

VSC 507 Production Technology of Underexploited Vegetables

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VSC 507 Production Technology of Underexploited Vegetable Crops 2+1

Theory

Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures and seed production of:

UNIT I

Asparagus, Jerusalem artichoke, leek and drumstick

ASPARAGUS

ASPARAGUS

BOTANICAL NAME	<i>Asparagus officinalis</i> L.
CHROMOSOME NUMBER	2n=2x=20
COMMON NAME	Satavari
FAMILY	Liliaceae

INTRODUCTION

- Asparagus is an herbaceous perennial and is grown in large areas in countries like USA, Germany, Spain and France, while India's contribution is meager.
- The tender shoots called 'spears' are used as vegetable and in preparation of soup.
- It is also eaten as salad.
- The canned and frozen spears are also used as processed foods.
- The tender shoots contain a white crystalline substance, asparagine, which is used in medicine as diuretic in cardiac dropsy and chronic gout.
- It has good potential as fresh vegetable.

ORIGIN

- Asparagus has been grown for many years.
- The Ancient Greeks and Romans relished this crop.
- It originated in Asia Minor and is a member of the lily family.
- California, Michigan, and Washington are the major producing states, but there is some commercial production in many of the northern and western states.
- Warm regions such as Northern Mexico and Southern California also grow it.
- Recent research has shown that asparagus can be grown at a profit in India too.

NUTRITIVE VALUE (per 100 g of edible portion)

Moisture (%)	91.7	Fat (g)	0.2
Thiamine (mg)	0.12	Calcium (mg)	15.8
Carbohydrates (g)	2.9	Energy (Kcal)	20
Vit. B ₂ (mg)	0.13	Fe (mg)	0.7
Protein (g)	1.7	Vitamin A(IU)	762
Vitamin C (mg)	25	P (mg)	46.9

CLIMATE

- Asparagus is grown in temperate and sub-tropical regions.
- Mean day temperature of 25-30°C and 15-20°C at night are ideal.

SOILS AND SOIL PREPARATION

- Well drained soils are must for successful production, and sandy soils are also preferred.
- Good drainage is important to control crown rot disease.
- Commercial plantings of asparagus should not be made in soil that is heavier than a sandy loam.
- Avoid sites which retain standing water for more than 8 hours after a heavy rain.
- The optimum pH is 6.5-7.5.

VARIETIES

- Many new asparagus varieties are now available.
- Varieties are broadly divided into two groups,
 1. With green coloured spears : more popular and mainly used in fresh market
 2. With white or light green coloured asparagus - mainly used for processing.
- All available male hybrids are more productive and do not produce seed which sprouts to become a weed.
- Jersey Gem, Jersey Giant and Greenwich produce superior yields in North Carolina.
- Jersey Gem has the added benefit of having tolerance to the disease *Cercospora* leaf spot.
- The increased yields of hybrids make them worth the extra seed cost.

Perfection:

- Recommended by IARI, New Delhi.
- It is an early, uniform, productive variety, delicious with high food value.
- The spears are large, green, succulent and light tipped.
- Average yield is 80-100 q/ha.

Selection-841:

- Bush type, medium, uniform plants and productive.
- The spears are 15-20 cm long, succulent, tender, green with better flavour and suitable for soup preparation.
- Yield is 90-110q green spears/ha.
- Despite these varieties, UC-72, UC-66 and Sel-831 are also grown in Kashmir, India.

SEASON/SOWING TIME

- In hills : March-May
- In plains : July-November

SEED RATE

- Asparagus can be propagated through seeds, seedlings and crowns but most commonly followed practice is through seeds only.
- It requires about 3-4 kg seed for cultivation in one hectare.

NUTRIENT MANAGEMENT

- Apply chicken manure @75-125 quintals per hectare or Farm Yard Manure@150 to 250 quintals per hectare as basal dose.
- In addition, during succeeding years, apply 80-120kg of nitrogen, 80-100kg of phosphorus and 60-80kg of potassium per hectare twice in a year.
- Make one application of N, P and K just before first appearance of spears in the spring in early March.
- Apply the same amount of fertilizer at the conclusion of the harvest season in mid-May.
- Apply the fertilizer to the top of the soil or with very shallow incorporation.

