

EFFECT OF MODERN GROWTH REGULATORS ON SEED YIELD OF FENUGREEK

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SUMMARY

Fenugreek (*Trigonella foenum-graecum*) is an annual plant in the family Fabaceae with leaves consisting of three small obovate to oblong leaflets. It is cultivated worldwide as a semi-arid crop. Its leaves and seeds are common ingredients in dishes from the Indian subcontinent, and have been used as a culinary ingredient since ancient times. Its use as a food ingredient in small quantities is safe. The present experiment was conducted at Research Farm, Department of Vegetable Science, CCS Haryana Agricultural University, Hisar (Haryana) during 2023-2024 and 2024-25, respectively. The experiment was laid out in Randomized Block Design with three replications. There were total nine modern growth regulators as treatments viz. Salicylic acid @ 50 ppm, Salicylic acid @ 100 ppm, Jasmonic acid @ 50 ppm, Jasmonic acid @ 100 ppm, Benzyl adenine @ 10 ppm, Benzyl adenine @ 20 ppm, Brassinosteroid @ 0.50 ppm, Brassinosteroid @ 1.00 ppm and water spray were used for the present study. These all nine modern growth regulators were applied 45 and 60 days after sowing (DAS) as a foliar spray of fenugreek crop. Maximum number of branches per plant (6.0), pods per plant (65.7), number of seeds per pod (19.1) and seed yield (2432 kg/ha) was recorded with foliar spray of salicylic acid @ 100 ppm while applied 45 and 60 days after sowing (DAS) followed by with the application of jasmonic acid @ 50 ppm in fenugreek seed crop.

Key words: Modern growth regulators, fenugreek, pods and seed yield

Fenugreek (*Trigonella foenum-graecum*) is an annual plant in the family Fabaceae with leaves consisting of three small obovate to oblong leaflets. There are two species of the genus which are of economic importance. One is *Trigonella foenum-graecum* L. that is common methi and the other is *T. corniculata*, champa or Kasuri methi. These two species differ in their growth habit and yield. Cultivated forms are diploid having the chromosome number is $2n=16$. It is cultivated worldwide as a semi-arid crop. Fenugreek seed is the ripe fruit of an annual herb. Fenugreek is a native of South Eastern Europe and West Asia, now cultivated in India, China, Argentina, Egypt, Spain, Turkey and Mediterranean countries (Southern France, Morocco and Lebanon). Fenugreek is the 3rd largest seed spice crop of India after coriander and cumin. It is cultivated all over India both tropical and temperate regions but Rajasthan, Gujarat, Maharashtra, MP, UP, Punjab, Haryana, Uttarakhand and are the principal states where it is grown on large scale. Its green fresh leaves and young pods are used as cooked vegetable and dried leaves and flowers for flavoring. It is an ancient and annual legume crop mainly grown for multiple uses in many parts of the

world. *Trigonella*, comes from Latin meaning 'little triangle', refers to the triangular shape of its small yellowish white flowers. The species epithet *foenum graecum* means 'Greek hay'. It is also called 'ox horn' or 'goat horn' because of the two seed pods projecting in opposite directions usually from the nodes of the stem base that resemble ox or goat horns. This robust herb has light green leaves, is 30-60 cm tall and produces slender, beaked pods, 10-15 cm long, each pod contains 10-20 small hard yellowish brown seeds, which are smooth and oblong, about 3 mm long, each grooved across one corner, giving them a hooked appearance.

It is a cold season crop and is fairly tolerant to frost and very low temperature. It is best suited to tracts of moderate to low rainfall and is sown in all types of soil but perform better in loam and clayey loam with proper drainage. It can also be grown on black cotton soils. The plants growing to height of 90 cm, flowering can occur in 30-37 days after sowing. Anthesis takes place between 9 AM and 6 PM and plants are typically self-pollinated.

