give secondary and territory branching bearing the leaves, flowers and fruits. The small shoots are classified in to four categories:

Vegetative shoots: bearing only vegetative buds and producing new shoots and leaves.



Vegetative shoots

Fruit bearing shoots: bearing flower buds: their number is greater in the low vigor trees.

Mixed shoots: bears vegetative and flowering buds concurrent ly: the flowers and fruits are borne at the base of the mixed shoots.

Water sprouts: originating from the trunk, branches and the thick shoots: these are very vigorous, grow vertically and they should be removed unless they are going to substitute for a low vigour branches.

Trunk

The olive trunk is cylindrical, with an uneven surface, bearing a lot of swellings. The wood is yellowish and darker towards the centre of the trunk.



Tree trunk

Taxonomic classification and species

Olea europaea, the olive tree, means olea-olive and *europaea*-Europe. So *Olea europaea* is the “olive from Europe.” The common name olive comes from the Latin word oliva and the Greek word elaiia. Olive belongs to the family Oleaceae, genus *Olea*. It has two main subspecies i.e. *Olea europaea* ssp. *cuspidata* (Wall. ex G. Don) Cif. – African olive; *Olea europaea* ssp. *europaea* L. – European olive. African olive has several synonyms includes Synonym(s): *Olea africana* Mill., *Olea chrysophylla* Lam., *Olea europaea* ssp. *africana* (Mill.) P. Green, *Olea ferruginea* Royle, and *Olea verrucosa* (Willd.) Link. Therefore, it can be placed as under

Species

Oleaceae has more than 30 species native to South Africa, New Zealand, India and Afghanistan. The species *Olea chrysophylla* is considered to be its wild ancestor who is native to Africa and Asia. It is highly polymorphic species as nine different geographic types have been described; some of them such as, *O. excelsa* of the Canary Islands have been evaluated to the status of the species. Intermediate taxa, between *O. chrysophylla* and *O. europaea*, is *O. laperrini* found in central Sahara and in Morocco. Some, however, consider the Euro-Mediterranean olive (cultivated *sativa* or wild *oleaster*), the *laperrini* and the Asiatic *cuspidata* as the three species of *O. europaea*. However, there are at least five natural subspecies distributed over a wide range: *Olea europaea* subsp. *europaea* (Europe), *Olea europaea* subsp. *cuspidata* (Iran to China), *Olea europaea* subsp. *guanchica* (Canaries), *Olea europaea* subsp.

maroccana (Morocco), *Olea europaea* subsp. *laperrinei* (Algeria, Sudan, and Niger). The salient characteristics of these species are given below:

***Olea chrysothylla*:** It is native to North Africa, however, found in abundance in Asia also. The species is highly polymorphic and numbers of its geographic types are common in its native place. Small tree, branches are slender or scurfy upward. Leaves are lanceolate, 5-10 cm long, petiole short or very short. Flowers are small in size (0.3 cm long) and are borne in axillary panicles. Fruit is a drupe, globose or somewhat long in shape and blackish in colour.

***Olea dioica* Roxb.:** Distributed in Eastern Himalayas, Duars, Assam and in Deccan peninsula chiefly in Western Ghats. Its wood has sweet scent thus known as Rose sandalwood, suitable for carving and cabinet work, also reported for medicinal uses. The bark is reported to be used as febrifuge. The leaves may be used as green manure.

Olea europaea* var. *communis (cultivated olive): A handsome, grey-green tree; bark is grey in colour and branches are obtuse angled. Leaves are lanceolate, willow-like in shape and fruits are globular or oblong.

***Olea europaea* subsp. *europaea* var. *europaea*:** Commercial olives are being produced from this species are of edible quality. Trees are small trees rarely exceed 6-8 m a few can up to 20 m. The wood is resistant to decay, and when the top of the tree is killed by mechanical damage or environmental extremes, new growth arises from the root system. The root system is generally is shallow, spreading to 0.9 - 1.2 m even in deep soils. The above ground portion of the olive tree is recognizable by the dense assembly of limbs, short internodes, and compact nature of the foliage. Leaves opposite thick, leathery, growing over 2-years period. Stomata on abaxial surface nestled in peltate trichomes reducing transpirational loss of water, which imparts relative drought resistant to olive tree. Leaves lanceolate or oblong in shape. Racemes of yellowish white fragrant flowers are borne on forking panicles emerging out from leaf axil, considered a native of Asia Minor. Fruit attains horticultural maturity during November.

