

Advance Production Technology of Fenugreek

(*Trigonella foenum-graecum* L.)



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Correct Citation: Kakani, R.K., Anwer, M.M., Meena, S.S. and Saxena, S.N. (2009).
Advance Production Technology of Fenugreek.
ICAR-National Research Centre on Seed Spices Tabiji. Ajmer- 305 206
(Rajasthan)

Published by: Director,
ICAR-National Research Centre on Seed Spices
Tabiji Ajmer 305 206, Rajasthan
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Printed: November 2009 (500 Copies)

First edition: 2009

Updated in: 2021

Updated by: Dr. S.N. Saxena, Dr. Y.K. Sharma, Dr. O.P. Aishwath, Dr. Ravindra
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Printed at: Job Offset Printers
Ajmer
98294 72031

PREFACE

Fenugreek (*Trigonella foenum-graecum* L.) is an annual crop belonging to the legume family. It is regarded as the oldest known medicinal plant in recorded history. Its seed and leaves have medicinal value, and have been used to reduce blood sugar and lower blood cholesterol in humans and animals.

Major fenugreek producing countries are India, Argentina, Egypt, France, Spain, Turkey, Morocco and China. India is the largest producer in the World. In India, Rajasthan, Madhya Pradesh, Gujarat, Haryana, West Bengal and Uttaranchal are the major fenugreek producing states. Rajasthan has maximum area and production of about more than 37 and 33% of India's total area and production, respectively. The productivity level of fenugreek crop in the country is 1566 Kg/ha (2019-20).

The technology that has emanated out of research efforts made at NRCSS, Ajmer and different centres located in the various agro-climatic regions, under the AICRP on Spices at various SAU's. This has been compiled in the form of Advance Production Technology of Fenugreek. We are sure that this publication shall prove highly useful to various stake holders such as field functionaries, growers, students and others having interest in growing fenugreek scientifically.

We hope that the technical bulletin provides relevant information for fenugreek production. Suggestions if any are welcome for further improvement of this bulletin.

Ajmer-

1st November, 2009

Authors

Introduction

Centre of origin of fenugreek is South-Europe, Mediterranean area and Western Asia. India is also to be a native of fenugreek and found growing wild in Kashmir, Punjab and upper Gangetic planes. Fenugreek is commercially important spice crop due to its multifarious uses and is extensively grown in almost every part of the country for seeds, tender shoots, and fresh leaves during winter season. There are two cultivated species of genus *Trigonella* viz. *foenuni-graecum* (common fenugreek) and *corniculata* (Kasuri type fenugreek). The major fenugreek producing countries are India, Argentina, Egypt, Southern France, Morocco, Spain, Turkey and China.

Production in India

In India, its production is concentrated mainly in the states of Rajasthan, Madhya Pradesh, Gujarat, Haryana, West Bengal and Uttaranchal. Major fenugreek growing districts with higher productivity in India are given in Table 1. During 2019-20, a total of 1,88,480ton of fenugreek seed was produced from 1,20,340 hectare area which is 11.22 % and 6.92 % of total seed spices production and area, respectively. The current productivity of fenugreek is 1566 kg/ha (DASD, Kozhikode).

Table 1. Major fenugreek producing states with zones / districts

State	High productivity	Agro- region
Gujarat	Banaskatha, Dahod, Patan, Surendranagar, Mehasana	Gujarat plain & hill region
Rajasthan	Bikaner, Sikar, Jodhpur, Churu, Pratapgarh	Western dry region
Madhya Pradesh	Ratlam, Mandsaure, Neemuch, Ujjain, Rajgarh, Shajapur, Guna, Dhar, Sehore, Betul, Khargone	Central plateau & hill region
Chhattisgarh	-	Central plateau & hill region
Haryana	-	West plateau & hill region
Maharashtra	-	Central plateau & hill region.

27,660 Metric tonnes of fenugreek seed of worth Rs. 1638.36 million was exported from India during 2019-20. The major importing countries for Indian fenugreek are USA, Y.A.R., UAE, South Africa, Korea, U.K., Nepal, Bangladesh, Saudi Arabia, Egypt, Shri Lanka, Germany and Sudan.

