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Role of Growth Regulators on Fenugreek (*Trigonella foenum-graecum* L.)

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A B S T R A C T

The experiment was carried out at Horticultural Research Station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal during *rabi*season of 2016-17 and 2017-18. Five growth regulators were included with three concentration of each namely GA_3 (50, 100 and150 ppm), NAA (25, 50 and 75 ppm), ethrel (100, 150 and 200 ppm), maleic hydrazide (500, 1000 and 1500 ppm), thiourea (250, 500 and 750 ppm) and control. Each replicated thrice. Maximum plant height (98.32cm) at 105 DAS and primary branches (5.41) at 45 DAS with $GA_3$100 ppm but maximum number of seed pod^{-1} (15.18) and plant height (41.26) at 45 DAS were recorded with GA_3 150 ppm. Maximum number of primary branches (8.46) and secondary branches (8.46) at 105 DAS were observed with thiourea 500 ppm. Shortest duration for 50% flowering (48.24 days), maximum number of pod plant^{-1} (73.74), yield plant^{-1} (16.24g) and projected yield ha^{-1} (16.31q) were recoded with NAA 75 ppm.

Introduction

Fenugreek (*Trigonella foenum-graecum* L.) is one of the most important seed spice crop cultivated throughout the world for seed, green leafy vegetable and forage purpose. The crop belongs to family Fabaceae of sub family Papillionaceae and the order Fabales (Petropoulos, 2002). Apart from its spice value, fenugreek is a valuable source of several highly desirable biologically active compounds such as galactomannan (Brummer *et al.*, 2003), diosgenin (Fazli and Hardman, 1968), 4-hydroxy- isoleucine (Fowden *et al.*, 1973) and trigonelline (Antony and Gopinathan, 1975) that have specific health benefits. India is the largest producer of fenugreek. The crop coverage in India was 1, 24,710 ha with a production of 134,100 metric tonnes; the average productivity of the country was 1075 kg ha^{-1} during 2014-15 (Spice board, 2015). Rajasthan, Gujarat,

Haryana, Uttar Pradesh and Uttarakhandare the important states for fenugreek under irrigated conditions.

It is also cultivated in the states of West Bengal, Madhya Pradesh, Bihar, Orissa, Karnataka and Andhra Pradesh to a limited extent mostly under supplementary or without irrigation (Sastry and Anandraj, 2013). In spite of its large scale cultivation in India, the productivity of these crops is low, mainly due to the paucity of high yielding varieties, inadequate access of the good seeds to the growers and lack of improved management practices. The productivity can be increased, if a proper combination of the varieties and management are available to the growers.

Plant growth regulators present a new possibility to break yield barrier, particularly imposed by the environment (Witter, 1971). The plant growth regulators act as chemical catalysts in plants and improve physiological and reproductive efficiency in the plants. The plant growth regulators possibly improve the gene expression for efficient sucrose transport and increase dry matter partitioning for seed production. Effectiveness of plant growth regulators depends on several factors *viz*., concentration, method and time of application etc. It is established fact that plant growth regulators in small quantity can regulate various physiological processes (Saxena, 1989) but information regarding the suitability of various plant growth regulators and their time of application for fenugreek is very limited. With this background the present experiment was undertaken to identify the suitable growth regulators and the concentration for maximization the seed yield of fenugreek under alluvial plains of West Bengal.

Materials and Methods

The present investigation was carried out during winter season of two consecutive years *i.e.* 2016-17 and 2017-18 at Horticultural Research Station, BidhanChandra Krishi Viswavidyalaya, Mondouri, West Bengal. The research station was located at 23.5º N latitude and 89º E longitude, with an altitude of 9.75 m above the mean sea level. The experiment consisting of five growth regulators along with three concentration namely GA_3 (50, 100 and 150 ppm), NAA (25, 50 and 75 ppm), Ethrel (100, 150 and 200 ppm), Maleic hydrazide (500, 1000 and 1500 ppm) and Thiourea (250, 500 and 750 ppm). The experiment was laid out in Randomized Block Design with three replications. Seeds were sown in the plot of 2m x 1.5m at spacing of 30 x 20cm. A fertilizer dose of 15 t ha^{-1} of farmyard manure, 20 kg N, 40 kg $P_2O_5$and 20 kg K_2O $ha^{-1}$was applied. Nitrogen was applied in two equal split dose *i.e.*, half basal and remaining dose at 30 days after the first application. The entire phosphorus and potassium were applied as basal. Growth regulators were applied as foliar spray as per the treatments at 30 and 60 days after sowing.

