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Gujarat Methi 3: High Yielding and Bold Seeded Cultivar

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ABSTRACT

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A new variety of Fenugreek (*Trigonella foenum-graecum* L.), Gujarat Methi 3 (GM 3) was tested in thirteen different locations in national trials and in state trials it was tested at Jagudan, Deesa, Bhiloda, Junagadh and Navsari centres. It was found superior with 16.31 and 12.97 per cent higher seed yield than national check Hissar sonali and state check Gujarat methi 2, respectively at Jagudan, Guntur, Kumarganj, Navsari and Pantnagar. Under Gujarat climatic condition, Gujarat Methi 3 (GM 3) had recorded yield of 2302 kg/ha, which was at par with Gujarat Methi 2. Average yield under normal conditions was 1604 kg/ha. The new variety had bold seed size with attractive seed colour and more number of pods per plant. Against biotic stress new variety was found less prone to the powdery mildew than check varieties. Due to all above salient features this variety was recommended for release in Gujarat state and under AICRP trials testing centers, it was found to be the best performing in Gujarat, Utrakhand, Andhra Pradesh and Uttar Pradesh.

Introduction

Fenugreek (*Trigonella foenum-graecum* L.) belongs to family Fabaceae, is one of the important seed spices largely cultivated in North India during *rabi* season as a semi arid crop. It is third important seed spice in India after coriander and cumin.

It is grown for both grain as well as vegetable purpose. The seeds and leaves are widely used as a culinary spice and condiments for flavoring food preparation and also used as animal feeds and green plants are used as vegetable purpose. It is being

commercially grown in India, Pakistan, Afghanistan, Iran, Nepal, Egypt, France, Spain, Turkey, Morocco, North Africa, Middle East and Argentina (Flammang *et al.*, 2004; Altuntas *et al.*, 2005).

In India fenugreek area is 1,21,800 ha, production is 1,88,600 MT with productivity of 1540 kg/ha (Spice board of India, 2018-19). Gujarat grows fenugreek in 7577 hectares and produces 14189 MT with an average productivity of 1872 kg/ha (Estimated, 2020-21). Dahod (2105 ha), Mehsana (851 ha) and Banaskantha (483 ha) are major fenugreek growing districts of the state. The productivity of North

Gujarat is the highest (2070 kg/ha).

Fenugreek is mainly attributable to the intrinsic dietary fiber constituent which have promising nutraceutical value (Srinivasan, 2006). These days it is used as food stabilizer, adhesive and emulsifying agent due to its high fiber, protein and gum content (Ahemad *et al.*, 2016).

Gujarat methi 3, a new variety of fenugreek for seed purpose was released in Gujarat, Uttarakhand, Andhra Pradesh and Uttar Pradesh states. A new variety is having bold seed and more number of pods per plant. It was tested under code FGK 136 for 3 years across the country and recorded 1604 kg/ha average seed yield which was 16.31 and 12.97 per cent higher seed yield than national check Hissar sonali and state check Gujarat methi 2, respectively at Jagudan, Guntur, Kumarganj, Navsari and Pantnagar. In addition to that, the released variety was at par in total fibre content and protein percent with check varieties. It was found less prone to the powdery mildew than check varieties. Gujarat methi 3 will be new choice for fenugreek growing farmers in the state of Gujarat and other fenugreek growing states of India.

Materials and Methods

Gujarat methi 3 was tested under code name JFg 2013-02 in station trials. The genotype was tested under station and state trials from 2016-17 to 2019-20 at Jagudan, Deesa, Bhiloda, Junagadh and Navsari centres. In CVT trials it was tested under code name of FGK 136 at thirteen different locations across India. For field evaluation standard Randomized Block Design (RBD) were followed. Weighted mean for seed yield over different checks varieties were calculated to find out superiority of Gujarat methi 3 over check varieties.

Quality parameters estimation was carried out *viz.*, total protein content using Microkjeldhal method and fiber content using fiberthern method in fenugreek at food testing laboratory, Department of Biotechnology, JAU, Junagadh. The Kjeldahl

method involves a three-step approach to the quantification of protein: digestion, distillation, and titration. Digestion of organic material is achieved using concentrated H₂SO₄, heat, K₂SO₄ (to raise the boiling point), and a catalyst (*e.g.*, selenium) to speed up the reaction.

