

**Finger millet** is also known as *ragi* or *mandua* and is widely distributed up to an altitude of 2100 m in the north-western Himalayas (NWH). It is a staple food in the hilly regions. It is grown both for grain and forage. In the NWH, grains are eaten in the form of *chapaties* and *halwa*. It is the richest source of calcium and is used in many preparations like cakes, puddings, sweets, etc. The green straw is suitable for making silage, which is sweet smelling and is consumed by cattle without any wastage. Germinated grains are malted and fed to infants also. It is also good for pregnant women. The grain of finger millet contains 9.2% protein, 1.3% fat, 76.3% carbohydrate, 2.24% minerals, and 0.33% calcium and 0.41% potassium. It is beneficial for individuals with low haemoglobin levels as it is great source of iron. It has low fat content and contains mainly unsaturated fat. It is also good for persons suffering from diabetes because of lower glycemic response, i.e. lower ability to increase blood sugar level. Its high intake could increase quantity of oxalic acid in the body. Therefore, it is not advised to patients having kidney stones.

The area under finger millet in the hills of Uttarakhand is continuously declining from 1.3 lakh ha in 2001 to 0.9 lakh ha in 2018 due to difficulty in its cultivation and easy availability of wheat flour. The yield is almost stagnant from 1534 kg/ha in 2005-06 to 1332 kg/ha in 2018-19. The minimum support price of finger millet increased 3.4 times during last ten years from 965 to 3295 rupees. Hence, production of organic finger millet is highly profitable with addition of small amount of premium price also. The yield of finger millet can be enhanced with following organic management.

#### **Climate**

It is heat loving plant and for its germination, the minimum temperature required is 8-10°C. A mean temperature range of 26-29°C during the growth is the best for proper development and good crop yield.

#### **Soil**

It can be grown on variety of soil ranging from rich loam to poor shallow upland soil with good organic matter. Black soil with good drainage can also be considered for cultivation, as this crop is sustainable to water-logging to some extent. Finger millet grows best in soil having pH 4.5-8 with porous and well drained loam to sandy loam soils having good fertility and reasonable water holding capacity. Finger millet can tolerate a certain degree of alkalinity. It has the ability to utilize rock phosphate better than any other cereals.

#### **Field preparation and level of organic manure**

One deep ploughing with mould board plough followed by two harrowings is necessary to prepare smooth seedbed. Minor land smoothing before sowing helps in better in-situ moisture conservation. Seeds are very small and take 5-7 days to germinate. Hence good land preparation helps in better germination, minimizes weeds problem and conserve effective soil moisture. Land smoothing, providing inward slope with a shallow drain helps in taking out excess rain water.

Application of farmyard manure to the crops is being practised for long period. Well decomposed farmyard manure in addition to supplying plant nutrients act as binding material and improves the soil physical properties of soil. It will support to increase the microbial populations and provides the sustainability in agriculture.

Application of 10-15 t of well decomposed FYM/ha (2-3 quintals per *nali*) should be incorporated at the time of field preparation to harvest the economic optimum grain yield. 2 quintal of FYM/ha (4 kg FYM/*nali*)

mixed with 50 g *Trichoderma harzianum* and 200 g *Bacillus cereus* strain WGPSB-2 powder and incorporated into the soil during field preparation to avoid fungal disease and white grub infestation, respectively. Application of 250 kg per hectare of *ghanjeevamrit* (prepared from indigenous cow dung, jaggery, pulse flour, indigenous cow urine and undisturbed soil from forest) enhances the soil health and yield.

#### **High yielding variety suitable for organic farming**

VPKAS, Almora has developed a number of varieties suitable for rainfed organic farming. VL Mandua 146, VL Mandua 149, VL Mandua 347, VL Mandua 352, VL Mandua 376, VL Mandua 379 have tremendous potential to produce higher yield under organic condition in the NWH.

#### **Sowing Time**

The optimum sowing time for finger millet in the NWH is end of May to mid of June. In hills at higher altitudes of Uttarakhand and Himachal Pradesh, it is sown in April–May. In region of high rainfall, it can be cultivated on well-drained soil as transplanted crop. Seedlings of 21-25 days old are ideal for transplanting in rows of 20 cm and 10 cm between hills with 2 seedlings/hill. For transplanting, the nursery is sown from the end of May to first week of June.