Results and Discussion

The experimental results (pooled data) presented in Tables 1 revealed details on plant height, primary branches per plant, secondary branches, days to 50% flowering, number of pod per plant, number of seeds per pod, seed yield per plant and projected yield showed significant variations. As shown in Fig.1 among various treatments, at 45 DAS, maximum plant height (41.26 cm) was recorded in plants treated with $GA_3$150 ppm followed by ethrel 200 ppm (38.64 cm) and GA_3 100 ppm (38.24 cm) as compared to minimum plant height of 25.82 cm in maleic hydrazide 1500 ppm. At 105 DAS, the plant height ranged between 76.34 to 98.32 cm. The maximum plant height was observed in GA_3 100 ppm followed by thiourea 500 ppm (93.74 cm) as compared to minimum plant height of 76.34 cm in maleic hydrazide 1500

ppm. The maximum number of primary branches (5.41) at 45 DAS was recorded with GA_3 100 ppm followed by NAA 75 ppm (5.28) and NAA 50 ppm (5.16) as compared to minimum branches (4.18) with ethrel 100 ppm as shown in Fig. 2. At 105 DAS, the maximum number of primary branches (8.46) was noticed in thiourea 500 ppm followed by GA_3 100 ppm (8.24) and NAA 75 ppm (8.15) as compared to minimum number of branches in control (6.47).

The plants sprayed with thiourea 500 ppm recorded maximum number of secondary branches plant^{-1} (8.46) and ethrel 200 ppm (8.06) against the minimum number of branches in control plants at 105 DAS (Fig.3). As represented in the Fig.4, minimum duration of 48.24 days required for initiation of 50% flowering with NAA 75 ppm followed by ethrel 200 ppm (51.26 days) and GA_3 50 ppm (51.76 days) as compared to the longest time required for 50% flowering in maleic hydrazide 1500 ppm (65.24 days) followed by thiourea 750 ppm (63.24 days). Required time for control plants was 58.24 days. In GA_3, maleic hydrazide and thiourea, with increasing the concentration the duration was increasing for initiation of 50% flowering. However, the opposite trend was noticed with NAA and ethrel*i.e.*, with the increasing concentration the duration required became shortened. Maximum number of pods plant^{-1} was recorded with NAA 75 ppm (73.24) followed by ethrel 200 ppm (71.42) and thiourea 500 ppm (70.45) as compared to the minimum number of pods (51.34) under maleic hydrazide 1000 ppm. Maximum number of seeds pod^{-1} was recorded under GA_3 100 ppm (15.18) followed by NAA 75 ppm (15.06) and NAA 50 ppm (14.82) as compared to minimum number of seeds pod^{-1} with maleic hydrazide 1500 ppm (11.76). Seed number increased with the increase of concentration in respect of GA_3 and thioureaupto medium concentration but in respect of NAA and ethrel the seed number increased with highest concentration.

Maximum seed yield plant^{-1}of 16.24 g was recorded in NAA 75 ppm followed by thiourea 250 ppm (14.72g) and ethrel 200 ppm (14.52g) as compared to lowest seed yield of 9.25g under maleic hydrazide 1500 ppm. The plants grown under NAA 75 ppm recorded maximum projected yield (16.31q ha^{-1}) followed by thiourea 500 ppm (15.69 q ha^{-1}) and ethrel 200 ppm (15.46 q ha^{-1}) as compared to control (11.23 q ha^{-1}). The lowest yield was recorded in maleic hydrazide 1500 ppm (Fig.5).