Because fenugreek is a seed and a legume, it is high in protein, which makes it very useful in

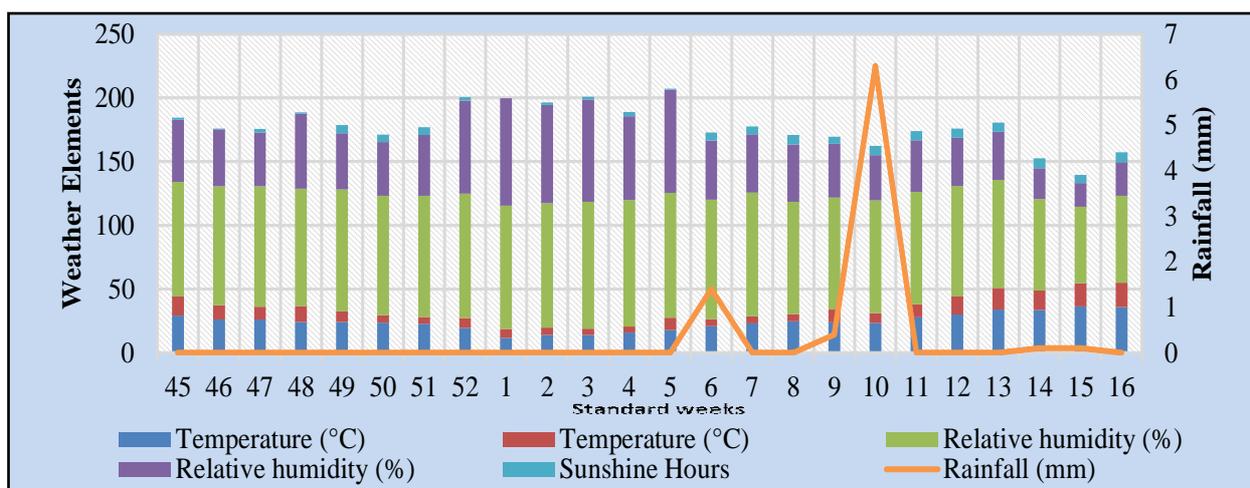
vegetarian diets. Fenugreek seed contains 45-60% carbohydrates, 20-30% proteins, 5-10% fixed oils (lipids), pyridine alkaloids, luteolin, orientin, free amino acids, histidine and lysine, calcium and iron, saponins (0.6-1.7%), glycosides yielding steroidal saponins on hydrolysis (diosgenin, yamogenin, tigogenin, neotigogenin), cholesterol and sitosterol, vitamins A, B₁, C and nicotinic acid and 0.015% volatile oils 'n-alkanes' and 'sesquiterpenes'. Uncooked fenugreek seeds have an unpleasant and bitter taste, so the seeds are usually roasted and ground before use to mellow the bitterness. Fenugreek is a favorite in Northern African and Middle Eastern dishes and is one of the few spices that are usually used in powdered form even in Indian curries. Seed extract is used in imitation vanilla, butterscotch and rum flavorings, and is the main flavoring in imitation maple syrup. Also used in breads in Egypt and Ethiopia. Ground seeds and/or leaves, can give a nice lift to some bland vegetarian dishes. It is also good in marinades. Generally, a nice unusual flavor to experiment with to achieve some different effects. Use very young shoots with only a few leaves and some watercress for a nice salad addition. Fenugreek seeds are also used in candy, baked goods, ice cream, chewing gum and soft drinks. The seeds can be roasted and used as a coffee substitute. Formerly used as a yellow dye. The leaves are dried and used as an insect repellent in grain storage. Common methi is quick growing, produces upright shoots, giving 2-3 cuttings, pinkish white bigger flowers borne in axils of leaves, 6-7 cm long straight pods, leaf simple, palmate, seed and flower size bigger than those of Kasuri type..

There is continues, needs for exploring its potential as a capable crop of the future due to its flexibility to harsh growing conditions and its high nutritional value. Land holding size is decreasing day by day and population is vice-versa across the country. Therefore, we have to capture maximum output with limited resources. Among the different limits in production of fenugreek through conventional methods need to innovative techniques for improve production and quality of fenugreek seed crop. Therefore, influence of modern growth regulators play significant function for seed production of the crop. Plant growth regulators play a vital role in the growth and development of the plant which has a significant effect on the yield of the plant (Sahu *et al.*, 2022). The use of PGRs in agriculture has become commercial. Exogenous application of PGRs has been reported to improve the growth and yield of various crops (Saxena *et al.*, 2014a). Salicylic