***Olea ferruginea* Royle syn *O.cuspidata* Wall. ex G. Don:** It is found in Himalayas from Kashmir to Kumaon hill and known as Indian olive; wood is whitish, it's durable and resistant to fungal attack. Fruits are edible. The timber is used chiefly for tool-handles, walking sticks, croquet balls, mallets, combs, toys, turnery articles, carving, ploughs, and ginning machines and boat-building. Suitable for engraving, printing blocks and for mathematical instruments. The fruits are edible. Leaves and bark are used as antipyretic in fever and debility. Leaves considered as a cure for gonorrhoea.

***Olea grandulifera* Wall. Ex G. Don:** In India it is found in outer Himalayas from Kashmir to Nepal, hills of South India. A handsome, medium sized the wood is used

for house construction, carpentry, agricultural implements and turnery. The bark and leaves are astringent and are used as antipyretic in fevers. Plants small bushy glabrous tree, bark is dull grey in colour, branches spreading and alternate. Leaves are large in size, elliptic-lanceolate in shape. Fruits are small in size, round to oblong and inedible. Flower white bisexual in terminal and lateral compound pyramidal panicle, petal rounded.

Olea laperrini: Wide spread in Morocco and central Sahara. Is regarded as an intermediate taxa between *Olea europaea* and *Olea chrysotholla*

***Olea europaea* var. *oleaster* or *Olea europaea* var. *sylvestris* (wild olive)**: Plants are medium to tall, 20 feet sometime even more, wild form, thorny, branches are four angled. Leaves are elliptic or oblong, fruits small, roundish and inedible. It is used as rootstock for cultivated forms.

Nutritional and medicinal importance

Olive oil is the healthiest oil among all the edible oils. It has high percentage of monounsaturated fatty acids which reduces LDL cholesterol and increases HDL-Cholesterol. It has tocopherols, a, b, g, d (a-tocopherols covers 88%). The ratio of vitamin-E to polyunsaturated fatty acids is better than in any other edible oils. It contains pigments like chlorophyll, pheophytin and carotene etc. Its oil is antipyretic, antiseptic, astringent, back cholagogue, demulcent, emollient, febrifuge, hypoglycemic, laxative and sedative. The oil is also used internally as a laxative and to treat peptic ulcers. It is said to be substitute for quinine in the treatment of malaria.

Area and production

Majority of olive producing countries lies in the Mediterranean basin and contributes around 98% of the world total production of olive and olive products. It is grown over an area of about 9.4 million hectares in the world with a production of 20.81 m tonnes and a productivity of 2.10 t/ha (FAO, 2016). Spain is a leader with production 4.56 m tonnes from an area of 2.52 million hectares however productivity was recorded highest by Egypt 9.29 t/ha (FAO, 2016). In Asia, cultivation is mostly confined to Iraq, Iran and China however, in India in spite of its vast potential it is grown only in an area of about 400 ha mostly in the Himalayan mountainous region encompassing the three northern states like Jammu and Kashmir, Himachal Pradesh and Uttarakhand hills at an altitude ranging from 1000 to 1300 m above mean sea level. Among the states Jammu & Kashmir leads with an area of 276 ha spread in the districts of Doda, Udhampur, Rajouri, Poonch, Kupwara, and Baramulla. The district Doda has the maximum area (59.76 %) followed by Udhampur (15.5%). The results of evaluation of some olive cultivars under temperate condition even at more than altitude of 1600 m above msl also found encouraging

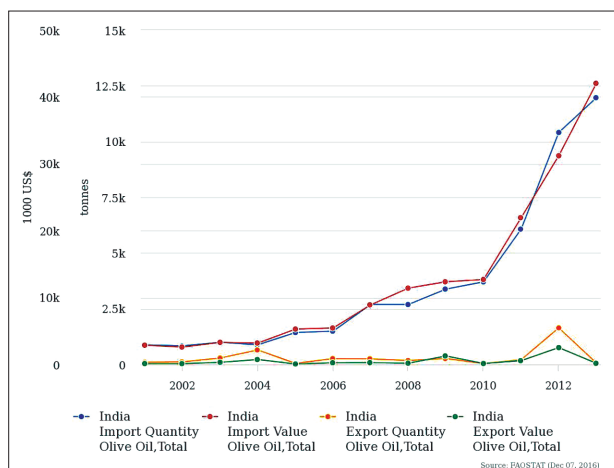
Table1: Top ten countries in olive area, production and productivity