Cultural Requirements

The cultural requirements including practices for higher fenugreek production are summarized as under:

Climate

Fenugreek requires cool climate for its better growth. A cool growing season without extremes of temperature is favourable for best development. It is cultivated both in tropical as well as temperate region. In India, it is mainly grown as a *Rabi* season crop but in South India, it is also grown as rainy season crop. The crop can be grown in areas of low to moderate rainfall but cannot withstand heavy rainfall. Continuous moist and cloudy weather invites insect – pests and a number of diseases. Dry weather during crop maturity is essential for harvesting better seed yield. Having wider adaptability, the crop can be grown successfully both in tropical and temperate regions up to an altitude of 2000 m above mean sea level (MSL).

Soil

Fenugreek can be grown in almost all type of soils having good drainage but grow best on well-drained loamy soils. Organic matter rich clay-loam soil may also be used if adequate drainage facilities are available. However, it can be grown on sandy or gravelly soils with slightly compromising yield. For rainfed cultivation, black cotton soils are best suited for its successful cultivation. Although the crop is sensitive to salinity except very low yet it can tolerate the pH up to 8.5, but in neutral soils having a pH range from 6.0 to 7.0 it always gives higher yield with better quality of leaves.

Cropping System

Fenugreek can be grown as mixed or intercrop. Being leguminous crops it fits well as component crop for most of inter cropping systems involving fennel, coriander, ajwain, dill and winter vegetable crops. Likewise crops should be grown as per standard principal of crop rotation.

Some of the crop rotation systems suggested are:

1. Maize/pearl millet- Fenugreek
2. Sesame-Fenugreek
3. Sesame-Fenugreek Summer Maize

Cultivated Varieties

Variety selection depends primarily on its adaptation to the soil and climatic conditions and preferably should have resistance / tolerance to pests and diseases prevailing in that region. There

are many varieties released for cultivation to different areas. The description of some of the important cultivated varieties recommended for different states are given as under:

(A) Rajasthan

Ajmer Methi 1 (AFg-1)

The variety has been developed through pure line selection from local germplasm at NRCSS, Ajmer. The seed are bold and large. The number of seeds per pod ranges from 17-20 with 17-20 g. test weight. The crop takes 137 days to mature and gives seed yield of 27.2 q/ha. The crop grown exclusive for leave purpose yield 76 q/ha green leaves from three cuttings.

Ajmer Methi 2 (AFg-2)

The variety has been developed through pure line selection from local germplasm at NRCSS, Ajmer. The seed are small in size. The number of seeds per pod ranges from 16-18. The crop takes 138 days to mature and give seed yield of 18.1 q/ha. The crop grown exclusive for leave purpose yield 72 q/ha green leaves from three cuttings.

Ajmer Methi 3 (AFg-3)

The variety has been developed through pure line selection. The seed are bold and large. The crop takes 137-140 days to mature with an average seed yield of 13-14 q/ha. Quality profile shows the presence of 1.79% diosgenin and 0.97% 4-hydroxyisoleucine content in seeds which enhances its medicinal quality for use in controlling diabetes. Moderately resistant to powdery mildew.

Ajmer Methi 4 (AFg-4)

The variety has been developed through pure line selection. The seed are bold and large. The crop takes 122-130 days to mature showing earliness, gives an average seed yield of 18-19 q/ha. Seed contain 1.74% diosgenin and 0.94% 4-hydroxyisoleucine in seeds. Moderately resistant to powdery mildew and root rot and usable as corrective measure for diabetes.

Ajmer Methi 5 (AFg-5)

The variety has been developed through pure line selection. The seed are bold and bigger in size. The crop takes 106-141 days to mature with an average seed yield of 17-18 q/ha. Seeds of AFg-5 showed higher antioxidant properties (66.4 mg BHT g⁻¹). Moderately resistant to powdery mildew and Alternaria blight.

RMt 1

It was developed at SKN College of Agriculture, Jobner (RAU, Bikaner) through pureline selection from local collection. The plants are semi-erect, tall and moderately branch, bold, typically containing yellow coloured grains. It is suitable for Gujarat and Rajasthan states and mature in 140-150 days, gives an average yield of 14.7 q/ha. It is moderately resistant to root rot and tolerant to powdery mildew. An average grain yield of 15 q / ha can be obtained over crop duration of 140 150 days.