acid is most important for sustainable vegetable production and its potential to enhance crop performance in the face of both biotic and abiotic stress conditions (Zhang *et al.*, 2023, Ding and Ding, 2020 and Vlot *et al.*, 2021). Benzyl adenine (BA), a synthetic form of cytokinin plays a crucial role in the regulation of plant growth and development. Recent investigations highlight its efficacy in stimulating cell division, postponing leaf senescence, boosting shoot proliferation and enhancing flowering traits in a range of crops and ornamental plants (Kumar *et al.*, 2023 and El-Mahrouk *et al.*, 2022). The foliar application of BA has been shown to elevate photosynthesis rates, increase chlorophyll content and improve yield particularly under stress conditions such as drought or shading (Abdelgadir *et al.*, 2023). GA₃ is a vital plant hormone that plays a significant role in regulating various physiological and developmental processes in plants. Quality seed is the most important input for realising potential productivity because it ensures good germination, rapid emergence and vigorous growth of the plant stand, resulting in a good crop yield that contributes approximately 15-20% to crop productivity (Chauhan *et al.*, 2016). Keeping the above facts in mind the present study was planned with the objective to study the influence of modern growth regulators on seed yield and quality of fenugreek.

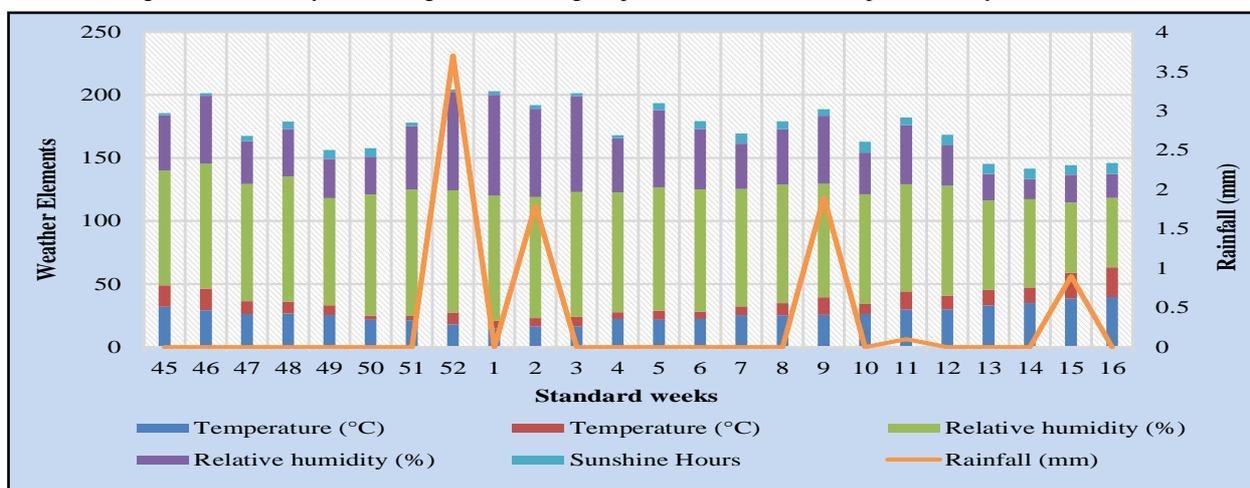
MATERIALS AND METHODS

The present investigation entitled "Influence of modern growth regulators on seed yield of fenugreek" was carried out at Research Farm of the Department of Vegetable Science, CCS Haryana Agricultural University, Hisar, Haryana during two consecutive *Rabi* seasons of 2023-24 and 2024-25, *respectively*. Hisar is located 215.2 metres above mean sea level between 29°10' North latitude and 75°46' East longitude. The climate in this region is semi-arid. The typical characteristics of this region include hot, dry winds in the summer and dry, bitter cold in the winter. The average temperature between the maximum and minimum reveals a large range of variation. The South-West monsoon contributes the majority of the 400 mm of rain that falls on average annually between July and September in each and every year. The experiment was laid out in Randomized Block Design with three replications There were total nine modern growth regulators as a treatments *viz.* Salicylic acid @ 50 ppm, Salicylic acid @ 100 ppm, Jasmonic acid @ 50 ppm, Jasmonic acid @ 100 ppm, Benzyl adenine @ 10 ppm, Benzyl adenine @ 20 ppm,



Source: Department of Agricultural Meteorology, CCS HAU, Hisar.

Fig. 1. Mean weekly meteorological data during crop season (November to April) for the year of 2023-24.