PLANTING

There are three methods of planting

a) Crown planting

- Use only certified crowns for planting as they may carry several diseases
- Plant asparagus crowns (roots plus plant buds) so that the top of the crown is 15 cm below the soil level.
- Depth of planting is critical, if planted too shallow, asparagus will produce a large number of small spears that are not commercially salable.
- If planted too deep, spears will be very large, but will be few in number.
- Plant crowns 30 cm apart in the row with the buds upright, and 150 cm between rows to have 21,750 crowns per hectare.
- Cover crowns with 5-7.5 cm of soil after planting.
- As plants grow, gradually fill in the rest of the furrow with 2.5-5 cm of soil in 3-5 cultivations, but do not completely cover plants.
- The furrow should be completely filled by July of the first year.
- Plant before the buds begins to appear in the spring.
- Both direct seeded and transplanted asparagus can be planted in single or double rows with 5 foot spacing between beds.
- Single rows should be planted on top of "W" shaped beds (Fig.15.1).
- The "W" shaped rows are formed with a wide furrow opener followed by a beds shaper.
- Double rows of direct seeded or transplanted asparagus should be planted on shelved beds (Fig. 15.2).
- Transplants can also be planted on the side of an angle-shaped furrow (Fig. 15.3). The "V" shape in the middle of the row is important since it provides a place for soil washed from the side of the beds during rains (Fig. 15.4).

b) Direct seeding methods

- Seeds should be placed 5 cm apart in the row, 2 to 2.5 cm deep.
- Single row seedlings require 2.5-3.4kg of seed per hectare and double row seeding require 4.5 to 6.8 kg seeds per hectare.
- Asparagus seeds germinate best at 24°C.
- Direct seeding is preferred when the soil temperature is at least 16°C.

c) Seedling transplant method

- Asparagus seedlings can be grown successfully in peat pots, plastic pots, trays, peat pellets or seedling type trays.
- Seedling growth and survival are usually better with larger cells up to 5x5 cm seedling cells.
- Most of the artificial soil media produce a good transplant.
- Good growth above the crown and good root system development require planting the seed not more than 1.25 cm deep.
- Transplanting of seedling is preferred after the threat of frost but before temperatures get above 32°C.
- Favourable conditions usually occur in April and May.

DIRECT SEEDING AND TRANSPLANTING

- Direct seeding have the following advantages over crown planting:
 1. Reduced costs, mechanization of planting, freedom from disease and increased yields are few advantages of this method.
 2. But these methods require more care, closer attention, irrigation and better management than crown planting.

USE OF PLANT GROWTH REGULATORS

- Abscisic acid appears to promote sink strength or encourage phloem uploading.
- Gibberellic Acid promotes growth of asparagus buds.
- Butyric Acid supports spear emergence.

IRRIGATION

- Adequate moisture should be maintained for good germination and early seedling growth.
- Do not let asparagus plants become dry while they are establishing a root system during the first two months.
- Water stress during this early stage can reduce yields.
- After the root system is established, irrigation is needed only during extreme drought.

WEED MANAGEMENT

- Weed control in asparagus production is very important.
- Timely cultivation is a critical part of any asparagus weed control program, especially during the first two years.
- The first year asparagus should be cultivated at least once in a month until September or 6 times.
- The number of cultivations may be reduced by using herbicides.
- Remove all weeds that are present after harvest.
- Use only very shallow disking (2.5 to 5 cm) to remove these weeds.
- Deeper disking will damage crowns and can drastically reduce yield.

HARVESTING

- Asparagus can be harvested on limited basis (2 to 3 weeks, or 8 spears per plant) during the first year after planting.
- Harvesting should be limited during the second year as it results in slight reduction in spear size which is as an indication of when to stop.
- It takes a long time for asparagus to develop a large root system.
- A large root system is necessary for a healthy bed of asparagus to produce for many years.
- Do not harvest too much in early years because bed life can be shortened and total yield and profit drastically reduced.
- Harvest 6 to 8 weeks during the third year of growth, generally until mid-May.
- Allow spears to reach 20 cm tall and then cut with a knife or hand snap at the soil surface.
- Spears should not be allowed to get taller than 22.5 cm.
- The decision on when to harvest is based on having an average of one harvestable size spear per foot of row.
- When temperature exceeds 27°C, it may be necessary to harvest daily.