RMt-143

It was developed at SKN College of Agriculture, Jobner through pure line selection from Jodhpur region and identified for release in 1997. It is suitable for Rajasthan and give average yield of 16.0 q/ha. It is suitable for Bhilwara, Jhalwar and Jodhpur areas of Rajasthan.

RMt 305

It was developed at SKN College of Agriculture, Jobner through mutation breeding in RMt-1 and is the first determinate type of fenugreek, yielding an average 1300 kg/ha. The plant is dwarf, determinate, multipoded, early maturity, resistant to powdery mildew and root knot nematode and suitable for all fenugreek growing areas.

(B) Gujarat

GM-1

This variety was developed by Gujarat Agriculture University. Its plants are dwarf and having average yield 18.6 q/ha. this variety is suitable for Gujarat region.

(C) Tamil Nadu

CO-1

It was developed by Tamil Nadu Agriculture University through selection from TG 2336 of IARI and released in 1982. The plants are short and green with medium sized brownish orange seeds. It is tolerant to root rot. It matures in 95 days and gives an average yield of 6.80 q/ha.

(D) Bihar

RajandraKranti

It was developed by Rajendra Agricultural University through mass selection from Raghunathpur germplasm and released in 1987. The plants are tolerant bushy green with medium sized golden

yellow seeds. It is moderately resistant to powdery mildew, caterpillars and aphids. It mature in 120 days, and gives an average yield of 12.50 q/ha.

(E) Andhra Pradesh

Lam Selection-1

It was developed by Andhra Pradesh Agriculture University through selection from germplasm collected from M.P. and released in 1992. The plants are bushy with medium sized golden yellow seeds. It is tolerant to root rot, powdery mildew, caterpillars and aphids. It mature in 90 days and gives an average yield of 7.40 q/ha.

(F) Haryana

Hisar Sonali

It was developed by Haryana Agriculture University through pure line selection from local germplasm and identified in 1983. The plants are bushy, semi-erect with bold yellow attractive seed (13-15 g/1000 seeds). It is moderately resistant to leaf spot and root rot complex disease. It mature in 140-150 days and gives an average yield of 19.0 q/ha.

Hisar Suvarna

This variety was developed through pure line selection from local germplasm by CCS Haryana Agriculture University, Hisar. This is a dual purpose cultivar and suitable for Haryana, Rajasthan and Gujarat. This variety is resistant to powdery mildew and moderately resistant to downy mildew with an average yield of 19-20 q/ha.

Hisar Mukta

This variety was developed at CCS Haryana Agriculture University, Hisar. It is a natural green seed coat mutant, selected from IL-335-1 germplasm line, a collection from U.P. Yield is around 20-23 q/ha. It is resistant to downy mildew and moderately resistant to powdery mildew. It is suitable for cultivation under all fenugreek growing states of North India.

Hisar Madhavi (HM-350)

It was developed by CCS Haryana Agriculture University through single plant selection from the line PLME 46-1, a pure line selection from collection from U.P. It is medium in maturity and having average yield 19-20 q/ha. This variety is resistant to powdery mildew and moderately resistant to downy mildew.

(G) Uttar Pradesh and Uttaranchal

Pant Ragini

This variety was developed by GB Pant University of Agriculture & Technology, Pantnagar. It is a dual purpose variety suitable both for leaf as well as seed purpose. Plants are tall and bushy type. The variety is resistant to downey mildew and root rot. It matures in 170-175 days.

Pusa Early Bunching

It was developed at IARI, New Delhi. It matures in 100-125 days and is quick growing variety with upright shoot having bold seeds. It is suitable for seed as well as leaf cutting and gives average seed yield of 12 q/ha.

Pusa Kasuri

It is small seeded *kasuri* type variety, mainly cultivated for leaf Purpose and not for seeds. It is late flowering variety with rosette type leaves and 5-7 cutting may be taken. It is heavy yielder of green leaves with special fragrance. It has been developed at IARI, New Delhi. It gives average seed yield of 5-7 q/ha and the crop grown exclusively for green leaves, produces an average yield of about 80 q/ha.

Cultural Practices

Preparation of Land

The land should be well prepared for better germination and growth of fenugreek. A total of 3-4 ploughings are required. The first ploughing should be done by soil turning plough followed by 2-3 ploughing with harrow to bring the soil to a fine tilth. At the time of sowing there should be good moisture in the soil for better germination of seed.