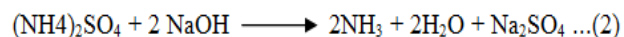
Digestion

The food sample to be analyzed is weighed into a digestion flask and then digested by heating it in the presence of sulfuric acid (an oxidizing agent which digests the food), anhydrous sodium sulfate (to speed up the reaction by raising the boiling point) and a catalyst, such as copper, selenium, titanium, or mercury (to speed up the reaction). Digestion converts any nitrogen in the food (other than that which is in the form of nitrates or nitrites) into ammonia, and other organic matter to CO₂ and H₂O. Ammonia gas is not liberated in an acid solution because the ammonia is in the form of the ammonium ion (NH₄⁺) which binds to the sulfate ion (SO₄²⁻) and thus remains in solution:

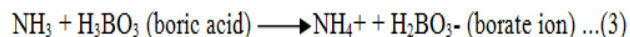


Neutralization

After the digestion has been completed the digestion flask is connected to a receiving flask by a tube. The solution in the digestion flask is then made alkaline by addition of sodium hydroxide, which converts the ammonium sulfate into ammonia gas:



The ammonia gas that is formed is liberated from the solution and moves out of the digestion flask and into the receiving flask - which contains an excess of boric acid. The low pH of the solution in the receiving flask converts the ammonia gas into the ammonium ion, and simultaneously converts the boric acid to the borate ion:



Titration

The nitrogen content is then estimated by titration of the ammonium borate formed with standard sulfuric or hydrochloric acid, using a suitable indicator to determine the end-point of the reaction.



The concentration of hydrogen ions (in moles) required to reach the end-point is equivalent to the concentration of nitrogen that was in the original food (Equation 3). The following equation can be used to determine the nitrogen concentration of a sample that weighs *m* grams using a *x*M HCl acid solution for the titration:

$$\% N = \frac{x \text{ moles}}{1000 \text{ cm}^3} \times \frac{(v_s - v_b) \text{ cm}^3}{m \text{ g}} \times \frac{14 \text{ g}}{\text{moles}} \times 100 \dots (5)$$

Where *v_s* and *v_b* are the titration volumes of the sample and blank, and 14g is the molecular weight of nitrogen N.

FIBRE THERM standardises fibre analysis in feedstuffs at a new level of quality, making it more efficient, more precise and more reliable for fibre content estimation. The device automatically controls and monitors all the boiling, washing and filtration processes within a self-contained cycle. No extraction is required.

The FibreBag technology optimises the digestion of the samples and speeds up the washing and filtration processes. All detergents are automatically added and dosed by calibrated pumps. The NDF value can also be determined after addition of α amylase during running operation without interrupting the process. An external dosing pump (accessory) automatically regulates the addition of the heat-resistant amylase. The energy feed and cooling water are automatically controlled and regulated. A glass-ceramic heating surface reduces heating times

and guarantees constant temperature conditions.

Results and Discussion

Gujarat methi 3 formally named as JFg 2013-02 was developed through pureline selection and evaluated in germplasm during 2013-14 to 2014-15. Fenugreek being less effort and inputs intensive crop, it's area is growing day by day along with awareness of it's health benefits (Prajapati *et al.*, 2010). So far only two varieties *viz.*, GM 1 and GM 2 has been released for general cultivation of ajwain growing area in Gujarat.

Seed yield is not a single character but it is conglomerate of many characters, ancillary observation like braches per plant, plant height (cm), number of pods/ plant, number of seeds/pod, pod length (cm) and Test wt. (g) are directly influences on seed yield. Gujarat methi 3 variety is found superior for all these characters than check varieties.

The variety has tested in five trials at Jagudan and four trials at Deesa, Bhiloda, Junagadh and Navsari centres, it was found at par with the local check GM 2. In state trial JFg 2013-02 gave significantly higher yield 2302 kg/ha which was 3.60 per cent higher check GM 2 (Table 1). In Initial Evaluation Trial at Jagudan pooled over three years data showed significant differences for seed yield. JFg 2013-02 recorded yield of 1824 kg/ha, which was 5.62 per cent higher than check GM 2 at Jagudan.