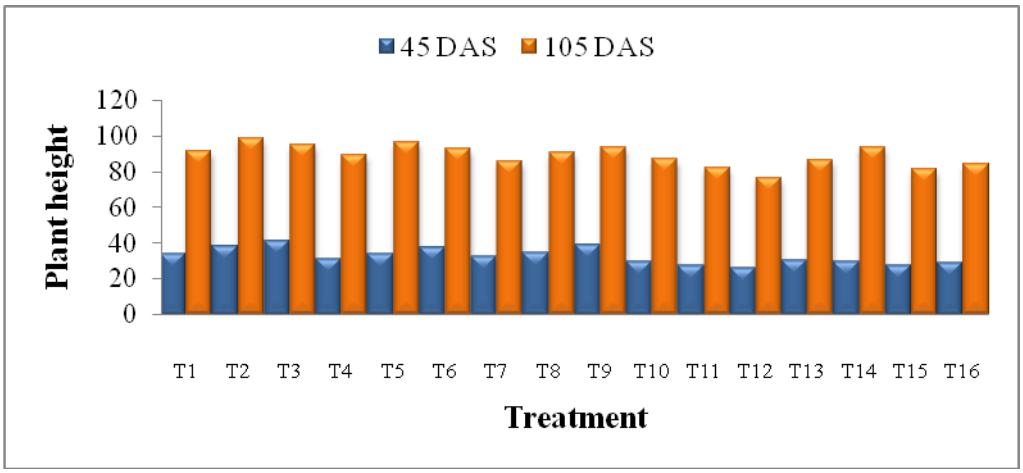

Fig.1 Effect of growth regulators on plant height of fenugreek at different stages

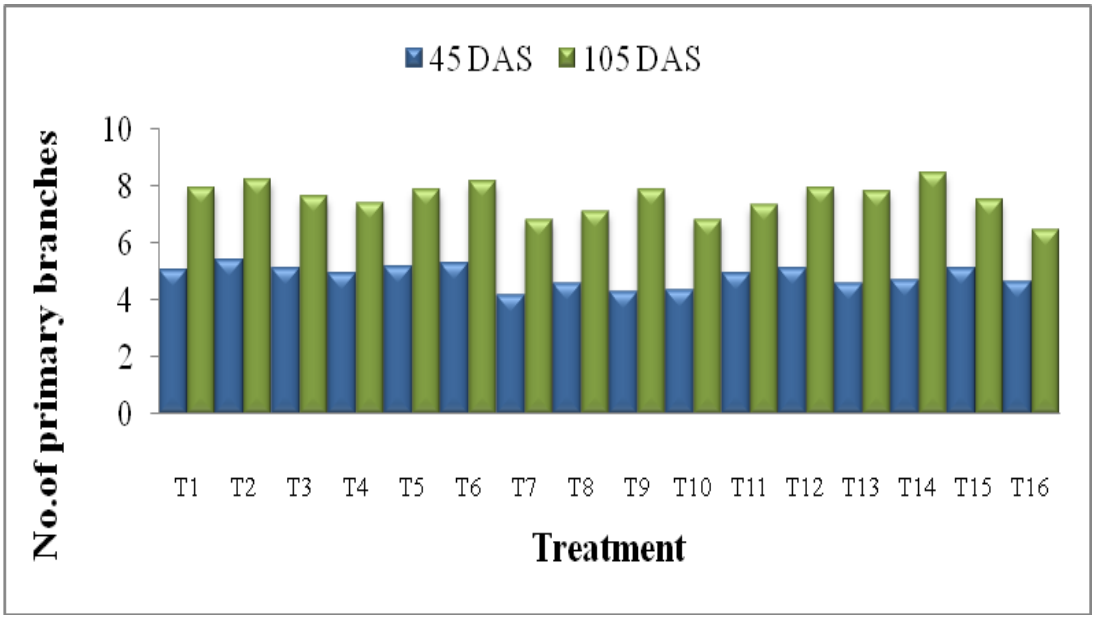

Fig.2 Effect of growth regulators on number of primary branches per plant of fenugreek

T_1 - GA_3 50 ppm T_2- GA_3 100 ppm T_3 - GA_3 150 ppm
T_4- NAA 25 ppm T_5 - NAA 50 ppm T_6-NAA 75 ppm
T_7 - Ethrel 100 ppm T_8- Ethrel 150 ppm T_9- Ethrel 200 ppm
T_{10}- MH 500 ppm T_{11} - MH 1000 ppm T_{12} - MH 1500 ppm
T_{13}- Thiourea 250 ppm T_{14}- Thiourea 500 ppm T_{15}-Thiourea 750 ppm
T_{16} - Control

