



Reviewed by

Dr. Madhu Bala
N.M. College of Agriculture,
Navsari Agricultural University, Navsari,
Gujarat, India

*Correspondence

Shyam Sunder Meena
ssmeena123@gmail.com

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Affiliation

¹ ICAR-National Research Centre on Seed Spices, Ajmer (Rajasthan),

² ICAR-Central Arid Zone Research Institute, Jodhpur (Rajasthan),

³ Maharana Pratap Horticulture University, Karnal (Haryana)

Ajmer Fenugreek-3 (AFg-3): A high 4-hydroxyisoleucine and diosgenin containing fenugreek variety

R.K. Kakani², S.K. Malhotra³, R.S. Meena¹, S.N. Saxena¹, Y.K. Sharma¹, S.S. Meena¹, K. Kant², R.K. Solanki², S.S. Rathore¹ and Shyam Sunder Meena^{1*}

Abstract

A high yielding coupled with enhanced quality traits, variety of fenugreek Ajmer fenugreek-3 (AFg-3) developed through pure line selection from a germplasm line collected from Sikar district of Rajasthan. Incoordinated varietal trials conducted during 2010-12, AFg-3 gave 18.8 % superior seed yield compared to national check Hisarsonali. AFg-3 has gained a special advantage for variety release due to possessing enhanced quality parameters viz. 34.6% higher diosgenin content, 15.5% higher 4-hydroxyisoleucine content and 11% higher fiber content. AFg-3 was found moderately resistant to powdery mildew and root rot diseases. The average percent disease index was recorded 26.0% while it was 40-50 % in check varieties for powdery mildew. It is notified for cultivation for all the fenugreek cultivating areas of India (Notification No. S.O 3666 (E) dated 06-12-2016). The seed of AFg-3 has been deposited in NBPGR and the IC number (IC-611680) was allotted for future reference.

Keywords: Ajmer fenugreek-3, germplasm, diosgenin, 4 hydroisoleucine, powdery mildew.

Introduction

Fenugreek (*Trigonella foenum-graecum* L.) popularly known as *Methi* is self-pollinated, multipurpose annual legume crop being used as a spice, condiment, leafy vegetable, fodder, medicinal, nutraceuticals, cosmeceuticals and many industrial purposes. Fenugreek spread over entire West Asian and Mediterranean regions. India is the largest producer, consumer and exporter of fenugreek which occupies a leading position among various seed spices grown throughout the country for both leaf and seed purposes. Among the seed spices fenugreek stands at third position in area (1.45 lakh ha) after cumin and coriander (Anon. 2022). Among the states fenugreek concentrated mainly in Rajasthan, which has a

share of about 80 per cent of the total fenugreek production of the country. Other states cultivating fenugreek are Gujarat, Uttar Pradesh, Himachal Pradesh, Madhya Pradesh, Andhra Pradesh, Tamil Nadu, Punjab etc. (Anon., 2015).

The seeds and green leaves of fenugreek are used in food as well as in medicinal applications which is the old practice of human history. It has been used to increase the flavor and color, and also modify the texture of food materials. Seeds of fenugreek have many medicinal properties such as hypocholesterolemic, antibacterial, gastric stimulant, for anorexia, antidiabetic agent, galactagogue, hepatoprotective effect and anticancer (Srinivasan, 2006). It is well known for its fiber, gum, other chemical constituents. Fenugreek has a high proportion of protein (approximately 20-30%) as well as amino acid, 4-Hydroxyisoleucine, which has high potential for insulin stimulating activity. The fenugreek seeds contain about 2–5% of steroidal saponins and 0.1–0.9% of diosgenin which are commercially important (Saxena *et al.*, 2024). Fenugreek oil is also a good source of linolenic acid or omega-3 essential fatty acid (Mahatma *et al.*, 2023). These days it is used as food stabilizer, adhesive and emulsifying agent due to its high fiber, protein and gum content. More importantly, it is used for the development of healthy and nutritious extruded and bakery products. Fenugreek has a beneficial influence on digestion and also can modify food products (Shashikumar *et al.*, 2018). Therefore, development of a variety possessing higher amounts of bioactive compounds is imperative.

Materials and Methods

Basically, all crop improvement programmes begin with germplasm collection and evaluation activities. More than 700 of fenugreek germplasm were collected from the NBPGR and various agricultural universities from Rajasthan, Gujarat, Andhra Pradesh, Haryana, Uttar Pradesh, Madhya Pradesh, Karnataka, Bihar, Himachal Pradesh etc. Initially, ICAR-NRCSS acquired fenugreek germplasm from NBPGR and all the agricultural universities having germplasm of fenugreek followed by field collection through exploration (Lal, 2018). Up to 2005, more than 200 germplasm accessions were acquired from different sources (Anonymous, 2006). The germplasm