In Co-ordinated varietal trial the released variety was tested at thirteen different locations in India for three years. JFg 2013-02 found superior at Jagudan, Guntur, Kumarganj, Navsari and Pantnagar locations. At Jagudan it was superior in two trials with 1638 kg/ha seed production which was at par with the check Hisar sonali. At Guntur, it was superior in three trials with 1562 kg/ha which was 43.57 per cent higher than national check Hisar sonali. At kumarganj, it was superior in yield for all the three trials with 1518 kg/ha seed yield which was 14.05 percent higher than national check.

Table.1 Overall performance of Fenugreek variety Gujarat Methi 3 (JFg 2013-02) over location and years in different trials conducted in Gujarat state [Yield kg/ha]

Year	Name of Trial	Locations	Proposed genotype JFg 2013-02	Gujarat Methi 2 (Check)	S.Em±	CD at 5%	CV%
2016	PET	Jagudan [@]	1338	1228	56.0	166	8.15
	Mean		-	-			
% Increase over checks							
2017	SSVT	Jagudan	2007	2049	67.89	202	5.8
		Deesa [@]	1510	1349	137.82	410	15.3
		Junagadh [@]	856	903	70.17	208	12.8
	Mean		2007	2049			
% Increase over checks				-			
2018	LSVT	Jagudan [@]	1760	1438	189.45	NS	18.86
		Deesa	2412	1886	224.34	662	13.26
		Junagadh [@]	782	681	49.06	144	10.06
	Mean		2412	1886			
% Increase over checks				27.8			
2019	LSVT	Jagudan [@]	1556	1444	171.89	NS	19.55
		Deesa [@]	1586	1604	122.35	359	13.17
		Bhiloda [@]	1134	1157	127.5	374	14.99
		Junagadh [@]	1040	868	62.8	184.1	13.18
	Mean		-	-			
% Increase over checks				-			
2020	LSVT	Jagudan [@]	1762	1656	109.01	324	10.85
		Navsari [@]	1117	1217	55.95	166.25	8.27
		Bhiloda [@]	745	815	81.55	242	13.50
		Junagadh	2486	2731	151.04	449	10.11
	Mean		2486	2731			
% Increase over checks				-			
Overall average (03 Locations)			2302	2222			
Overall % increase over the checks				3.60			
Frequency in top non-signi. groups			1/03				

@ = Data not considered due to below state average yield (State average 2011 kg/ha (2015-16), 1933 kg/ha (2016-17), 1900 kg/ha (2017-18), 1939 kg/ha (2018-19), 1934 kg/ha (2019-20) and 1872 kg/ha (Estimated 2020-21)).

Table.2 Yield Performance of Fenugreek variety Gujarat Methi 3 (JFg 2013-02) in comparison with check varieties in the different zones of Gujarat state [Yield kg/ha]

Year	Name of Trial	Locations	Proposed genotype JFg 2013-02	Gujarat Methi 2 (Check)	S.Em±	CD at 5%	CV%
Zone: North Gujarat							
2016	PET	Jagudan [@]	1338	1228	56.0	166	8.15
	Mean		-	-			
	% Increase over checks						
2017	SSVT	Jagudan	2007	2049	67.89	202	5.8
		Deesa [@]	1510	1349	137.82	410	15.3
	Mean		2007	2049			
% Increase over checks							
2018	LSVT	Jagudan [@]	1760	1438	189.45	NS	18.86
		Deesa	2412	1886	224.34	662	13.26
	Mean		2412	1886			
% Increase over checks							
2019	LSVT	Jagudan [@]	1556	1444	171.89	NS	19.55
		Deesa [@]	1586	1604	122.35	359	13.17
		Bhiloda [@]	1134	1157	127.5	374	14.99
	Mean		-	-			
% Increase over checks							
2020	LSVT	Jagudan [@]	1762	1656	109.01	324	10.85
		Bhiloda [@]	745	815	81.55	242	13.50
	Mean		-	-			
% Increase over checks							
Overall average (02 Locations)			2209	1967			
Overall % increase over the checks				12.3			
Zone: Saurashtra							
2017	SSVT	Junagadh [@]	856	903	70.17	208	12.8
Mean							
% Increase over checks							
2018	SSVT/LSVT	Junagadh [@]	782	681	49.06	144	10.06
		Mean	-	-			
	% Increase over checks						
2019	SSVT/LSVT	Junagadh [@]	1040	868	62.8	184.1	13.18
		Mean	-	-			
	% Increase over checks						
2020	SSVT/LSVT	Junagadh	2486	2731	151.04	449	10.11
		Mean	2486	2731			
	% Increase over checks						
Overall average (1 Locations)			2486	2731			
Overall % increase over the checks				-			
Zone: South Gujarat							
2020	SSVT/LSVT	Navsari [@]	1117	1217	55.95	166.25	8.27
Mean			1117	1217			
% Increase over checks							
Overall average (1 Locations)			1117	1217			
Overall % increase over the checks				-			