Sowing Time

Fenugreek, being cool season crop, is sown in the month of October to November in northern plains, whereas, in hilly tracts, it is sown from March to May, depending on altitude. In areas with mild climate, fenugreek for fresh greens may be grown round the year except extreme hot months of summer and rainy season. In southern states of India, particularly Karnataka, Andhra Pradesh and Tamil Nadu, fenugreek is sown twice, Once in *rabi* (September- December) and again in *Kharif* season (June-July). *Kasuri* type varieties require preferably extra cool weather for longer duration, is thus raised more successfully in northern states during winter than the southern states of India. For higher yield, it is better adjusted sowing time such that the pod development and seed

maturity phase may coincide with a dry and rain free period. Recommended sowing time for seed crop in different states is given in Table 2.

Table 2. Sowing time recommended for different states in fenugreek.

State	Sowing time
Rajasthan	First week of October to last week of November
Gujarat	Last of September to First week of October
Bihar	Middle of October
Uttar Pradesh	October- November
Tamil Nadu	First week of October
Haryana	Middle of October up to November (First week of November is ideal)
Andhra Pradesh	First week of October

Seed Rate

The quantity of seed required for the sowing of unit area depends on the purpose for which the crop is sown. For common type the seed requirement is 20-25 kg/ha and for *Kasuri* type the seed requirement is 10-12 kg/ha. Seed rate recommended for different states are given in Table 3.

Table 3: Seed rate recommended for fenugreek.

State	Seed rate
Rajasthan	20-25 kg/ha
Gujarat	20-25 kg/ha
Bihar	20-25 kg/ha
Uttar Pradesh	15-20 kg/ha
Tamil Nadu	20-25 kg/ha
Haryana	20-25 kg/ha
Andhra Pradesh	30 kg/ha

Seed Treatment

Fenugreek is a legume crop, it fixes nitrogen about 283 kg per hectare per year from the atmosphere into the soil. The role of *Rhizobium* in fenugreek production is well established, and thus inoculation of seed with *Rhizobium* culture before sowing has proved beneficial in getting higher seed yield. Seeds should be treated with *Rhizobium meliloti* local culture prior to sowing, especially when the crop is sown in new field. Seed should also be treated with *Trichoderma* culture 10g/kg seed for the control of seed and soil borne fungal diseases.

Sowing Method

Fenugreek can be sown either in lines or by broadcasting seeds in well- prepared flat seedbeds and raking the bed surface prudently, however, sowing in lines is comparatively better than the broadcasting since it facilitates the intercultural operations, like hoeing and weeding. Line to line spacing of 25-30 cm is required and later the plants are thinned to maintain 10-15 cm spacing within the lines. The seed germinates in about 5-7 days of sowing. The field should have adequate moisture at the time of sowing. Although the depth of the sowing seeds depends on soil type and soil moisture at the time of sowing, but being small size, the seeds of common fenugreek are usually sown at a depth of 3 cm and kasuri fenugreek at 1.0-1.5 cm.

Table 4: Crop geometry recommended for fenugreek

State	Spacing
Rajasthan	25 cm x 10 cm row spacing
Gujarat	15 cm x 10 cm and 30 x 10 cm
Bihar	20 cm x 10 cm
Uttar Pradesh	30 cm x 10 cm
Tamil Nadu	15 cm x 10 cm or 22.5 x 10 cm
Haryana	30 cm x 10 cm

Manures and Fertilizers

The fenugreek crop has been reported to show very good responsive behaviour towards absorption of both macro as well as micro-nutrients. The crop removes N, P and K in the ratio of 2 : 1 : 1 from the soil, in the uptake order of 10 , 3.5, 8.2 kg respectively. Therefore to maintain a steady state of productivity, application of FYM (10 t/ha) has a beneficial effect on the enhancement of vegetative growth and resulted in higher dry matter production of fenugreek. Application of one ton per hectare of neem cake has also proved beneficial. The microbial inoculation with *Azospirillum*, *Azotobator* and *Rhizobium* has been reported to be suitable means for organic cultivation of fenugreek. The *Azospirillum* combination with organic manure 10 t/ ha yield high seed yield of 13.9 q/ ha, which was 25% less than the yield obtained from combinations applied with chemical nitrogen with reduced incidence of root rot (8.4%). Doses of fertilizer depend on fertility status of the soil and variety. State wise recommendation of fertilizer requirement is given in table 5.