collection of fenugreek possesses workable genetic variability for further selection for various specific traits in future (Jain *et al.* 2013). Ajmer fenugreek-3 is the progeny of a germplasm, accession collected from Sikar district of Rajasthan through pure line selection. Many single plants were selected with better seed yield from this germplasm line and harvested individually. Plant to row progenies of selected plants were evaluated for seed yield and attributing traits during 2005-06. The selected promising advanced lines were evaluated in station trial as compared to check varieties during 2007-09 at ICAR-NRCSS, Ajmer. In station trials, the proposed line gave more than 20 % seed yield over the check variety hence, contributed for testing under multilocation trials of AICRP on spices during 2010. Ajmer fenugreek-3 was tested in coordinated trials with code no. of FGK-27 along with twelve other test entries and national check (Hisar Sonali) at twelve locations *viz.* Ajmer, Jobner and Udaipur (Rajasthan), Jagudan (Gujarat), Hisar (Haryana), Faizabad (UP), Jabalpur (MP), Dholi (Bihar), Pantnagar (UK), Raigarh, (Chhattisgarh), Guntur (AP) and Coimbatore (TN) during 2010-12. Overall performance on the basis of three years (2009-10 to 2011-12) pooled mean percent superiority of AFg-3 was calculated. Disease scoring for powdery mildew and downy mildew was recorded at Ajmer Center during 2007-8 and 2008-09 by using 0-4 scale for calculating percent disease index (PDI). An agronomical trial on spacing and fertilizer doses was conducted during 2012-13 at Ajmer Center. All combinations of two spacing (30x10 cm and 20x10 cm) and two combinations of NPK *viz.* NPK-40:40:20 and NPK-50:50:25 was evaluated in factorial design.

Results and Discussion

Yield performance

Based on average performance over 32 trials, over three years (2009-10 to 2011-12) AFg-3 gave 18.8 % higher seed yield (Table 1) coupled with moderately resistance for powdery mildew and root rot. This variety ranked 1st at seven locations namely Ajmer, Udaipur, Dholi, jagudan, Jabalpur, Raigarh and Guntur center on pooled mean basis. It gave highest seed yield at Udaipur (2594 kg ha⁻¹) followed by Ajmer (2409 kg ha⁻¹), Jagudan (2276 kg ha⁻¹) on the basis of overall mean.

Based on disease scoring of two years at Ajmer center under natural condition it AFG-3 found moderately resistant for both powdery and downy mildew diseases. The average PDI for powdery mildew of AFG-3 recorded 26.0 % as compared to national check (50.0%). The proposed variety has gained special advantage for variety release due to possessing of enhanced quality parameters viz. 34.6% higher diosgenin contain, 15.5% higher 4-hydroxyisolucine content and 11% higher in fiber content (Table 2). AFG-3 gave highest yield at seven locations on the basis of three years average out of eleven locations and exhibited yield superiority up to 45 percent (Fig.1). Variety release proposal of Ajmer fenugreek-3 was submitted to the Central Sub-Committee on Crop standards, Notification and Release of Varieties of Agri-Horticultural crops for identification during 23rd Annual Workshop of AICRP on Spices held at ICAR-IISR, Calicut during Sep. 29 to Oct 1, 2012. Ajmer fenugreek-3 variety notified for cultivation for all the fenugreek cultivating areas of India in 2016 (Notification No. S.O 3666 (E) dated 06-12-2016). Seed of Ajmer Fenugreek-3 has been deposited in NBPGR and IC number (IC-611680) allotted for future reference for retrieval from long term storage system of ICAR-NBPGR, New Delhi.

Salient features of AFG-3

- Ø In multilocation testing AFG-3 gave 13.8 q ha⁻¹ average seed yield which is 18.8 % superior as compared to national check Hisar Sonali in 32 trials conducted at different locations across the country.
- Ø AFG-3 gave 17.8 % average seed yield which is 39.5 % higher than the national check Hisar Sonali in CVT at Ajmer location under station trials conducted during 2010-12.
- Ø It gave highest seed yield (16.8 q ha⁻¹) among the test entries under adaptive trials conducted during 2013-14 in Zone-IIIa of Rajasthan.
- Ø In demonstration conducted during 2013-14 in four villages of Nagour district it gave 21.4 q ha⁻¹ seed yield which is 44.0 % higher than the local cultivars.
- Ø Under agronomical trials on spacing and fertigation conducted for during 2012-13 AFG-3 yielded 26.9 q ha⁻¹ in row to row with spacing of 22 cm and fertigation of NPK at 50,50,25 kg ha⁻¹.
- Ø AFG-3 found moderately resistant to powdery

mildew and root rot diseases.

- Ø Quality of AFG-3 reported superiority viz. its seed contains 0.97 % 4-hydroxyisolucine, 1.79 % diosgenin and 21.9 % crude fibre which is higher by 15.5, 34.6 and 11.0 percent higher, respectively as compared to Hisar Sonali.
- Ø In agronomic trial AFG-3 was evaluated for different spacing and fertilizer doses and concluded that this variety gave highest seed yield (27.0 q ha⁻¹) in the combination of spacing 22 cm x 10 cm spacing and 40-40-20 kg ha⁻¹ NPK, respectively.

