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Chapter - 11

Package and Practices of Finger Millet

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Abstract

Finger millet can tolerate harsh conditions and provides higher nutrition than rice and wheat. This crop can grow in areas having water scarcity or in regions with a certain risk of failure of conventional crops. Finger millet cultivation has the potential to bridge the demand and supply of food grains in resource-poor areas and therefore, its production needs to be increased by various means such as the system of finger millet intensification. Finger millet, however, a coarse cereal grain is a most encouraging millet for its solidarity of calcium, iron, dietary fibre and polyphenols. Yet, the data archived such a long way on finger millet alludes more to assortments and development rehearses. This article covers the Indian data in a strategic manner, the finger millet cultivation aspects, taxonomy, disease-pest and their management, medical advantages of finger millet and post-harvest management. Finger millet is gaining popularity worldwide because it is easy to grow than other millets and more adaptable as a food. Finger millet has been used across Africa and Southeast Asia for thousands of years. Today, finger millet can be found in health food stores and large supermarket of this crop throughout the United States. Finger millet is widely used as an alternative to wheat or other grains.

Keywords: Climate, Disease, Finger millet, Management, Processing, Soil, Weed

Introduction

Millets are a group of highly variable small-seeded grasses, widely grown around the world as cereal crops or grains for human food and as fodder. Fifty years back, millets were largely cultivated in Asia and Africa. Following the western model of development, fine cereals like rice, wheat and maize were popularized in place of millets due to change in food habits. Among minor millets, finger millet (*Eleusine coracana* L. Gaertn.) is one of the most popular millets in India. It is predominantly grown as a dry land crop and consumed in Karnataka, Andhra Pradesh and Tamil Nadu and consumed to a limited extent in Odisha, Maharashtra, Uttarakhand and Goa. Finger millet contributes for about 50% of total small millet area and 65% production of total small millet of India. Foods prepared from it, are recommended by physicians for patients and infants above six months age. Besides this, finger millet is a C₄ crop which may yield more in future in the changing climatic scenario.

Finger millet is an annual herbaceous plant that is widely cultivated as a cereal crop in the arid and semiarid regions of Africa and Asia. It is also known as Bird's foot millet and African millet. It has different names in local languages. These names are ragi (in Kannada, Telugu and Hindi), Mandua/Mangal also in Hindi, Kodra (Himachal Pradesh), Mandia (Oriya), Taidalu (in Telangana region), Kezhvaragu in Tamil *etc.* In eminent vedic literature ragi is mentioned as 'ragika'. It is a tetraploid and self-pollinating species that most likely descended from *Eleusine africanus*, a wild cousin. The mountains of Ethiopia and Uganda are considered as home of finger millet. The ability of finger millet to endure cultivation at altitudes exceeding 2000 m above sea level, its great drought tolerance, and the lengthy grain storage period are all intriguing crop traits.

Botanical Name: *Eleusine coracana* L. Gaertn.

Family: Poaceae

Origin: East Africa

Chromosome no.: 2n=36

Area, Production and Productivity:

In India, this crop ranks sixth in production after rice, wheat, maize, sorghum and bajra. Finger millet is grown over an area of 1.19 million hectares with a production of 1.98 million tonne and a yield of 1661 kg ha⁻¹ in India (Sakamma *et al.*, 2018). Karnataka is the leading state with respect to finger millet area and production in India and accounts for 55.6% of the area and 60.7% of production in the country.

Economic Importance

In northern hills, ragi grains are eaten mostly in the form of 'Chapatis' and 'halwa'. In south India, grains are used in many preparations like cakes, puddings, sweets *etc.* The green straw is suitable for making silage, which is sweet smelling and consumed by cattle without wastage. Finger millet contains about 5–8% protein, 1–2% ether extractives, 65–75% carbohydrates, 15–20% dietary fiber and 2.5–3.5% minerals (Chethan and Malleshi 2007a). It has the highest calcium (Ca) content among all cereals (344 mg/100 g).

Health Benefits:

- Finger millet is an excellent source of natural Ca which helps in strengthening bones for growing children and aged people. Regular consumption of finger millet is good for bone health and keeps diseases such as osteoporosis at bay and could reduce risk of fracture.
- Finger millet is a very good source of natural iron (Fe) and its consumption helps in recovery of Anemia. The Ragi based foods are highly suited for expectant mothers and elderly due to their high Fe content.
- It is now established that phytates, polyphenols and tannins can contribute to antioxidant activity of the millet foods, which is an important factor in maintaining health, aging and controlling metabolic diseases.
- Finger millet's phytochemicals help in increasing digestion process. The study found that diet based on wholegrains of finger millet helps in controlling blood sugar level (glycemic index) in the condition of diabetes. This is due to presence of factors in finger millet flour which lower digestibility and absorption of starch.
- It has been found that finger millet-based diet helps in preventing constipation, high blood pressure and intestinal cancer as it contains higher fibre than rice and wheat.