BLANCHING

- Mounding the soil to a height of 25-30 cm over the rows is practiced to blanch the young spears and get 'white asparagus' for canning.
- After harvest, the spears should be held in a cool shaded place and sprinkled with water to prevent shriveling and wilting.

- A single irrigation sprinkler over the boxes works well. Asparagus should be hydro cooled before packing.

MARKETING

- When preparing asparagus for market, spears should be uniform in length.
- Tie in bunches of 500-1000g or pack loose in a carton.
- Asparagus loses edible quality rapidly and should be cooled as soon as possible.
- After bunching, place the butts of the spears in damp peat moss or blotter paper in a crate or carton.
- Pack 6.8 or 13.6 kg in special pyramid-shaped crates.

YIELD

- Male plants give the higher total yield while female plants produce larger individual spears.
- Yield varies with varieties, region, climate, and sex form.
- On an average, 25-40 q spears are produced in one hectare

STORAGE

- Asparagus can be stored for 2-3 weeks at 95 per cent relative humidity and at 0-2°C.
- Spears stored in wet tissue paper looked fresh and firm after 13 or 16 days of storage.

Jerusalem Artichoke

- The Jerusalem artichoke (*Helianthus tuberosus*) is a large, perennial sunflower native to the Great Plains of North America.
- It is closely related to the common sunflower (*H. annuus*) that grows along roadsides and vacant fields throughout the western United States.
- It has been cultivated by native Americans for centuries, and was introduced into Europe in the early 1600s.
- Like true potatoes, it produces edible tubers at the ends of underground stems called rhizomes.
- The tubers contain "eyes" or buds and are technically modified stems rather than roots.
- The common name may have been corrupted from the Italian name for the plant "girasole articiocco".
- "Girasole" refers to the way the flowers turn to face the sun, and "articiocco" refers to artichoke.
- Some people say the tubers taste like artichoke hearts if they are steamed with the peel on.
- The peel imparts the artichoke flavor to this vegetable.
- The tubers are eaten raw in salads, steamed, fried, baked and mashed. Raw tubers are very crisp and sweet, with a taste more like water chestnuts than potatoes.
- Jerusalem artichokes provide an abundant source of nutritious, tasty tubers in poor soils with very little care.
- The original name of "sunchoke" was applied to a hybrid between the Jerusalem artichoke and the common sunflower.

Description

- It is an herbaceous perennial plant growing to 1.5–3 m tall with opposite leaves on the lower part of the stem becoming alternate higher up.
- The leaves have a rough, hairy texture and the larger leaves on the lower stem are broad ovoid-acute and can be up to 30 cm long and the higher leaves smaller and narrower.

- The flowers are yellow, produced in capitate flower heads which are 5–10 cm diameter, with 10–20 ray florets.
- The **tubers** are elongated and uneven, typically 7.5–10 cm long and 3–5 cm thick, and vaguely resembling ginger root, with a crisp texture when raw.
- They vary in color from pale brown to white, red or purple.
- The **tubers** of Jerusalem artichoke contain fewer calories than potatoes, and they are especially high in vitamin A, the B-complex, potassium and phosphorus.
- They contain the polysaccharide inulin instead of starch, which is a nutritious food for diabetics and hypoglycemics.
- The hydrolysis of inulin yields fruit sugar (D-fructose), while true insoluble starch (amylopectin) yields D-glucose.
- Starch (amylum) is actually composed of two polymers, soluble starch (amylose) and insoluble amylopectin. Starch polymers are packed into membrane-bound starch grains or amyloplasts within plant cells.
- Sugars from the digestion of inulin do not elicit rapid insulin production compared with other starchy foods.
- Jerusalem artichokes have 650 mg potassium per 1 cup (150g) serving.
- They are also high in iron, and contain 10-12% of the US RDA of fiber, niacin, thiamine, phosphorus and copper.