Source: Department of Agricultural Meteorology, CCS HAU, Hisar

Fig. 2. Mean weekly meteorological data during crop season (November to April) for the year of 2024-25.

Brassinosteroid @ 0.50 ppm, Brassinosteroid @ 1.00 ppm and water spray were used for the present study. These all nine modern growth regulators were applied 45 and 60 days after sowing (DAS) as a foliar spray of fenugreek crop.

Fig. 3.1 and 3.2 shows the highest and lowest temperatures, the number of sunny hours, the relative humidity and the amount of rain that fell each week throughout the investigation period at the Meteorological Observatory at the Department of Agro-Meteorology, CCS Haryana Agricultural University, Hisar is given below.

Fenugreek crop Variety Hisar Sonali was sown in the Rabi season in the first week of November for both consecutive years. The seed was sown in by drilling in lines keeping the spacing 30 cm between the lines. Seeds were sown 2-3 cm deep because of its small seed size and then covered with

thin and fine layer of soil. Plant to plant spacing within the rows is maintained 10 cm at the time of thinning. First irrigation was given as a *plewa* (pre-irrigation) before sowing of fenugreek crop and subsequent irrigations were given at 8-10 days intervals and whenever required to maintain optimum moisture content. To maintain the fertility of investigated field 25 ton FYM and two major elements nitrogen and phosphorus were applied in the form of urea and di-ammonium phosphate, *respectively* at the rate of 60:50 kg per hectare at the time of field preparation. Weeding was important in early stage of crop growth due to its small seed size and slow early growth. Pendimethalin 1000-1250 g/acre (stomp 30% @ 3.25 liters) just after sowing was applied for better weed control, while there is moisture in the field. There were total two hands weeding made to keep the weeds under check. One weeding and hoeing should be done



Plate 1. Photographs of the trials.

about 20-25 days after sowing. Second weeding should be done 45-50 days after sowing. The data was analyzed statistically by using OPSTAT software developed by CCS Haryana Agricultural University, Hisar (Haryana) (Sheoran *et al.*, 1998).

RESULTS AND DISCUSSION

The results obtained have been thoroughly analyzed and interpreted in this chapter under the following headings.

Influence of modern plant growth regulator on plant height (cm) and branches per plant

The significant differences were obtained for all the treatments for plant height. The application of modern PGRs significantly enhanced plant height as compared to the control treatment (water spray). Among the all the PGRs treatments, benzyl adenine @ 10 ppm recorded the maximum plant height with mean score of 117.7 cm which was statistically at par

with benzyl adenine @ 20 ppm, salicylic acid @ 50 ppm, and brassinosteroid @ 0.50 ppm as well as @ 1.00 ppm across both years 2023-24 and 2024-25, respectively. Similar results were recorded by Aminifard *et al.* (2020) who studied the effect of different levels of benzyl adenine and salicylic acid along with control (distilled water) on vegetative and reproductive growth, chlorophyll contents and some biochemical indices of coriander. It was revealed that spraying of BA (250 to 500 ppm) and SA (75 to 150 mM) were found effective to obtain better growth and development in coriander. On the other side, Shivran *et al.* (2016) found that the plant growth regulators significantly affect the growth and yield parameters of fenugreek. The growth and yield parameters like as, plant height, number of pods per plant, number of seeds per pod and biological yield were observed maximum with the foliar application of NAA 50 ppm as compared to other treatments.

Regarding the branches per plant significant differences were obtained for all the treatments for

TABLE 1
Effect of modern growth regulators on growth parameters of fenugreek (Pooled data 2023-24 & 2024-25)

S. No.	Modern growth regulators	Plant height (cm)			Branches/plant		
		2023-24	2024-25	Mean	2023-24	2024-25	Mean
1.	Salicylic Acid @ 50 ppm	125.6	91.5	108.6	5.2	5.6	5.4
2.	Salicylic Acid @ 100 ppm	114.7	100.0	107.4	5.7	6.3	6.0
3.	Jasmonic Acid @ 50 ppm	112.4	97.3	104.9	5.4	6.0	5.7
4.	Jasmonic Acid @ 100 ppm	106.6	86.0	96.3	5.8	6.1	6.0
5.	Benzyl adenine @ 10 ppm	132.2	103.1	117.7	5.2	5.3	5.3
6.	Benzyl adenine @ 20 ppm	126.4	99.1	112.8	5.5	5.7	5.6
7.	Brassinosteroid @ 0.50 ppm	120.5	103.0	111.8	5.9	5.8	5.9
8.	Brassinosteroid @ 1.00 ppm	124.6	93.0	108.8	5.0	5.7	5.4
9.	Water Spray	106.3	104.1	105.2	5.1	5.6	5.4
	CD at 5%	9.1	10.1	9.6	0.4	NS	0.4
	C.V.(%)	4.4	6.0	5.2	5.2	5.9	5.6