Table 5: Fertilizer recommended for fenugreek

State	Fertilizer recommended
Rajasthan	10 FYM at the time of field preparation. 40 kg N(applied at the time of sowing and at post flowering stage), 40 kg P ₂ O ₅
Gujarat	40 kg N, 40 kg P ₂ O ₅ /ha
Bihar	40 kg N, 60 kg P ₂ O ₅ , 20 kg K ₂ O
Uttar Pradesh	60 : 50 : 10 kg NPK/ha
Tamil Nadu	N 50 kg/ha, 25 kg/ha and 40 kg K/ha
Haryana	40 kg/ha P

Irrigation

Fenugreek, being primarily an irrigated crop, requires light irrigation at frequent interval for its quick growth but can also be cultivated under rainfed conditions in certain parts of the country. Usually the crop is sown when the field is having plenty of soil moisture so irrigation is not applied unless the seedling attain 2- 4 true leaves, however, if the initial moisture in the field at sowing is inadequate, a light irrigation should be applied very soon after sowing and should be followed by another light irrigation on third day to facilitate rapid and uniform germination. Subsequent irrigations are given at 12 to 15 days interval, depending on soil type, season, rainfall, and other temporary weather conditions. In general, frequent and light irrigations are essential for quick foliage growth and as a thumb rule, each cutting should be followed by a light irrigation. The early growth period and seed setting are the critical stages for irrigation requirement. Too much irrigation is also as harmful as the scarcity of moisture, since excessive moisture in any form and at any stage increases the incidence of root rot and powdery mildew. Application of seven irrigations at 1.0 IW/CPE ratio of 0.75 was found optimum for Gujarat conditions. Care should be taken to avoid water stress at pod and seed development stages. Normally 6-7 irrigations are required in light soil and 4-5 irrigations are needed in heavy soil.

Inter-Culture Operations

Fenugreek, being leguminous crop, needs proper soil aeration for normal development of root system, thus, hoeing and weeding during early stages of plant growth are very essential to make the soil loose around the roots and to control the weeds. Weeds, due to slow growth of fenugreek seedlings may pose problem in initial stages, however, in later stages, when the crop canopy is fully developed, weeding is not at all required as the crop itself suppresses the weeds. Weeds emerging 30 DAS caused a very little reduction in yield and there was no significant gain in increasing weed free period beyond 30 days, thus, first 30' days were identified as a critical period with respect to crop weed competition in fenugreek. Generally 2-3 hand weeding are required to

keep the crop weed free and reducing the crop weed competition for growth resources like nutrients, moisture, light and others. The first hoeing and weeding is done at the time when the plants are 5 cm tall.

Two weedings and hoeings, are required, first at 10-20 days after sowing, along with thinning of the plants and second weeding at 40-50 days after sowing. Integrated weed management using pre- sowing application of pendimethalin @ 1 kg/ ha (Haryana), pre sowing application of fluchlorin @ 0.75 kg/hg in 500-600 liters of water, supplemented with one hand weeding once in 50 DAS is very effective method of weed control for realizing higher yield and benefit in fenugreek cultivation.

Crop Protection

Fenugreek crop are attacked by numbers of insect pests and diseases from germination to pod maturity. The important among them are sucking pests (aphid, white fly, mites, jassidsetc), leaf miner, pod borers etc. Powdery mildew, downy mildew, *Alternaria* leaf blight and root rot are commonly observed diseases of fenugreek. The plant protection measures should include selection of resistant varieties, crop management practices such as time of sowing, balanced nutrition, crop rotation, green manuring etc.

Insect-Pests

A- Sucking Pests

Aphids (*Acrythosiphonpisum*, Henis. and *Aphis craccivora*, Koch.):

The most common insect that attacks the fenugreek crop is aphid and are found in colonies sometimes very serious in patches on tender leaves, stem and inflorescence. Both nymphs and adults suck sap from the tender leaves thus reducing market value. The severe infestation affects the yield and quality of leaves badly.