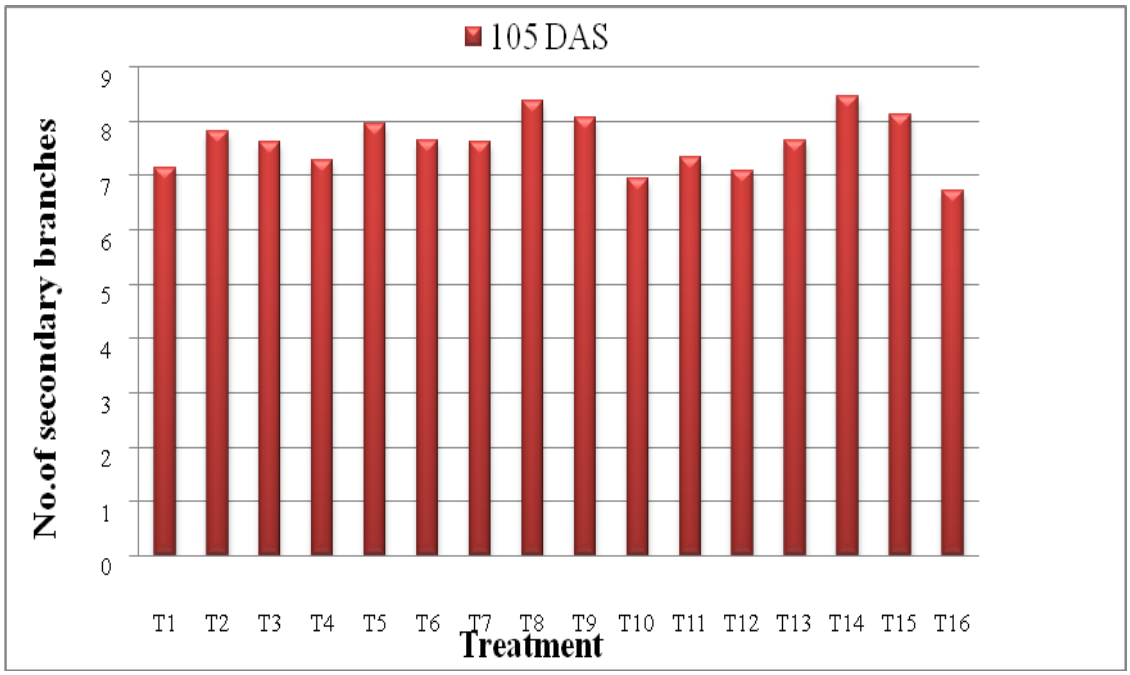

Fig.3 Effect of growth regulators on number of secondary branches per plant of fenugreek

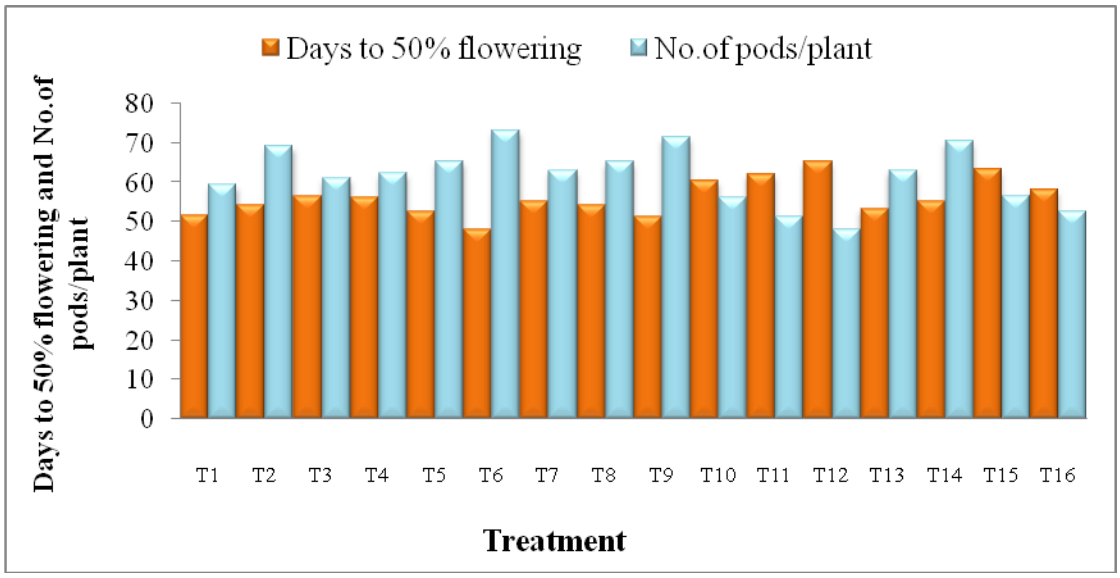

Fig.4 Effect of growth regulators on days to 50% flowering and number of pods per plant **of** fenugreek