Etymology

- Despite its name, the Jerusalem artichoke has no relation to Jerusalem, and it is not a type of artichoke, even though both are members of the Daisy family.
- The origin of the name is uncertain.
- Italian settlers in the USA called the plant Girasole, the Italian word for sunflower because of its resemblance to the garden sunflower.
- Over time the name Girasole may have been corrupted to Jerusalem.
- To avoid confusion some people have recently started to refer to it as sunchoke or sunroot.
- The artichoke part of the Jerusalem artichoke's name comes from the taste of its edible tuber.
- *Samuel de Champlain*, the French explorer, sent the first samples of the plant to France, noting that its taste was similar to an artichoke.

- Jerusalem artichokes were first cultivated by the Native Americans long before the arrival of the Europeans; this extensive cultivation obscures the exact native range of the species.
- The French explorer Samuel de Champlain found domestically grown plants at Cape Cod in 1605.
- The Jerusalem artichoke was titled 'best soup vegetable' in the 2002 Nice festival for the heritage of the French cuisine.

Cultivation and Uses

- Unlike most tubers, but in common with other members of the Asteraceae (including the artichoke), the tubers store the carbohydrate inulin (not to be confused with insulin) instead of starch.
- For this reason, Jerusalem artichoke tubers are an important source of fructose for industry.
- The crop yields are high, typically 16–20 tonnes/ha for tubers, and 18–28 tonnes/ha green weight for foliage.
- Jerusalem artichoke also has a great deal of unused potential as a producer of ethanol fuel, using inulin-adapted strains of yeast for fermentation.
- Jerusalem artichokes are easy to cultivate, which tempts gardeners to simply leave them completely alone to grow.
- However, the quality of the edible tubers degrades unless the plants are dug up and replanted in fertile soil.
- This can be a chore, as even a small piece of tuber will grow if left in the ground, making the hardy plant a potential weed.
- The tubers have a consistency much like potatoes, and in their raw form have a similar taste to potatoes.
- The carbohydrates give the tubers a tendency to become soft and mushy if boiled, but retain their texture better when steamed.
- The inulin is not well digested by some people, leading in some cases to flatulence and gastric pain.

LEEK

AIM: Leek is a non-bulb forming member of the onion family and is grown for its blanched stem and leaves. It is eaten raw alone or mixed in salads and cooked as flavouring in soups and stews. It is not grown in India on commercial scale but is a favourite vegetable in a kitchen garden. The climatic and soil requirements are the same as those for onion. The present chapter will make the students understand with its importance, production technology, seed production practices and plant protection measures.

BOTANICAL NAME	<i>Allium ampeloprasum</i> var. <i>porrum</i> L. Syn. <i>Allium porrum</i> L
CHROMOSOME NUMBER	2n=2x=32
COMMON NAME	<u>Leek</u>
FAMILY	Alliaceae

INTRODUCTION

- Leek is a non bulb forming tetraploid plant of onion family.
- Except large size it looks like green onion.
- Its cultivation is not commercial in India and grown only in kitchen garden.
- Leek is cultivated for blanched stems and leaves.
- It is a biennial plant, consumed as salad and used in flavouring the soups.

ORIGIN

- The *Allium* species are not evenly distributed with in the northern hemisphere, since most of them occur in old world.
- Leek is thought to have been derived from the sand leek (*A. ameloprasum*) which grows wild in southern Europe, North Africa and the Middle East.

NUTRITIVE VALUE (per 100 g of edible portion)

Energy (kcal)	77	Vitamin-A(IU)	30
Moisture (g)	78.9	Thiamine(mg)	0.23
Protein (g)	1.8	Calcium(mg)	50
Fat (g)	0.1	Iron(mg)	2.3
Carbohydrates(g)	17.2		

ADAPTABILITY

- Leeks grow best in a cool to moderate climate.
- The Willamette Valley and Oregon Coast are ideal.
- They can be grown all the year round.

SOIL

- A well aerated soil with both good drainage and good moisture retention capacity with a pH of 6.5-7 is best, which should not be subjected to flooding at any time.
- Deep ploughing is recommended so that a longer shaft can be developed.
- They can be grown successfully on mineral soils but in heavy clay soils, harvesting should be held up and the removal of surplus soil from roots may require more labour.