Country	Area (mha)	Country	Production (m ton)	Country	Productivity (t/ha)
Spain	2.52	Spain	4.56	Egypt	9.2981
Tunisia	1.59	Italy	1.96	Peru	8.9343
Italy	1.16	Greece	1.78	China, Taiwan Province of	8.4052
Morocco	0.95	Turkey	1.77	China	8.4052
Greece	0.94	Morocco	1.57	United States of America	5.7559
Turkey	0.83	Egypt	0.57	Iraq	5.5273
Syrian Arab Republic	0.70	Algeria	0.48	Chile	5.2688
Algeria	0.38	Portugal	0.46	Afghanistan	3.2304
Portugal	0.35	Syrian Arab Republic	0.39	Montenegro	3.0602
Libya	0.30	Tunisia	0.38	Argentina	2.8155

(FAO, 2016)

Trade

India’s olive oil imports are expected to rise 20 per cent to 13,500 tonnes 2015-16 fiscal on the back of rising demand in metros and tier II cities. The country had imported 11,106 tonnes of olive oils, 65 per cent of which is sourced from Spain, in 2015-16 fiscal. There has been tremendous growth has been seen since 2000. During the year 2000, the total olive import was 523






Status of import export of olive oil from 2002-2013





tonns only which was increased 11965 tonn during 2013 (FAO, 2014) which showed great potential of this oil crop.

Varieties identified for higher productivity

At ICAR- Central Institute of temperate Horticulture, Srinagar, a total of nineteen olive (exotic) cultivars have been evaluated for plant growth parameter, oil content and fruit yield characteristics. The following olive varieties were found suitable for commercial cultivation and on average year to year oil content among cultivars vary from 15-25% and the salient features of important cultivars are given below:

Table 2: Varieties and their descriptions found suitable for temperate region

No.	Variety	Salient features	Figure
1	Coratina	A high oil yielding variety with cold tolerance characteristics. Highly self sterile but starts bearing early and ripens late. Tree is medium vigorous, dense, spreading growth habit with very good adaptability to different soils and climates. Fruits are large, green color, elongated ovals and asymmetrical in shape. Yields high quantity of good quality oil which is exceptionally high in polyphenols, resulting in excellent stability.	
2	Pendolino	Moderate in vigour with dense drooping growth habit. Flowering early and profuse with long bloom period which makes it an ideal pollinizer. Self-incompatible, fairly tolerant to cold temperatures. Fruit small, delicious green and black table olive. Maturity is mid season. Susceptible to olive knot and peacock spot, it is highly susceptible to <i>verticillium</i> and sooty molds, moderate susceptible to the olive fly.	
3	Cipressino	This has vigorous vegetation, rapid upward growth with a typical rising habit and gathered crown. The fruits are rounded oval shape. Maturation is spread out but is complete between the middle of November and the middle of December. Beside this it is a self-sterile variety of excellent and constant fruiting with a notable percentage of aborted ovaries (50-60%). Pollinators: Frantoio, Leccino, Pendolino. Excellent resistance to high winds, good resistance to climatic extremes and parasites.	

4	Frantoio	A dual purpose variety with moderately vigorous with spreading-drooping growth habit and medium-dense canopy. Yield fairly high and consistently, high adaptability and cold sensitive. Frantoio is self-fertile, but using pollinizers increases yields. Pendolino and Leccino can be used as pollinizers, it is susceptible to peacock spot, scale insects and olive knot and also moderately susceptible to olive fly and to <i>verticillium</i> wilt. It is world's premier oil varieties with high oil yield. Frantoio is a late ripening variety.	
5	Picholine	Picholine are green olives of French origin. It is partially self-fertile, Manzanillo and Leccino are good pollinizers. Resistant to leaf spot, moderately resistant to olive knot and <i>verticillium</i> wilt, with medium level of drought and cold tolerance and attractiveness to olive fly. Freshly brined right after being picked in citric acid has a subtle and mild salty taste.	
6	Leccino	A rustic variety and widely planted throughout the world. The tree is quick to produce and resists well adverse climatic conditions and parasites. More recently it has been used for the production of table olives, semi-ripe or black. This variety is self-sterile and so needs a pollinator, principally Pendolino or Picholine.	
7	Messenese	A green olives variety with partially self-fertile, Coratina and Pendolino are good pollinizers. Large fruit size with heavy bearing and has medium level of drought and cold tolerance and attractiveness to olive fly.	