T_1 - GA_3 50 ppm T_2- GA_3 100 ppm T_3 - GA_3 150 ppm
T_4- NAA 25 ppm T_5 - NAA 50 ppm T_6-NAA 75 ppm
T_7 - Ethrel 100 ppm T_8- Ethrel 150 ppm T_9- Ethrel 200 ppm
T_{10}- MH 500 ppm T_{11} - MH 1000 ppm T_{12} - MH 1500 ppm
T_{13}- Thiourea 250 ppm T_{14}- Thiourea 500 ppm T_{15}-Thiourea 750 ppm
T_{16} - Control

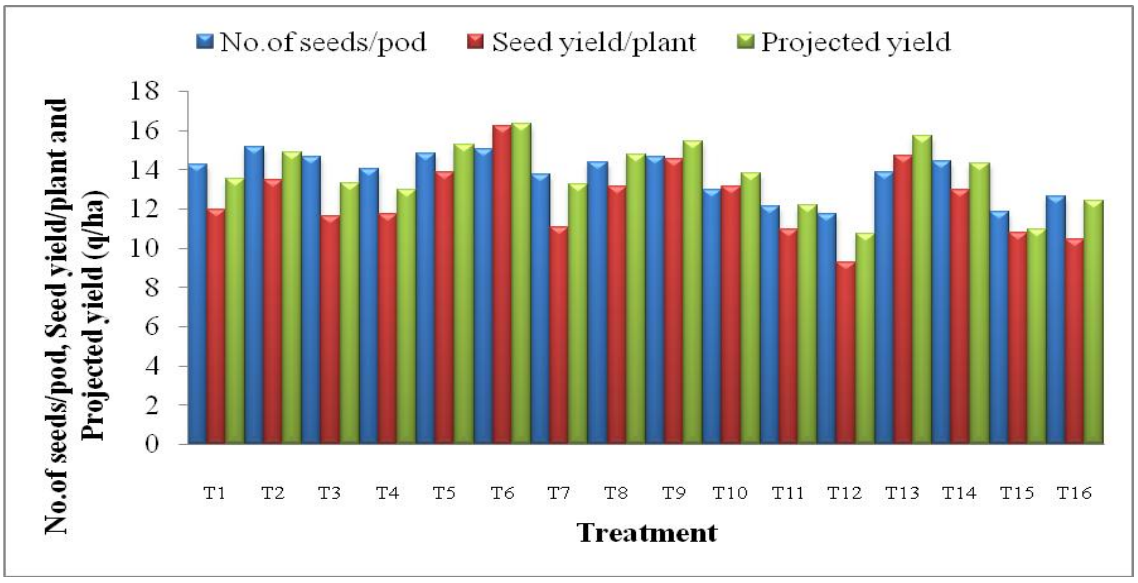

Fig.5 Effect of growth regulators on number of seeds per pod, seed yield per plant and projected yield (q/ha) of fenugreek

T_1 - GA_3 50 ppm T_2- GA_3 100 ppm T_3 - GA_3 150 ppm
T_4- NAA 25 ppm T_5 - NAA 50 ppm T_6-NAA 75 ppm
T_7 - Ethrel 100 ppm T_8- Ethrel 150 ppm T_9- Ethrel 200 ppm
T_{10}- MH 500 ppm T_{11} - MH 1000 ppm T_{12} - MH 1500 ppm
T_{13}- Thiourea 250 ppm T_{14}- Thiourea 500 ppm T_{15}-Thiourea 750 ppm
T_{16} - Control