VARIETIES

Main fall varieties (August to October):

- American Flag, Jolant, Kilima, King Richard, Primor.

Late fall - winter (October to December):

- Derrrick, Electra, Goldina, Goliath, Kilima, Tivi, Wintereuzen.

Overwinter (spring harvest):

- Carina, Conqueror (moderate bulbing), Eskimo and Siberia.

These varieties mature in 80-120 days.

Characteristics of few varieties is given here under

PPL-1

- It is a selection from exotic germplasm.
- The whole plant is consumed.
- Leaves light green, swollen stem and do not form bulb.
- Ready in 150-160 days and good replacement for green onion.

Palam Paushtik:

- An alternative of green onion, suitable for salad, soup and cooking.
- Matures in about 140-150 days with average yield of 300-350q/ha.

SOWING TIME

- August – October is the ideal time of sowing in plains and seedlings are planted when they are 15cm height. In hills, it is sown in March-April.
- Leek withstands heat and cold better than onions.
- Temperature is more important than day length in seed stalk development.
- It thrives well in higher altitude.
- Seeds are produced in India at higher altitude.

SEED AND SEED TREATMENT

- About 5-7 kg of leek seeds is required to be sown per hectare, but leeks are not commonly direct seeded.
- Use treated high quality seed for transplant production.

- **Leek** seed, like other *Alliums* has very limited useful viability (less than 2 years) unless stored under ideal conditions.

Seeding and Transplanting

- Direct field seeding is possible but not recommended due to the lack of registered herbicides and length of time needed to harvest from direct-seeded plantings (8-12 months or longer).
- Leeks are normally transplanted.
- They should be seeded under protection early in the season (February to March) or in outdoor seedbeds (April to May).
- Leeks for harvesting in August-September should be sown from mid-February to mid-March.
- For harvesting in early winter sow the crop from mid-March to mid-April.
- For spring harvest, seed may be sown from April to mid-May.
- The right varieties (above) must be used for each harvest season.
- At transplanting, **leek** seedlings should be placed in furrows 15 cm deep.
- Furrows are filled in during cultivation and as the plants develop, the rows should be hilled up.
- Leeks should have a white shaft that reaches almost to the base of the leaves.
- Care must be taken not to allow soil between leaves as it will penetrate the shaft.
- Another method of transplanting is to drop each seedling into an individual hole, 15 cm deep, pressed into the ground.
- This procedure eliminates the need for filling of furrows but ridging should still be done.
- Seedlings are spaced at a spacing of 40 x 10 cm.

NUTRITIONAL REQUIREMENT

- A soil test is necessary to determine phosphate and potash requirement.
- Apply 200-250q well rotten Farm Yard Manure or compost along with 80-100kg N, 60 kg P₂O₅ and 80 kg k₂O/ha.
- Entire quantity of FYM, P₂O₅, k₂O and half N should be thoroughly mixed in the soil at the time of planting. Remaining N is side dressed one month after.

USE OF GROWTH REGULATORS

For proper growth and development

- Ethephon @ 50mg/l as foliar spray should be applied 20-25 days after sowing.
- NAA @50mg/l should be applied at 60 and 90 days after planting.

IRRIGATION

- Irrigate uniformly to maintain vigorous, uniform growth and tender stalks.
- A total of 12-15 inches of water may be required depending on planting date, seasonal variation and variety.
- Soil type does not affect the amount of total water needed, but does decide frequency of water application.
- Lighter soils need more frequent water applications, but less water applied per application.

WEED CONTROL

- Same as that of onion.

BLANCHING

- Blanching is important in leek cultivation.
- It is done by covering the plants to a certain height so as to bleach them, which improves the quality of the crop.
- For this purpose, plants are put in up to their center leaves in trenches or pits which are heavily manured and to earth up soil as they grow.
- Care should be taken not to earth up soil too early when the plants are young.

HARVESTING AND HANDLING

- Leeks do not bulb or go dormant in the fall but continue to grow slowly.
- The time of harvest is, therefore, very flexible, depending on the time of planting, market conditions and variety of leek planted.
- Small leeks can be sold starting in early August and varieties that have frost tolerance may be harvested throughout the fall and winter months.
- Machine harvest of leeks is now possible, but most leeks are lifted or dug by machine and then harvested, cleaned and packed by hand.
- Single or multiple row harvesters can be used effectively.