#### **Seed rate, spacing and depth of sowing**

In order to get higher yield, a plant population of 4-5 lakhs per hectare is optimum and seed rate of 10 kg/ha for sowing in main field. The optimum plant population in field is maintained by doing gap filling and thinning operation in the field. After 20-25 days of sowing, when plants are established in the field, thinning of excess seedlings is necessary. Similarly, wherever plant population is not uniform, gap filling with 20-25 days seedlings should be used. Higher or lower than optimum population will lower down the yield. For optimum population, use spacing of 20 cm × 10 cm (20 cm between rows and 10 cm between plant to plant distance). Sow seeds at a depth of 2.5-3.0 cm in a furrow and close the furrow after sowing. Seed should not be sown more than 3-4 cm deep. Seedlings are to be grown in raised bed for transplanting in the main field. About 5 kg seeds/ha is enough for the transplanted crop.

#### **Seed treatment**

Soak seed in water (one litre water for every kg of seeds) for 6 hours. Drain the water and tightly tie the seeds in wet cloth bag for two days. After two days, remove seeds from wet cloth bag, they will show some sign of germination. Dry them in shade for two days. Use such seeds for sowing purpose. Treating seeds with *Azotobacter* (N fixing bacterium) and phosphate solubilizing bacteria (PSB) (*Pseudomonas fragii*) and plant growth promoting rhizo-bacteria (PGPR) (PGERS17) is beneficial.

The seed inoculation with *Azotobacter*, PSB and PGPR each with 25 g/kg of seed; and soil application of arbuscular mycorrhiza (*Glomus fasciculatum*) @ 5 kg/ha (100 g/*nali*) enhance the grain yield. The *beejamrit* (prepared from indigenous cow dung, lime, undisturbed soils from forest and indigenous cow urine) can also be used as seed treatment. Sticker solution is necessary for effective seed inoculation. This can be prepared by dissolving 25 g jaggery or sugar in 250 ml water and boiling for 5 minutes. The solution thus prepared is cooled. Smear the seeds well using the required quantity of sticker solution. Then add culture to the seeds and mix thoroughly so as to get a fine coating of

culture on the seed. The culture-coated seed is to be dried well in shade to avoid clumping of seeds. Use the inoculated seeds for sowing. It is better to sow seeds of inoculated finger millet during morning hours. The inoculated seed should neither be dried nor sown during bright sunshine.

#### **Method of Sowing**

Line sowing is beneficial and helps in inter cultivation and control of weeds effectively. It should be done with the use of seed drill. Maintenance of optimum plant population of 4-5 lakh plants per hectare by thinning is an important activity.

#### **Crop management**

*Ragi* is mostly grown as intercrop or mixed crop with non-cereal crops, viz. black soybean, horse gram, etc. Crop rotation is very important in finger millet crop. It provides higher yield. In the NWH, finger millet crop is rotated with lentil. Spraying of *jeevamrit* @ 500 litres per ha twice a month enhances the yield. Spraying of 3% *panchagavya* and vermiwash during pre-flowering and flowering stages enhances the soil health and grain yield.

#### **Weed control**

In initial stage of crop, weed control is necessary to obtain good crop growth along with good yield. Major weed flora observed in finger millet are: *Echinochloa colona (sama)*, *Cynodon dactylon (doob)*, *Dactyloctenium aegypticum (makra)* (at initial stage) and *Eleusine indica (kodai)* (at later stages) among grasses; *Cyperus rotundus (motha)* among sedges; and *Commelina benghalensis (kankoua)*, *Ageratum conyzoides (jangli pudina)*, etc. among broadleaved weeds. A concern about the potential increase in weed population in finger millet crop is rated as the most serious problem for finger millet cultivation. Management of weeds in early stage (2-3 weeks after germination) is of utmost importance. Weeding is to be undertaken within the critical period of the crop. The first hoeing & weeding is done at 2 to 3 weeks after sowing. When necessary, the second weeding is to be done at 35 days after sowing. The morphology of *Echinochloa colona (sama)* and *Eleusine indica (kodai)* is almost similar to finger millet crop. Hence, only experienced person, who can distinguish the crop and weeds, should be engaged for weeding.

Stale seed bed is a relatively simple weed management tactic followed for finger millet crop due to more weed density and difficulty in distinguishing weeds and crop. It generally involves four steps: 1) field preparation, 2) weed seeds in the shallow soil zone germinate naturally or by pre-monsoon rain and then emerge, 3) emerged weeds are then killed with minimum soil disturbance as necessary, and 4) the crop is promptly seeded into mostly weed free soil. Protocols that encourage the greatest amount of “weed flush” without disturbing the soil generally will result in fewer weeds germinating and competing with the crop after it is planted.