Because of its high nutritional content, ragi flour is recommended as a weaning food especially in the southern parts of India.

- Finger millet consumption helps in relaxing body naturally. It is beneficial in conditions of anxiety, depression and insomnia. It is also useful for controlling migraine problems.
- Green ragi is recommended for conditions of liver disorders, asthma and heart weakness. It is also recommended to lactating mothers in condition of lack of milk production.

- As a result of regular consumption, finger millet could help in reducing malnutrition, degenerative diseases and premature aging.

Soil Requirement:

Ragi is cultivated on a variety of soils ranging from loam to shallow upland soils. It prefers porous and well drained loam to light red loam and sandy loam soils of good fertility but reasonable water holding capacity. It can tolerate water logging to some extent. Black soils with sufficient drainage capacity also support to cultivate ragi crop. It can be grown in soils with pH of 4.5-7.5. It can tolerate soil salinity better than other cereals.

Climate Requirement:

As a short-day plant, finger millet thrives well in conditions with consistent sunshine and optimum day-time temperature between 30 and 34°C and night-time temperature between 22 and 25°C. It does best where an average of 1000 mm of rainfall per year occurs.

Land Preparation:

In rainfed crop, ploughing operation is done in main field 2-3 times deeply to conserved moisture in soil. Before sowing, secondary tillage with cultivator and multiple tooth hoe to prepare smooth seedbed is necessary. Before sowing in nursery bed, do minor land smoothening operations, it helps in better in-situ moisture conservation.

In Uttaranchal where frequent ploughing operations are difficult to carry out, effective digging and turning of soil, removing perennial weeds, land smoothening, providing inward slope with a shallow drain helps in taking out excess rain water.

Sowing Time:

In the regions of high rainfall, it can be cultivated on well-drained soil as transplanted crop. It can be grown as a rainfed crop as well as in irrigated conditions. It is grown in all cropping seasons in different parts of our country. More than 90% of finger millet area is under rainfed condition, grown during *kharif* season. In Uttaranchal, it is normally grown in the month of June. The irrigated crop is sown in September and October in Karnataka, Tamil Nadu and Andhra Pradesh.

Spacing:

Higher or lower than the optimum population will lower down the yield. A plant population of 4 to 5 lakhs per ha is optimum for getting higher yields. For maintaining

optimum plant population, use spacing of 25 cm x 15 cm (25 cm between two rows and 15 cm between two plants) during transplanting. Under seed drilling, 15 cm x 15 cm (for long duration varieties) and 15 cm x 10 cm (for short duration varieties) is maintained.

Sowing Depth:

Seeds should not be sown less than 3-4 cm deep.

Sowing Methods:

The following methods are used for irrigated and rainfed ragi.

Direct sowing:

1. Broadcasting: In dry lands, sowing is done by broadcasting and seeds are covered by working with blade harrow which is generally practiced in coastal districts of Andhra Pradesh & Tamil Nadu. This approach is frequently used because it is simple.
 2. Line sowing: It is better technique of sowing than broadcasting. Line sowing helps to distinguish among weeds and crops more clearly, which facilitates organic weed management. When using this technique, lines should be spaced at 22 to 30 cm. About 3 cm of soil should be covered above the seeds.
 3. Drilling in rows: Finger millet is also sown by bullock drawn seed drills in shallow depths of 3-4 cm. This is generally adopted in Rayalaseema & Telangana regions of Andhra Pradesh and Karnataka. Conservation agriculture employs this technique.
- Transplanting: The seedlings are raised in nursery beds before being transplanted to the main field. During transplanting, beds must be levelled and watered. Four-week-old seedlings should be placed into the field. Seedlings should be transplanted at 25 cm x 15 cm for the early *rabi* and *kharif* seasons and at 30 cm x 10 cm for the late *kharif* season. Planting should be done in the soil in ridge and furrow method and flat bed method under assured irrigation.

Seed Rate:

In case of line sowing, seed rate should be between 8-10 kg/ha. When the crop is raised by transplanting, 4-6 kg seed/ha is sufficient for raising nursery. In order to get higher yield a plant population of 1.6-2 lakh per acre is optimum. Maintain optimum plant population in a field by doing gap filling and thinning operation. After 20-27 days of sowing, when plants are established in field, thinning operation of excess seedling is necessary. Similarly, where plant population is not uniform, gap filling with 20-25 days old seedlings should be done.