@ = Data not considered due to below state average yield (State average 2011 kg/ha (2015-16), 1933 kg/ha (2016-17), 1900 kg/ha (2017-18), 1939 kg/ha (2018-19), 1934 kg/ha (2019-20) and 1872 kg/ha (Estimated 2020-21).

Fig.1

Photographs of variety Gujarat Methi 3



Gujarat Methi 3

Gujarat Methi 2 (C)

Table.3A Evaluation of fenugreek genotypes for seed Yield (kg/ha) under IET trials from the year 2015-16 to 2017-18 (Pooled basis)

Sr. No.	Entry	Seed Yield (kg/ha)			Mean	Rank	% IOC GM 2
		2015-16	2016-17	2017-18			
1	JFg-2013-02	1338	2085	2047.5	1824	II	5.62
2	JFg-2013-04	1185	2031	2054.9	1757		1.74
3	JFg-2013-05	1194	2004	2198.8	1799		4.17
4	JFg-2013-06	1227	2021	2103.1	1784		3.30
5	JFg-2013-07	1028	2362	1892.6	1761		1.97
6	JFg-2013-08	1315	1930	1599.4	1615		
7	JFg-2013-14	1129	1970	1829.6	1643		
8	JFg-2013-15	1069	1994	1876.5	1647		
9	JFg-2013-16	1185	2444	2178.4	1936	I	12.10
10	GM 2 (C)	1228	2006	1946.9	1727		
	S.Em. ±	56	134.57	126.36	28.728		
	C.D. at 5%	166	NS	375.43	85.36		
	C.V. %	8.15	11.18	11.09	9.66		

Table.3B Seed Yield (kg/ha) from the year 2018 to 2021 of fenugreek under Coordinated Varietal Trial (CVT) (05 selected locations)

Location	Year	Proposed entry	Check variety		CD @0.05	CV %
		JFg-2013-02	Hisar Sonali (NC)	GM 2(LC)		
Jagudan	2018-19	1255	1182	1185	364	17.37
	2019-20	1947	1938	1476	408	14.67
	2020-21	1711	1785	1690	308	12.02
	Mean	1638	1635	1450	110	16.02
	%IOC	-	0.18	12.97		
Guntur	2018-19	2168	1314	-	310	9.50
	2019-20	1440	1056	-	295	12.20
	2020-21	1077	894	-	152	9.80
	Mean	1562	1088	-		
	%IOC	-	43.57	-		
Kumarganj	2018-19	1541	1361	-	817	3.40
	2019-20	1492	1305	-	741	3.20
	2020-21	1520	1326	-	614	2.60
	Mean	1518	1331	-	218	0.92
	%IOC	-	14.05	-		
Navsari	2018-19	1813	1442	-	278	10.58
	2019-20	1128	1165	-	217	12.12
	2020-21	1270	1036	-	255	13.11

	Mean	1404	1214	-		
	%IOC	-	15.65	-		
Pantnagar	2018-19	1875	1551	-	245	8.87
	2019-20	2041	1870	-	157	5.46
	2020-21	1780	1462	-	180	6.15
	Mean	1899	1628	-		
	%IOC	-	16.65	-		
Overall mean (15 locations)		1604	1379			
% increase over check (15 locations)		-	16.31			
Overall mean (03 locations)		1638	1635	1450		
% increase over check (03 locations)		-	0.18	12.97		

Table.4 Mean of ancillary characters of proposed variety JFg 2013-02 at Jagudan centre (2018-2021)