White fly (*Bemisiatabaci*)

White fly is serious pest of fenugreek in some area. It attacks the crop at early stage to pod formation stage. Nymph and adult suck the sap of plant causes yellowing of plant and subsequently plant die.

Jassids (*Empoasea* spp.)

Jassids attack on fenugreek crop at early stage. Nymph and adult suck the leaf sap causing browning of leaves.

Mites (*Pertobialatens*)

Infestation of mites can be seen occasionally. The insect mostly feeds on young leaves. The severe infestation affects the yield and quality of leaves. Small mites are seen on lower side of leaves and when serious, cause webbing and feed within the web. Plants get stunted at severe infestation.

Control of Sucking Pests:

- Trapping and monitoring with yellow stick trap
- Timely sowing of crop help in lower build up of pests population. Late sown crops are more prone to heavy attack by number of insect pests.
- Crop should sown in desired geometry.
- Recommended doses of nitrogenous fertilizers should be applied. Because higher application of nitrogenous fertilizers causes more succulent to the crop.
- Spraying of Neem seed kernel Extract (NSKE) @ 5 % or Neem oil 2% effectively check the early population build up of aphids on the crop.
- Application of entomopathogen *Verticillium lecanii* (10^8 spores/g) powder formulation @5.0 g/litre of water gives good result.
- At high aphid population any one of the synthetic insecticides should he sprayed i.e Dimethoate 0.03%, Metasytox-0.03%, Emamectin benzoate @ 10 g ai/ha, or Imidachlorprid - 0.005%.
- Spray ethion 0.05 % or dicofol 0.07 % for mite management.

Leaf eating caterpillar (*Spilarcitia oblique* and *SpodopteralitumFabricius*):

The large numbers of caterpillar appear and destroy the leaves. The eggs are laid in clusters and young larvae gregariously feed on leaves. They scrap out the green matter from the leaves and gives the appearance of papery white structure. The last instars of larvae feed voraciously causing defoliation of plants and thereby causing considerable losses in yield and quality of greens.

Control

- Destroy the egg mass and gregarious young larvae.
- Monitoring of adult population through pheromone/light trap.
- Spray neem seed kernel extract (NSKS 5%) or neem oil 2% in the early stage of larvae.
- Use of nuclear polyhydrosis virus (NPV) @ 250 LE/ha and *Beaveriabassiana* @ 10^{10} spores/ml is an effective biological control.
- Spray quinalphos - 0.05 % at 7 to 10 days intervals

Pod borer (*Helicoverpa armigera* Hubner):

The pest is found to feed on leaves, flowers and pods. Eggs are laid on young leaves, which are later damaged by young larvae. The first instars of larvae bore the fruits and damage them, causing 10-90 % losses, if left unprotected.

Control

- Monitor adult population through pheromone / light trap.
- Release of *Trichogramma chilonis* @ 50,000 eggs/week, spray of *Beauveria bassiana* @ 10¹⁰ spores/ml or HaNPV @ 250 LE/ha is an effective biological control.
- Spray of NSKE 5% or neem oil 2% controls when population build up is at low level.
- Spray quinolphos 0.05% when population reaches at higher level.

Leaf minor (*Empoasca* spp.)

Excess mining of leaves at early stage causes stunting growth of plant. Heavy infested crop gives less production.

Control

- Spray dimethoate 0.03% or Emamectin benzoate @ 10 g ai/ha
- Spray neem oil (2%)

Diseases

Root rot (*Rhizoctonia solani* Kuhn.):

This is a soil borne disease. The symptoms include varying degrees of rotting of the root leading to foliage yellowing generally in 30-45 days old plants. The affected plants wither and dry up later on. It is a serious problem in major fenugreek growing areas and drastically reduces the yield.

Control

- Seed treatment with thiram or captan @ 2 to 3 g / kg of seed.
- Seed pelleting with antagonistic fungi like *Trichoderma viride*, *T. harzianum* (Talc based formulation @ 4 g/kg of seed) followed by soil application of neem cake 150 kg/ha.
- Drenching of carbendazim (0.1%) once at initial appearance of disease and after one month.
- Deep summer ploughing of field and adoption of crop rotation practice.
- Use of bio-inoculants *Azospirillum* or *Azotobacter* plays significant role in reducing incidence of root rot to 8.2%.