Disease resistance

Ajmer fenugreek-3 found moderately resistant for powdery mildew and root rot. Screening for powdery mildew and root rot was done in station trial conducted for two years during 2007-09 at Ajmer location under natural conditions. The average percent disease intensity was recorded 26.0% while it was 40-50 % in check varieties. The aphid infestation was at par with other popular varieties hence recommended POP is to be followed for harvesting potential production (Table 4).

Agronomic aspects

Ajmer fenugreek-3 is recommended for cultivation in all fenugreek growing areas of India. It is found suitable for cultivation on loamy and sandy loam soils having good drainage conditions, dry cool and frost-free environments. For optimizing productivity 20-30 October is the most suitable time for sowing with seed rate of 18-20 kg ha⁻¹. Line sowing with 22 cm line to line and 10 cm plant to plant distance was found best for maximizing the seed yield. Sufficient conserved soil moisture from late rains or pre-sowing irrigation is recommended for uniform emergence. First irrigation is recommended at 30-35 days followed by 3-4 subsequent irrigations in sandy loam soil and 2-3 irrigations in heavy soils. Fenugreek crop is prone to shattering at full maturity therefore, crop should be harvested at physiological maturity (Table 3).

Conflicts of Interest: The authors declare no conflicts of interest.

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Table 1. Seed yield of AFg-3 in Station trials and multilocation CVT of AICRP on Spices

Particulars	Station trial at Ajmer (2008-09)			CVT of AICRP (2008-12)		
	AFg-3	RMt-1 check	Local check	AFg-3	Hisar Sonali	Local check
Average seed yield (q ha ⁻¹)	22.1	15.0	17.4	13.8	11.6	11.9
Number of locations	2	2	2	32	30	29
% increase over checks	-	47.0	27.2	-	18.8	15.4

Table 2. Quality attributes of the Ajmer fenugreek-3 as compared to check varieties.

Particulars	AFg-3	Hisar Sonali	SD (±)	% increase over Hisar Sonali
Saponin (%)	7.79	7.09	0.6409	9.9
Diosgenin (%)	1.79	1.33	0.2523	34.6
Crude fat (%)	7.05	6.35	0.3905	11.0
% Crude fiber (Insoluble)	21.95	19.05	1.6070	15.2
4-Hidroxy-isolusine (%)	0.97	0.84	0.0681	15.5

Table 3. Agronomic and quality traits of the Ajmer Fenugreek-3

S.No.	Characteristic	Average of CVT trials at all India level		
		AFg-3	Hisar Sonali	Local check
1.	Days to flowering	58.8	61.9	60.3
2.	Days to maturity	125.4	126.7	126.4
3.	Plant height (cm)	80.5	77.8	79.9
4.	Primary branches/plant (Nos.)	5.0	5.1	5.4
5.	Secondary branches/plant (Nos.)	2.1	2.2	5.3
6.	Pods/plant (Nos.)	43.2	48.5	49.6
7.	Pod length (cm)	11.0	10.1	9.8
8.	Seeds/pod (Nos.)	15.1	15.6	14.9
9.	1000 seed weight (g)	16.5	14.1	15.1
10.	Seed yield (q/ha)	17.8	12.8	13.1

Table 4. Disease scoring of Ajmer fenugreek-3 for powdery mildew at Ajmer under natural conditions

S.No.	Name of Entry	Percent disease intensity of powdery mildew		
		2007-08	2008-09	Average
1.	Ajmer fenugreek-3	22.8	29.3	26.0
2.	Ajmer fenugreek-4	20.3	25.3	22.7
3.	Ajmer fenugreek-1	40.0	50.7	45.3
4.	RMt-1	-	30.7	30.7
5.	RMt-305	50.0	-	50.0

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Table 5. DUS characteristics of Ajmer Fenugreek -3 for identification of the variety

S.No.	DUS Characteristics	AFg-3
1.	Basal shape of first leaf blade	Acute
2.	Apex shape of first leaf blade	Rounded
3.	Size of leaf on first primary branches axis for length and width (L/W)	Large in length but narrow
4.	Basal shape of leaf blade on first primary branch axis	Acute
5.	Apex shape of leaf blade on first primary branch axis	Rounded
6.	Size of leaf on first pod axis for length and width (L/W)	Large in length but narrow
7.	Basal shape of leaf blade on first pod axis	Obtuse
8.	Apex shape of leaf blade on first pod axis	Acute
9.	Size of leaf on fully grown terminal leaf for length and width (L/W)	Large and wider
10.	Basal shape of leaf blade on first pod axis fully grown terminal leaf	Acute
11.	Apex shape of leaf blade on fully grown terminal leaf	Obtuse
12.	Number of primary branches	More >6
13.	Plant growth pattern	U type
14.	Plant growth habit	Indeterminate
15.	Plant height (cm)	Tall (>45)
16.	Pod/plant	High (>50)
17.	Pod length (cm)	Long (>12)
18.	Pod curvature	Moderately curved
19.	1000 seed weight (g)	Low (<16 g)



Apical view of plant of Ajmer Fenugreek-3



Ajmer Fenugreek 3: Leaf shape and size



View of pod curve of Ajmer Fenugreek-3



Seed color of Ajmer Fenugreek-3

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