Seed Treatment:

Soak the seeds in water (one kg of seeds in one litre of water) for six hours. Drain the water and tightly tied the seeds in wet cloth bag for two days. After two days, remove the seeds from wet cloth bag and germination occurs. Dry them in shade for two days and then used for sowing purpose. Treating seeds with *Azospirillum brasilense* (N fixing bacterium) and *Aspergillus awamori* (P solubilizing fungus) @25 g/kg seed is beneficial. If seeds are treated with chemicals, then doing of chemical seed treatment first and then go for biological seed treatment before sowing of seeds is mandatory.

Any one of the below mentioned fungicides/insecticides can be used:

Fungicide/insecticide name	Quantity (Dosage per kg seed)
Thiram	4 g
Captan	4 g
Carbendazim	2 g

Manures and Fertilizer Requirement:

Application of 5-10 tonnes of well decomposed farm yard manure one month before sowing will give better results in terms of grain yield, seed quality and residual soil fertility. Finger millets respond well to chemical fertilizer application specifically to nitrogen and phosphorus fertilizers. Testing of soil to know exact requirement of fertilizers is important to stop the indiscriminate use of chemical fertilizers. If soil test facility is not available then application of 60:30:30 kg/ha of N:P₂O₅:K₂O for rainfed crop should be done. In irrigated condition, for nursery: 40:40:40 kg N:P₂O₅:K₂O/ha and for main field: 60:30:30 kg N:P₂O₅:K₂O/ha. Apply full dose of P and K and half dose of N at time sowing. Remaining half dose of N should be applied in two equal splits (at 30 and 50 days after sowing) depending upon the moisture availability in soil. The entire quantity of fertilizer should be applied 8-10 cm deep in soil at the time of sowing.

Important Cultivars:

VL Mandua 101, VL Mandua 204, VL 124, VL 149 , VL 146, VL Mandua 315 (maturity in 105-115 days) and **VL Mandua 324** (maturity in 105-135 days). **KM-65** and **PES 176** for hilly areas.

PES 400: Ready to harvest in 98-102 days. It gives average yield of 8 qtl/acre. It is early maturing variety and it is resistant to blast.

PES 176: Ready to harvest in 102-105 days. Gives average yield of 8-9 qtl/acre. Seeds are of brown colour and this cultivar is resistant to blast.

KM-65: Ready to harvest in 98-102 days. Gives average yield of 8-10 qtl/acre.

VL 315: Ready to harvest in 105-115 days. It gives average yield of 10-11 qtl/acre. It is tolerant to finger and neck blast diseases.

VL 146: Ready to harvest in 95-100 days. It gives average yield of 98-102 qtl/acre. This variety is resistant to blast.

VL 149: Ready to harvest in 98-102 days. Gives average of 10-11 qtl/acre. Wide adaptation and earliness and resistance to blast are some characteristics of this cultivar.

VL 124: Ready to harvest in 95-100 days. Average yield 10 qtl/acre. It is good for seed as well for fodder.

Other State Cultivars:

VL Mandua 352: This one is applicable for cultivation for all states except Tamil Nadu and Maharashtra. This cultivar is being ready to harvest in 95 days.

Parentage: VR 708 x VL 149

Average grain yield: 3.0-3.5 t/ha

Other features: Short duration cultivar and also used for contingent crop planning

Released from: ICAR-Vivekananda Krishi Anusandhan Sansthan, Almora, Uttarakhand

KMR 204:

Parentage: GPU 26 x GE-1409

Average grain yield: 3.0-3.5 t/ha

Other features: Early duration cultivar

Released from: VC Farm, Mandya, University of Agricultural Sciences, Bengaluru

Arjuna:

Parentage: SDFM 30 x PE 244

Average grain yield: 2.5-2.8 t/ha

Other features: It can tolerate dry spells, moderately resistant to leaf blast and finger blast diseases

Released from: OUAT, Bhubaneswar

VR 708: It is a drought tolerant cultivar. Applicable for all states for cultivation.

Akshya

PES 110

PR 202

JNR 852

MR 374

Cropping Sequences:

Finger millet in rainfed conditions is cultivated generally as a mixed crop with sorghum, pearl millet and a variety of oil seeds and pulses. In hilly areas, it is grown mixed with soybean.