Sr No	Entry	Days to 50% Flowering	Maturity days	Plant height (cm)	Branches / plant	Pods / plant	Length of Pod (cm)	Seeds/ pod	Test wt. (g)
1	RM 196	49.00	126.50	48.20	3.70	25	12.80	15.05	13.90
2	RM 201	50.00	126.50	57.20	3.55	27	11.85	15.20	14.75
3	HM 273	47.23	127.10	64.40	3.80	21	12.13	15.83	14.20
4	HM 355	50.23	127.67	64.03	4.30	29	13.07	15.40	13.20
5	NDM 80	49.77	128.90	63.50	4.03	31	12.83	14.70	13.40
6	MDM 120	47.90	126.00	61.13	4.40	28	13.57	14.50	13.83
7	KFG 1	47.33	127.77	63.20	3.77	29	14.13	14.57	13.40
8	KFG 2	48.90	127.90	63.73	4.17	29	12.57	14.97	11.90
9	UM 393	47.77	127.23	59.67	4.23	31	13.20	15.83	14.03
10	UM 411	48.23	126.43	60.17	3.67	27	12.27	14.57	13.37
11	IFGS 11	49.33	128.33	60.13	3.53	28	12.17	14.33	12.80
12	AFG 06	47.43	128.57	60.33	4.23	31	12.10	16.23	11.40
13	AFG 07	48.77	128.43	60.20	4.00	32	12.30	13.50	10.83
14	JFg-2013-16	47.10	128.10	57.83	3.63	30	11.37	13.77	10.80
15	JFg-2013-02	49.43	127.10	58.53	3.83	38	13.63	15.03	13.17
16	HM 444	52.77	128.00	55.43	3.73	30	11.90	15.33	13.03
17	Hisar Sonali (NC)	54.10	128.33	59.57	3.63	29	13.53	15.30	13.80
18	GM 2(LC)	49.00	127.90	58.70	3.90	25	12.50	14.67	13.70

Table.5 Fiber and total protein content of JFg 2013-02 in comparison with local check GM 2 (2021)

Sr. No.	Parameters	Proposed entry JFg 2013-02	GM 2 (LC)	Method
1.	Fibre	12.71%	14.60%	Using fiberthern
2.	Total protein	32.97%	32.00%	Microkjeldhal

(Source: Food testing laboratory, Dept. of Biotechnology, JAU, Junagadh)

Table.6 Reaction against powdery mildew disease of proposed variety JFg 2013-02 at Jagudan (2018-19 to 2020-21)

Powdery mildew: (PDI)				
Entry	2018-19	2019-20	2020-21	Range
RM 196	2.00	40.00	NG	2.0-40.00
RM 201	7.00	45.00	NG	7.00-45
HM 273	10.00	35.00	20.10	10.00-35.00
HM 355	12.00	25.00	15.30	12.00-25.00
NDM 80	15.00	25.00	23.10	15.00-25.00
MDM 120	15.00	20.00	17.70	15.00-20.00
KFG 1	12.00	14.00	15.20	12.00-15.20
KFG 2	11.00	18.00	14.90	11.00-18.00
UM 393	5.00	15.00	9.10	5.00-15.00
UM 411	8.00	2.00	5.00	5.00-20.00
IFGS 11	7.00	15.00	6.20	6.20-15.00
AFG 06	10.00	15.00	7.10	7.10-15.00
AFG 07	7.00	20.00	10.50	7.00-20
JFg-2013-16	15.00	15.00	8.30	15.00
JFg-2013-02	-	18.00	11.80	11.80-18.00
HM 444	5.00	20.00	3.20	3.20-20.00
Hisar Sonali (NC)	10.00	25.00	15.80	10.00-25.00
GM 2(LC)	6.30	25.00	14.90	6.300-25.00

At Navsari, it was superior in two trials with 1404 kg/ha which was 15.65 higher than national check. At pantnagar it was superior in all the three trials with 1899 kg/ha which was 16.65 higher than national check. Over all mean (15 trials) of JFg 2013-02 was 1604 kg/ha, which was 16.31 per cent higher than national check variety hisar sonali. The seeds of genotype JFg 2013-02 are uniform in size with attractive seed colour, bold seed size, higher fibre and protein content (Table 5). Released variety is less prone to powdery mildew disease (Table 6). GM 3 is suitable for timely sown under irrigated condition with recommended agro techniques.

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