Powdery mildew (*Erysiphepolygoni* D.C. and *Laveillulaturica* Lev.):

The disease generally appears late in the season. The symptoms include the appearance of whitish fungal growth on leaves and other above ground parts of the plant. The disease becomes serious at temperatures between 15°- 25°C and at a relative humidity more than 60%.

Control

- Dusting with 300 mesh sulphur (25 kg/ha) or by spraying wettable sulphur (0.25%) or hexaconazole (0.1%) twice commencing from initiation of disease at 15 days interval.
- Grow resistant /tolerant varieties.

Downy mildew (*Peronospora trigonella* Gaum.):

Symptoms include the presence of yellow patches on the upper surface and downy growth on the lower surface in the corresponding areas. In the advance stage of infection, the leaves turn yellow and shed, thus plant growth is checked adversely.

Control

- Spray 400-500 lit solution of 0.2% copper oxychloride or chlorothalonil. Repeat the spray after 10 days interval if needed.
- Spray of metalaxyl+mancozeb (1g/Lit) at 15 days interval is also recommended.
- Give hot water treatment to seed before sowing.

Damping off (*Pythium aphanidermatum*):

The infected seedlings appear water-soaked, discoloured and soft, emitting a bad odour. The infection mostly occurs at or below the ground level and the seedlings topples down and withers off.

Control

- To minimize the source of infection seed treatment with carbendazim (2.5 g/kg seed) is recommended in reducing the seedling mortality.
- Use of soil amendments like neem cake @ 10 q/ha and farmyard manure @ 10-25 t/ha is beneficial.
- Adoption of proper crop rotation and deep summer ploughing.
- The antagonistic fungus *Trichoderma viride* and soil application of neem cake effectively control the disease.

Leaf spot (*Cercospora traversiana* SOCC):

This is a minor disease of fenugreek in India. The disease symptoms appeared with the presence of round spots beneath the leaves. The spots are white at the center and brown at the periphery.

The affected leaves drop-off prematurely. Symptoms also appear on pods in later stage. The occurrence of disease adversely affects the market quality of green leaves.

Control

- Follow at least 2 year crop rotation in infested areas.
- Healthy seed must be used.

Rust (*Uromycesanthyllidis*):

The yellow spots bearing aecia in clusters are earlier symptoms of the disease. The disease is observed in the form of minute brown pustules on both the surfaces of leaves. The disease is of minor importance but under cool and wet climate in northern India entire plant may be damaged with the disease.

Control

- Adopt good cultural operation and field sanitation.

Harvesting and Yield

The common fenugreek becomes ready for cutting fresh green leaves and young shots in about 20 days after sowing while *kasuri* type fenugreek is ready in 25-30 days after sowing and subsequent cuttings may be taken at an interval of 15-20 days. The crop when grown for dual- purposes after taking one cutting, which does not affect the seed yield, is left for seed production. The crop after harvest is bunched and marketed. The cutting is usually done with sharp knife by leaving stubs 3-4 cm above the ground level and after taking 4-5 cutting the crop grown exclusively for green leaves is uprooted. Common fenugreek can be harvested by clipping the young plants from the base and the clipped plants are allowed to grow further and their tops are nipped periodically until flowering. If fenugreek is harvested late, its leaves develop a bitter taste.

Depending upon variety and season of growing the seed crop takes about 80-165 days from sowing to harvesting. The entire plants is either pulled out of cut from the base with sickle when 70 % of the pods turn yellow, and made into small bundles for drying them in sun. Seeds are separated by beating with stick and winnowing. The seed is cleaned and sun dried before packing in jute bags containing polyethylene lining.

The fenugreek yield depends upon the variety used, location and season of growing. Usually, the cultivars yielding higher grain yield tend to produce low fresh green leaf yield. Under irrigated conditions, the common type fenugreek varieties normally give a fresh green leaf and seed yield of 70-80 and 15-20 q/ha, respectively, and *kasuri* type 80-100 q green leaves per hectare. However,

higher yield can further be expected under good management practices. The *kasuri* type fenugreek varieties give higher yield due to more cuttings in comparison to common fenugreek.