Production technology

Climate

Olive tree like cool winters and hot summers (Mediterranean-like climate). In India it can be planted from 800-1400 m above sea level. Olive requires a temperature range of 7-25°C; however, 15-20 °C is ideal. Occurrence of prolonged hot and

dry summers coupled with acute water stress cause post anthesis flower and fruit drop. Adequate chilling 7.2°C during winter is essential to break rest period and to promote fruitfulness. Olive can grow well in a wide variety of soils, but for optimum growth and productivity it requires deep, fertile and well drained soil having pH range 6.5-7.5.

Pollination management: Olive trees produce two different types of creamy white flowers, a perfect flower, which contains both male and female parts, and a staminate flower with stamens only. The small feathery flowers, with ten-cleft calyx and corolla, two stamens and bifid stigma, are borne generally on the last year's branches, in racemes springing from the leaf's axils. The flowers are largely wind pollinated with most olive varieties being self-pollinating, although fruit-set is usually improved by cross pollination with other varieties. There are self-incompatible varieties that do not set fruit without other varieties nearby, and there are varieties that are incompatible with certain others. Therefore to overcome this problem variety and pollinizers combination were identified as given below.

Table: Varietal cross compatibility studied at CITH, Srinagar

Variety	Pollinizer
Frontoio	Picholine, Leccino
Cipressino, Picholine	Leccino
Leccino	Picholine, Pendolino
Coratina	Frontoio, Picholine, Messenese
Pendolino, Messenese	Coratina, Picholine
Messenese	Coratina, Pendolino

**At least 10% pollinizer variety should be planted in commercial orchard.*

Training and pruning

There are many ways to manage the olive canopy but a few general training forms are widely adopted. Olive trees normally grow in a basal form, which means that lower laterals will grow just as vigorously in as the leader. The easiest way to manage this tree habit is to allow for the development of 3 or 4 scaffold branches and to keep the center open to maintain good light exposure in the lower portion of the tree. Unless the desire is for a low bush-shaped tree with multiple trunks, the single trunk tree is much preferred. Single trunk trees provide ease in inter-culture operation. Olive trees store most of their energy in their leaves, and unlike deciduous trees do not show much response to pruning. In this condition main task of pruning is to modify the vegetative growth and regulate its production efficiency. It should also aim at lowering the bearing head, removal of non-bearing wood and proper spacing

of shoots. This is attained by thinning out and light heading back of shoot. Olive bears fruits on one year old branch and pruning is generally practiced after every years or two years as per condition. Management and higher yield, light pruning in winter +balanced dose of fertilizers and other orchard management leads to bearing from un-bearing trees.



Olive tree with Single trunk



Olive tree with 3-4 scaffolds



Olive tree with multiple trunks

Propagation

Commercially olive can be propagated by stem cuttings. A semi-hard wood cutting of 12-14 inch long, 1-3 inch wide and 4 nodes cuttings from the two year old wood of a mature tree is treated with a IBA @4000 ppm, planted in sand +Soil (1:1) found effective. Grafting and budding can also be done on rootstocks such as *Olea europaea* var. *Oleaster* seedlings (wild form) and *Olea cuspidate* (Indian native olive or locally called as Kahu). The time of budding and grafting is important. Best periods for budding (May-June) and grafting (Nov.-Dec.). The rootstock should be 9-18 month old. Even micro-propagation technique also standardized. To improve wild olive tree and rejuvenation of old senile tree, the top working by side veneer grafting method of these tree during July showed better success (50%).



Propagation under controlled condition with different rooting media

Planting

The planting density should be done at 8m. x 8 m. apart to accommodate 150 trees/ha, whereas, it should be 400 trees/ha with planting distance of 5m x 5m in square system or in rectangular plantation system, a planting distance of 8m×5m or 6m×5m corresponding to a planting density of 250 and 333 tree/ha can also be accommodated.

Inter cropping

Since olive comes in to bearing in 5-7 years after planting. Initial years no return comes from the plant and they also planted at wider space, therefore during initial years the strawberry, cape gooseberry, saffron, leguminous vegetable or nursery raising activities could be taken up as intercrop to utilize space between the row and generation of income from the same land.