Table.1 Effect of growth regulators on growth and yield of fenugreek

Treatment	Plant height (cm)		No. of Primary branches plant^{-1}		No. of Secondary branches plant^{-1} at 105 DAS	Days to 50% flowering	No. of pod plant^{-1}	No. of seeds pod^{-1}	Seed yield plant^{-1} (g)	Projected yield (q ha^{-1})
	45 DAS	105 DAS	45 DAS	105 DAS						
GA_3-50 ppm	34.17	91.45	5.06	7.96	7.14	51.76	59.34	14.26	11.98	13.55
GA_3-100 ppm	38.24	98.32	5.41	8.24	7.83	54.28	69.24	15.18	13.45	14.85
GA_3-150 ppm	41.26	94.75	5.12	7.63	7.62	56.43	61.13	14.64	11.62	13.32
NAA-25 ppm	31.38	89.40	4.94	7.43	7.28	56.18	62.38	14.05	11.74	12.96
NAA-50 ppm	34.06	96.38	5.16	7.86	7.95	52.76	65.46	14.82	13.89	15.28
NAA-75 ppm	37.64	92.46	5.28	8.15	7.65	48.24	73.24	15.06	16.24	16.31
Ethrel-100 ppm	32.56	85.63	4.18	6.82	7.62	55.32	63.16	13.74	11.08	13.24
Ethrel-150 ppm	34.72	90.48	4.56	7.13	8.38	54.16	65.28	14.36	13.15	14.76
Ethrel-200 ppm	38.64	93.62	4.32	7.89	8.06	51.26	71.42	14.64	14.52	15.46
MH-500 ppm	29.38	86.74	4.35	6.83	6.95	60.52	56.18	12.98	13.14	13.82
MH-1000 ppm	27.24	82.13	4.96	7.35	7.34	62.16	51.34	12.14	10.95	12.17
MH-1500 ppm	25.82	76.34	5.14	7.96	7.10	65.24	48.26	11.76	9.25	10.72
Thiourea-250 ppm	30.46	86.35	4.61	7.84	7.65	53.46	63.2	13.86	14.73	15.69
Thiourea-500 ppm	29.38	93.74	4.72	8.46	8.46	55.25	70.45	14.45	12.97	14.33
Thiourea-750 ppm	27.49	81.58	5.14	7.52	8.13	63.24	56.72	11.82	10.77	10.93
Control	28.65	84.36	4.67	6.47	6.73	58.24	52.74	12.62	10.46	12.38
S.Em. (±)	**0.302**	**0.832**	**0.045**	**0.071**	**0.072**	**0.532**	**0.582**	**0.129**	**0.115**	**0.127**
C.D (P=0.05)	**1.205**	**3.326**	**0.177**	**0.281**	**0.281**	**2.126**	**2.324**	**0.355**	**0.459**	**0.503**

The role of NAA in enhancing the growth, fruit set and yield attributes in fenugreek has been reported by Alagukannan and Vijayakumar (1999). The present study confirms the earlier reports of Gour *et al.*, (2012). Similar beneficial effect of growth regulators also obtained by Shivran *et al.*, (2016), Krishnaveni *et al.*, (2016), Gour *et al.*, (2010), Bhunia *et al.*, (2006) and Lakshmi *et al.*, (2015) in fenugreek. The possible reason for increased yield was due to higher photosynthetic activity of treated plants as compared to control (Audus, 1960). The better performance of GA_3 at 100 ppm over other two concentrations in respect of plant height at 105 DAS, number of primary branches at 45 DAS, number of seed per pod was possibly because of its better efficacy in promoting vegetative and reproductive parameters (Tania *et al*., 2015).

It is concluded that, among different treatments, shortest duration for 50% flowering (48.24 days), maximum number of pod plant^{-1}(73.74), yield plant^{-1}(16.24g) and projected yield ha^{-1} (16.31q) were observed with NAA 75 ppm. Plants treated with GA_3 100 ppm recorded maximum plant height (98.32cm), primary branches (5.41) at 105 and 45 DAS respectively. Thiourea 500 ppm recorded both maximum number of primary branches (8.46) and secondary branches (8.46). From yield maximization point of view the most effective treatment was NAA 75 ppm (16.31qha^{-1}) followed by thiourea 250 ppm (15.69 q ha^{-1}) and ethrel 200 ppm (15.46 qha^{-1}) under alluvial plains of West Bengal for fenugreek production.

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