#### **Disease management**

**Blast (*Pyricularia grisea*):** The fungus infects to different stages of the crop leading to leaf blast, neck blast and finger blast. It appears as circular lesions that are pointed towards both ends. The greyish centre is surrounded by brownish borders. In severe condition, these spindle shaped spots coalesce together, leading to drying of the entire leaf. The most affected stage is neck blast stage, as it prevents grain formation or shrivelling of grains.



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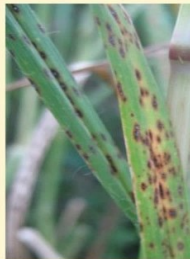
ICAR-Vivekananda Parvatiya Krishi Anusandhan Sansthan,  
Almora-263 601 (Uttarakhand)  
2021

Toll free Krishak helpline - 1800 180 2311  
Contact Timings - Every working day (10 AM to 5 PM)

**Management:** Use of resistant varieties is the most ecologically sound and affordable way to combat disease. Avoid high plant density. Use recommended level of organic manure. Seed treatment with *Trichoderma harzianum* and one spray of *Pseudomonas fluorescens* at the time of flowering and second spray 10 days later can also control all three blast diseases. Sprays of plant extracts of notchi and *Prosopohis* sp. have been found effective in organically grown finger millet. Two sprays of *P. fluorescens* @ 0.3% (first spray at 50% flowering followed by second spray 10 days later) are recommended for the control of neck and finger blasts.



**Cercospora leaf spot (*Cercospora eleusine*):** Initial symptoms appear as reddish brown specks with yellow halo. Later, several such specks coalesce to form large lesions with yellow hollow. In some cases, the lesions enlarge to form eye shaped spot measuring up to 15 x 3 mm. Such leaves give burnt appearance. As crop matures, severely infected leaves turn necrotic, shrivelled and dry. At this stage the plants look completely blighted.



**Management:** Several biocontrol agents had been tested for reducing disease but none was found effective. Use of varieties with inbuilt genetic resistance is the best means of combating disease problem. Field sanitation is to be maintained to reduce disease infection.

## Insect management

**Aphid (*Rhopalosiphum maidis*):** Aphids are small brackish green insects live in colonies and feed on the crop by sucking the sap. The plant will become stunted and yield less. Sugary secretion of honey dew can also be seen. There are many natural enemies available for aphids in the field itself. Coccinellids and syrphid grubs prey upon them. Spraying of 250 litres of concentrate *neemashtra* solution per hectare can control aphids. Adopting proper spacing and application of recommended level of organic manure are advised for the management of aphids.



**Pink borer (*Sesamia inferens*):** The larva is pink in colour found feeding on the stem causing dead heart of growing tip. The infestation on the later stage of crop leads to white-ear, in which the entire panicle has chaffy grains.



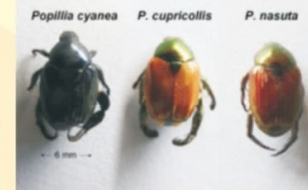
The white-ear with larva can be removed and destroyed at the early stage of infestation. Spray of *neem* oil in the crop at the time of egg laying will repel the adult moths from egg laying on the treated plants. Use of pheromone lures @ 7 per acre will help to attract and trap the adult moths and thus the pest can be managed.

## Cetonid/Pollen beetles (*Popillia cyanea*, *P. cupricollis*, *P. nasuta*):

These are brightly coloured beetles feed normally on the flowers and pollen. Since, it also damages the developing seed, the seed production and yield will be affected.



Spray of *neem* oil based insecticides will repel the insect from the treated plants. Use of biocontrol agents, *Bacillus cereus* WGSPB2 in the soil @ 10 kg per ha will manage the grubs in the soil and thus aids in pest management.



*Dashparni* extract is useful to manage all kind of insect-pests. 5-6 litres of *dashparni* extract is diluted in 250 litres of water for spraying one ha crop area.

## Harvesting, threshing and storage

Harvesting of finger millet is done in two stages. Earheads are harvested with sickles and straw is cut close to ground. Earheads are heaped and then drying is done in sun for three to four days. After good drying, threshing is carried out. In some places whole plant along with earhead is cut, heaped and dried in sun for 2-3 days and then threshed. The straw of finger millet makes nutritious fodder.

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

## For further details, contact us

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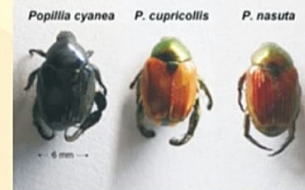
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