Intercropping of olive and saffron

Weed management

Weeds compete directly or indirectly with the use of water and nutrients applied in the olive orchards besides also build-up hard pan and increase plant debris in orchards which creates an obstacle in intercultural operation. In established orchards weeds are controlled between tree rows by dicing or moving, and a basal treatment of herbicide is applied around each tree or in a strip application down the tree row. The pre-emergence herbicides can also be applied to either a square or circle around each tree at least (1.2 to 1.8 m) across, or as a band down the tree row.

Water management

Olive trees are considered one of the drought-tolerant species which can survive under water stress during tree growth and development periods and a little water support tree longevity. But to get optimum yield irrigation should be provided at critical stages like:

- Fruit bud differentiation
- Flowering
- After fruit set
- Fruit development (stone hardening stage)

Drip irrigation in commercial olive orchards brought considerably higher olive oil yield (30% – 50%), water savings (30% – 45%), and improvement in oil qualitative characteristics, in comparison to rain-fed and surface flood irrigation methods.

Nutrient management

At pre- bearing stage, 20 kg FYM, N (225g), P (150 g), K(150g) or can be supplemented by CAN (900g), single super phosphate (900), MOP(240g) should be applied however, bearing tree (8 years and above) 50kg FYM, N (750g), P (500g), K(500g) or can be supplemented by CAN (3000g), super phosphate (3000 g), MOP(800g). The whole quantity of phosphorus and potasic should be applied along with FYM and borax during Oct.-Nov. in irrigated areas but onset of winters in arid regions. Nitrogen should be applied in 3 spilt doses. 1/2th dose of N immediately after harvesting or with onset of winter (Dec.), 1/4th during June July. Foliar spray of Borax 0.5 % has been recommended at flowering stage to enhance fruit set, fruit retention and overall yield.

Maturity indices and harvesting

For olive oil production, irrigation should be stopped for the weeks leading up to harvest to avoid accumulation of high moisture content in the fruit and difficulties during oil extraction. Optimum moisture content is 50%. Use freshly picked olives (no longer than 24 – 48 hours from picking to processor) for producing extra virgin olive oil. Maturity at harvest is the most important factor that determines the shelf life and quality of the fruit. The olive fruits reach their best when allowed to ripen on the trees. Therefore, maturity indices are important for deciding when the olive fruits should be harvested.



Harvesting of olive fruits

For temperate condition

At ICAR-CITH, Srinagar, maturity indices for getting maximum oil extraction from the fruits was recorded and initial results showed that from second week of Oct. to first fortnight of Nov. month, was found best to harvest fruits to get higher oil percentage in Coratina, Leccino and Pendolino however in Messinese, Cipressino and Picholine from second fortnight of Oct to end of Oct. found suitable for harvesting the fruits to get maximum oil yield.

For sub temperate condition

The maturity indices of the fruit revealed that under sub-temperate condition the olive fruits of cvs Zaituna, Coratina, Picolina, Etna & Itrana should be harvested after September except Leccino and Messinese when their index reaches above three which correlates with high oil content of different varieties.



Maturity stages of different genotypes of olive

The harvesting methods include manual, such as small hand rakes, picking bags with harness, pneumatic olive harvesters and limb shakers. The traditional method of beating olives off the tree is not recommended.

Disease and insect management

Major diseases

Disease/pest	Symptoms	Management
Root rot	Caused by fungus <i>Armillaria mellea</i> . Infected bark and outer wood of the upper roots and crown show discoloration. Infected roots have white to yellowish fan-shaped mycelial mats between the bark and the wood.	Remove soil from around the base of the tree to a depth of 9-12 inches. Leave the trunk exposed and keep the upper roots and crown area as dry as possible.