YIELD

- Leek yields approximately 925q green bulbs per hectare.

STORAGE

- Store leek seed at 0°C and 95 to 100 per cent relative humidity.
- Leeks, if properly handled, should be kept satisfactorily for 2 to 3 months at 0°C.
- Leeks should be cooled promptly after harvest to near 0°C by hydro cooling, crushed ice or vacuum cooling and they should be kept at this temperature with high relative humidity throughout storage.
- Yellowing and decay develop rapidly at warmer storage temperatures.
- High relative humidity is essential to prevent wilting.
- The use of polyethylene film crate liners and of crushed ice can aid in preventing moisture loss.
- Good refrigeration will retard the elongation and curvature that develops in leeks at 10°C or 21.1°C.
- Respiration or heat evolution of leeks is about eight times faster at 21.1°C than at 0°C.
- Storage for 4-5 months at 0°C is possible by using a controlled atmosphere (CA), although there will be some loss in quality.
- The best CA contains from 1-3 per cent oxygen and from 5-10 per cent carbon dioxide.
- This CA retards yellowing and decay.
- Atmospheres containing 15-20 per cent carbon dioxide cause tissue injury.

- Cultivar, pre harvest and post harvest conditions, degree of trimming and method of packing will all influence the storage life of leeks.

PACKAGING

- Leeks are commonly trimmed to 12 inch length, bunched depending on diameter and often placed in polyethylene film bags.
- They are usually packaged in 5 kg cartons or wire bound crates, holding 10 film bags, each 500 g
- Other crates may be packaged with 18-24 bunches with a net weight up to 15 kg.

DISEASES

- Diseases of leek are same as that of onion

DRUMSTICK

(*Moringa olerifra* Lam.) (2n = 22)

(Hindi : Seeng, Sahgan) Family : Moringaceae

Drumstick is grown for its nutrient rich tender, but full grown pods, leaves and flowers which are used for culinary preparations. Fruits are rich in vitamin C (120 mg/100g), carotene (110 mg), phosphorus (110 mg) and minerals like magnesium (28 mg), potassium (259 mg), sulphur (137 mg), chlorine (423 mg) etc. The crop is grown in homesteads for family uses or cultivated commercially for market. Tender leaves and flowers are comparable to that of colocasia in vitamins and minerals and have great role for combating malnutrition of urban and rural masses. Certain morigna types principally grown for its foliage are reported from West Indies. Drumstick roots are good substitute for horse radish. Root, bark and seed have many industrial uses also.

Origin and distribution

Originated in South West India, drumstick became a popular vegetable in South Indian states. The crop is widely distributed in India, Sri Lanka, Pakistan, Singapore, Malaysia, Cuba, Jamaica and Egypt.



Botany

Drumstick is a small or medium sized perennial tree of about 10 m height with fragile and corky stem. The leaves are usually tri-pinnate with elliptic leaflets. Pods are pendulous and length ranges from 20 cm to 100 cm. Seeds are trigonous with wings on angles. Flowers are produced on current season growth on large and erect panicles or monocladiol cyme. Flowers were yellowish creamy white and sweet smelling. Individual flowers are bisexual, zygomorphic and pedicellate.

Calyx and corolla consist of five sepals and petals. Androecium also has five stamens alternating with five stamindodes. Gynoecium has a superior, one celled and three carpelled ovary containing many ovules on parietal placentation. Stigma is truncate.

Flowering in drumstick varies from place to place and is greatly influenced by rain, temperature, humidity, wind, soil temperature, soil moisture etc. Under South Indian condition, one or two distinct peak periods of flowering noticed. Peak period of flowering in central parts of Kerala is December-January while in southern part it is February-March and July-August with maximum flowering in February-March. Under Coimbatore and Bangalore conditions, flowering seasons are March-May and July-September respectively. Anthesis continues throughout the day. Two anthesis peaks i.e., 2.00 p.m and 4.00 a.m. are noticed at Thiruvanthapuram. In most parts of Tamil Nadu, flowering is from 4.30 a.m. to 6.30 p.m.