Storage

Green leaves are very perishable in nature, therefore, they are marketed soon after harvesting. However, well dried leaves can be stored for about 10-12 months. The leaves can be stored only for about 24 hours after harvesting under ambient conditions, however, in cold stores at 0°C temperature and 90-95 % relative humidity the storage period can be extended up to 10 days. Seeds are stored in gunny bags lined with polythene film. Vacuum gravity separator is used for cleaning fenugreek seeds. The properly cleaned fenugreek seeds are stored with an initial moisture level of 7-8 % and at an equilibrium relative humidity of 40 %. Fenugreek seeds well packed is stored in ventilated dry and cool place under ordinary conditions till sowing of next season crop.

Post Harvest Management

Keeping in view the requirement of targeted market, the post harvest operations are advised to follow suitably for green leaves as vegetable, dehydrated leaves and seeds. In case of fresh greens, the edible portion is the tender leaves and stem, which are cut to length of about 7-10 cm. After harvesting, the yellow, diseased and damaged leaves are trimmed off and thereby healthy and disease free leaves are tied into small bunches for the convenience in handling and marketing. Since the dried leaves can be stored for one year for further use in off- season, the fenugreek leaves are sun-dried or dehydrated in a suitable dehydrator. However, during dehydration, chlorophyll is oxidized and ascorbic acid is lost, so as to retain green colour of leaves, blanching in boiling water (80°C) for 3-6 minutes can be practiced. The palatability of fenugreek leaves improve with steaming and with addition of seasoning rather than with boiling or frying. The average vitamin C value in fenugreek leaves is 43.10 mg/100 g and after boiling in water or steaming and then frying, the leaves lose 10.8 % and 7.4 % of this vitamin, respectively.

Uses

Every part of this multipurpose crop is useful and utilized in one or the other form as food, fodder, medicine, and cosmetics. Its green fresh leaves and tender immature pods are used as green cooked vegetable. Sun dried leaves, which are having aromatic qualities, are used as spice for seasoning of foods in off- seasons. Being odoriferous, the dry seeds and their powder are used as condiment/flavoring agent and for medicinal purposes. The seeds are also used for making dye

and extraction of alkaloids or steroids. In certain parts, the green or dry fodder is usually fed to the cattle. It is recognized well as commercial uses in syrups, pickles, baked foods, condiments, chewing gums, icings, and cooked food seasonings. The fenugreek leaves and seeds have use in cosmetics and hair conditioning. In Punjab, dried plants are added to store grains as insect repellent.

Medicinal Uses

Fenugreek, one the few spices is used extensively for medicinal purposes owing to its hypoglycemic and hypocholesteremic properties. The seeds are carminative, tonic and aphrodisiac and customarily used for the treatment of colic, flatulence, dysentery, diarrhea, dyspepsia with loss of appetite, chronic cough, dropsy, enlargement of liver and spleen, rickets, gout and diabetes, and are good for the elimination of bad breath and body odor. It is believed that regular intake of fenugreek seed reduces the level of glucose total cholesterol, and triglycerides in blood. Fenugreek is known to possess galactagogue properties, and thus Indian women consume the seeds for its power to promote lactation. Fenugreek seeds substantially contain diosgenin (0.40-1.26 %), which is used as a starting material in the synthesis of sex hormones as stimulant and contraceptive.

Fenugreek also helps to combat dandruff and is a cure for baldness. The ground powder mixed with cotton seed is fed to cows and buffalos for increasing the flow of milk. It is used in cattle feeds and in veterinary medicines also.

Economics of fenugreek cultivation:

Based on the primary survey of the farmers during 2018-19, average input cost of cultivating one hectare of fenugreek farmers incurred input cost of Rs. 31698 per ha. Average yield harvested at surveyed farmer's field was 19 quintal per hectare valued at Rs. 83632. The return after adjusting input cost was arrived at approx 52 thousand per ha yield an average return of 2.64 rupee per rupee of cost (A2).

S. No.	Particulars	Value in rupees
1	Cost of production per hectare (Cost A2)	31698.00
2	Gross return per hectare	83632.00
3	Returns over cost A2 per hectare	51934.00
4	Return per rupee of cost A2	2.64

Acknowledgement

This matter has been collated from original research work carried out at NRCSS and from research reports of other centres and also from AICRP on spices. It includes the following references.

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