Disease/pest	Symptoms	Management
Leaf mould	Caused by fungus <i>C. cladosporioides</i> or <i>Pseudocercospora cladosporioides</i> . First signs appears as grey blotches on the underside of the leaves, the top of the leaves turn yellow and these leaves may fall, causing some defoliation. Fruit can also develop small, brown lesion spots and not mature uniformly.	Prune to open the canopy for improved airflow. Reduce nitrogen use to prevent excessive canopy growth. Avoid excessive irrigation. Copper can be applied before the start of spring or autumn rains.
Peacock spot (olive leaf spot) and 'Bird's-eye spot'	Caused by fungus <i>Spilocaea oleagina</i> . Peacock spot appears on leaves as sooty blotches that develop into black, circular spots about 2.5–12 mm in diameter. There may be a yellow halo around the spot. The typical symptoms are the appearance of sooty blotches on the leaves that later become muddy green to black, often with a yellow halo. Often the leaves drop prematurely.	Prune to open the canopy for improved airflow. Reduce nitrogen use to prevent excessive canopy growth. Avoid excessive irrigation.
Bacterial stem cankers and dieback	It is caused by bacteria, <i>Pseudomonas syringae</i> , <i>Xanthomonas campestris</i> , and <i>Ralstonia solanacearum</i> . These bacteria enter plants through pruning wounds or where frost/cold injury cause stems tissue to crack or peel. Symptoms vary from slow decline of trees and tree death, to localized cankers around wound sites.	Avoid wounding trees, as this acts as an entry point for bacteria. Copper can be used as a protectant, but is not able to eradicate established infections.
Olive Fruit Fly (<i>Bactroceraoleae</i>)	It is considered the most damaging pest of olives all over the world. Damage by olive fruit fly includes oviposition “stings” on the fruit surface, fruit drop, or direct pulp destruction rendering fruits useless for canning. Larval feeding allows microorganisms to invade the fruit, causing rot and lower oil quality.	Remove old fruit remaining on trees following harvest. Olive fruit fly adults feed on honeydew, reduction in black scale populations reduces a food source needed during high summer temperatures. Cultural controls, the use of GF-120 Fruit Fly Bait, sprays of kaolin clay, and mass trapping found effective measures.

Processing and Value addition

The olive fruit is a drupe and cannot be eaten straight. The olive fruit contain a distinctive, bitter principle called oleuropein which has a strong, bitter taste and necessary to remove from olive before consumption. Primarily olive are processed for removal the bitterness, preservation of the fruit and enhancing flavor and being processed accordingly viz., oil, pickle and culinary etc. Olives are being cured since ancient times that make naturally bitter fruit in to a deliciously salty, tart snack. Water curing, brining, dry curing and lye curing each yield distinctly different flavors and textures. From olive different value added product can be prepared such as olive pickle, jam, chatni, syrup, vinegar, tea, lip balm, luxury soap and crude olive cake.



Brined olives

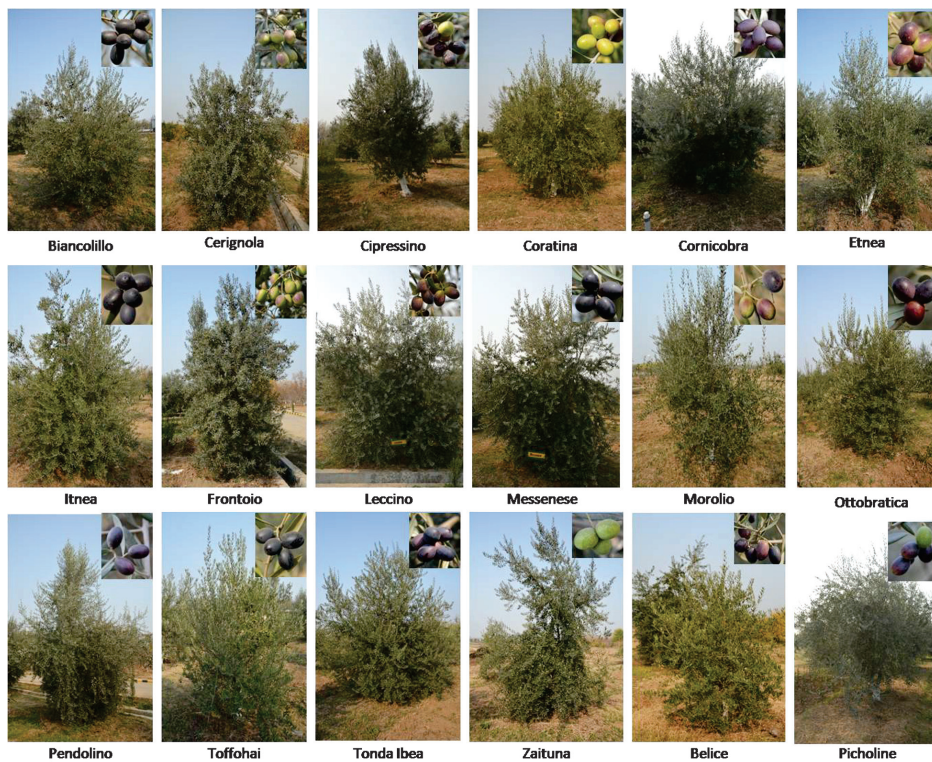


Figure: Olive genotypes in bearing at ICAR-CITH, Srinagar