In southern part of Kerala, stigma becomes receptive one day prior to flower opening and continues with maximum receptivity on the day of opening and a sudden decline

thereafter.

Varieties / cultivars

A number of local cultivars are known by the place of their cultivation. Details of local cultivars are given:

- **Jaffna moringa** - a perennial type which bears 60-90 cm long pods with soft flesh and good taste.
- **Chavakacheri moringa** - a perennial type producing 90-120 cm long pods.
- **Chemmuringa**- This perennial type flowers throughout year and bears red tipped fruits.
- **Yazhpanam moringa** – same as Jaffna type
- **Pal muringai** – Pods having thicker pulp and better taste
- **Puna moringa**– Thinner fruits.
- **Kodikal moringa**– produces short pods of 15-20 cm long and is used as support for betel vine plants. Propagated by seeds.

There are only a few named varieties and the details are given below:

KM-1 (Kudumianmalai 1)– Bushy variety propagated through seeds. Plants come to bear 6 months after planting and can be rationed for 2-3 years. Productivity 400-500 fruits / year. Developed at Anna Pannai, Kudumianmalai of Pudukottai.



PKM – 1 – This “seed moringa”, propagated through seeds is developed at Horticultural Research Station, TNAU, Periyakulam. Plants grow to a height of 4-6 m and come to flower in 90-100 days after planting. The first harvest starts 160-170 days after planting and on an average each tree bears 200-225 fruits / year. Pods are 65-70 cm long with 6.3 cm girth and 150 g weight. Fruits are green coloured and highly pulpy.



PKM 2– This “seed moringa”, propagated through seeds, is also developed at Horticultural Research Station, TNAU, Periyakulam. Pods are extra long (125-130 cm), pulpy and suitable for homestreads.

Dhanraj– This is also an annual drumstick propagated through seeds and is evolved at KRC College of agriculture, UAS, Arabhavi, Karnataka.

Crop improvement programmes in the Department of Olericulture, Kerala Agricultural University, Vellanikkara resulted in the development of three promising perennial drumstick clones viz., MO 70, MO 95 and

MO 44 and one annual seed drumstick, AD 4.

Climate and soil

Drumstick is predominantly a crop of dry and arid tracts. However intensive cultivation with good irrigation and systematic cultural practices will give good yield especially for annual type. The plant put forth luxuriant growth at 25-30°C. Higher temperature results in heavy flower shedding. Crop is also injured severely by frost. Though the crop comes up well in all types of soil, performance is better in sandy loam rich in organic matter. A pH range of 6.0 – 6.72 is most ideal.

Propagation

Perennial types are propagated through limb cutting of 90-100 cm length and 5-8 cm diameter. Annual types are propagated by seeds. Average seed weight is 0.288 g and 10 g contain 35 seeds. Seeds @ 625 g/ ha can be either sown in pits or transplanted after raising seedlings in polythene bags. Transplanting of seedlings can be made one month after sowing. It is always advisable to raise a few plants additionally in polythene bags for purpose of gap filling. Time of sowing of seeds for annual seed drumstick or planting of limb cuttings varies from region to region depending on receipt of monsoon.

Land preparation

Field is ploughed 3-4 times. Apply FYM @ 20 t ha⁻¹ at last ploughing. Take pits of size 45 x 45 x 45 cm at a spacing of 6.0 x 6.0 m for perennial types and 2.5 x 2.5 m for annual types, apply 10 kg FYM and fill up pits.

Interculture and manuring

To facilitate side branches, shoot may be nipped off when the seedlings are at 75 cm height. Apply 100 g Urea, 100 g Super phosphate and 50 gm MOP and irrigate heavily. Top dress plants with 100 g Urea again 3 months after first application. Provide light irrigation for early emergence of seedlings for annual type.

VSC 507 Production Technology of Underexploited Vegetables

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After harvest of main crop, annual types are cut back one meter height from ground level for rationing. These rationed plants develop new shoots and start bearing four to five months after rationing. Likewise about three ratoon crops can be taken. At each and every ratoon crop, plants are supplied with N, P and K nutrients as already mentioned along with 20-35 kg of FYM and irrigate.