Under irrigated conditions, it is grown in rotation with crops like tobacco, vegetables, bengal gram, linseed, mustard *etc.*

Some of the most prevalent cropping sequences in north India are:

Finger millet - Bengal gram

Finger millet - Mustard

Finger millet - Tobacco

Finger millet - Linseed

Some of the most prevalent cropping sequences in south India are:

Finger millet - Groundnut

Finger millet - Sugarcane

Finger millet - Potato - Maize

Finger millet - Potato - Finger millet

Finger millet - Rice

Irrigation Requirement:

As finger millet is a rainy season crop it does not required irrigation. But at the stage of flowering and grain filling, if rain stops for long time span, then irrigation is necessary for good plant growth along with good grain yield. Prepared furrows and ridges for irrigation purpose will serve dual purpose of irrigation and drainage. This crop cannot withstand any waterlogged condition, therefore care should be taken for complete drainage of excess water. In case of transplanted crop, after establishment of seedlings for a week or 10 days, irrigation should be cut off. This

helps in hardening of seedlings and for vigorous and healthy growth.

S. No.	Irrigation Interval in nursery bed
1 st irrigation	Apply immediately after sowing
2 nd irrigation	Apply on 3rd day after sowing
3 rd irrigation	On 7th day after sowing
4 th irrigation	Apply 12th day of sowing
5 th irrigation	Apply 18th day of sowing

Weed Management:

In initial stage of crop, weed control is necessary to obtain good crop growth along with good yield. *Echinochloa colona*, *Digitaria sanguinalis*, *Cyanadon dactylon*, *Panicum milliacea*, *Dactyloctenium aegyptium*, *Cyperus rotundus*, *Amaranthus viridis*, *Eleusine indica*, *Celosia argentia*, *Commelina benghalensis*, *Euphorbia geniculate* etc. are the major weed species found in finger millet crop. The critical crop-weed competition period is from 25 to 45 days after sowing (DAS). In line sown crop, two to three inter-cultural operations and one hand weeding is necessary. For effective weed control, take spray of pre-emergence herbicide like oxyfluorfen @1.25kg/acre or isoproturon @400g/acre. Spraying of 2-4-D sodium salt @250g/acre as post-emergent spray around 25-30 DAS is required for effective control of weeds.

Integrated weed management: Pre-emergence herbicides like metoxuran @0.75 kg a.i./ha + one hand weeding at 35 DAS gives excellent control of weeds.

Plant Protection: Insects:

- Army and cutworm
- Aphid
- White stem borer
- Earhead bug
- Leaf folder

Diseases:

- Mosaic
- Blast

Harvesting and Threshing:

Generally, this crop matures in 120-135 days, duration may vary depending upon the growing condition and the choice of cultivar. Harvesting is done in two steps.

Earheads are harvested with sickles separately and straw is cut close to the ground. Earheads are kept for drying in sun for three to four days after cutting. After good drying, threshing is carried out. In some places whole plant along with earhead is cut, heaped and dry in sun for two to three days and then threshed by hand/stone roller/bullock.

Yield:

Yield always depends on the crop management practices and the variety cultivated. In rainfed condition, 0.7 to 0.8 t/ha – grain yield; 1.1 to 1.8 t/ha – fodder yield. In irrigated condition, 3.0 to 3.5 t/ha – grain yield; 3.5 to 5.0 t/ha – fodder yield are generally obtained.

Storage:

For grain purpose: thoroughly drying of the seeds to a moisture content of 10% is necessary.

For seed purpose: mix 100 kg of seed with 1 kilogram of activated kaolin or 5% malathion dust. Place the seeds in gunny bags or polythene-lined gunny bags for storage.

Post Harvest Management

Malting of finger millet is a traditional process followed in India and is used in infant foods and in milk thickener formulations. This is conveniently called ragi malt and is used in the preparation of milk beverages. A fermented drink or beer is also prepared from the grains in some parts of the country.

Conclusion

Finger millet is a significant product that can withstand drought and has a high nutritional value. It can be effectively grown with the right soil preparation, choice of cultivars, planting methods and management of nutrients. High yield can also result from good weed, insect-pest and disease control techniques. Farmers can improve their yield and their way of life by using the suggested cultivation technique. The finger millet's dietary fibre and polyphenols have been perceived to offer several medical advantages. For example, hostile to diabetic, security from diet related persistent sicknesses, hypocholesterolemia, cell reinforcement and antimicrobial impacts to its customary buyers. Additionally, it is similarly wealthy in sugar, energy and sustenance which makes finger millet a significant element of dietary and wholesome adjusted food sources. The standard utilization of finger millet as a supplement and its items helps in overseeing various issues of body by keeping

up with blood glucose homeostasis. Likewise, the entire feast-based finger millet items might be attractive because of the defensive job of seed coat matter that have wellbeing upgrading benefits.

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