TABLE 2
Effect of modern growth regulators on pod of fenugreek (Pooled data 2023-24 & 2024-25)

S. No.	Modern growth regulators	Pods/plant			Pod length (cm)		
		2023-24	2024-25	Mean	2023-24	2024-25	Mean
1.	Salicylic Acid @ 50 ppm	58.3	42.4	50.4	12.2	11.0	11.6
2.	Salicylic Acid @ 100 ppm	64.4	66.9	65.7	12.6	12.0	12.3
3.	Jasmonic Acid @ 50 ppm	61.5	62.2	61.9	12.0	11.8	11.9
4.	Jasmonic Acid @ 100 ppm	58.8	52.3	55.6	12.1	11.8	12.0
5.	Benzyl adenine @ 10 ppm	54.7	43.2	49.0	14.1	11.0	12.6
6.	Benzyl adenine @ 20 ppm	61.4	50.2	55.8	14.0	11.2	12.6
7.	Brassinosteroid @ 0.50 ppm	54.1	41.8	48.0	13.5	10.6	12.1
8.	Brassinosteroid @ 1.00 ppm	57.5	52.3	54.9	13.1	11.6	12.4
9.	Water Spray	62.0	41.2	51.6	11.8	10.4	11.1
	CD at 5%	5.9	7.5	6.7	0.6	0.9	0.8
	C.V.(%)	6.7	8.5	7.6	3.7	4.5	4.1

the year 2023-24 and maximum branches (5.9) per plant in fenugreek were recorded in the treatment of brassinosteroid @ 0.50 ppm were applied as a foliar spray. On the second year of 2024-25 results regarding the branches per plant were found non-significant, however, maximum branches (6.3) per plant was recorded where salicylic acid was applied @ 100 ppm.

Influence of modern plant growth regulator on number of pods per plant and pod length (cm)

The application of PGRs significantly enhanced the number of pods per plant compared to the others treatment as exhibited in Table 2. The maximum number of pods consistently recorded under salicylic acid @ 100 ppm with mean score of 65.7 followed by jasmonic acid @ 50 ppm with mean score of 61.9 pods per plant. On the other hand, maximum pod length (12.6 cm pooled mean) was recorded where benzyl adenine @

10 ppm and benzyl adenine @ 20 ppm was applied as a foliar spray on the fenugreek crop. Similar results were recorded by Shivran *et al.* (2016) found that the plant growth regulators significantly affect the growth and yield parameters of fenugreek.

Influence of modern plant growth regulator on number of seed per pods and Seed yield (kg/ha)

The significant differences were obtained for all the treatments. Maximum number of seed per pods (19.1) and seed yield (2432 kg/ha) was recorded with the application of salicylic acid @ 100 ppm followed by seed per pods (19.0) and seed yield (2243.5 kg/ha) was recorded with the application of jasmonic acid @ 50 ppm. Jasmonate (JA) plays a significant role in regulating various developmental process. Similar findings were reported by Parmer *et al.* (2018), Patil *et al.* (2021).

TABLE 3
Effect of modern growth regulators on seed yield (kg/ha) of fenugreek (Pooled data 2023-24 & 2024-25)

S. No.	Modern growth regulators	Seeds /pod			Seed yield (kg/ha)		
		2023-24	2024-25	Mean	2023-24	2024-25	Mean
1.	Salicylic Acid @ 50 ppm	16.3	17.2	16.8	2070.0	2056.0	2063.0
2.	Salicylic Acid @ 100 ppm	18.5	19.6	19.1	2384.4	2479.6	2432.0
3.	Jasmonic Acid @ 50 ppm	19.4	18.5	19.0	2298.0	2188.9	2243.5
4.	Jasmonic Acid @ 100 ppm	17.3	18.4	17.9	2072.8	2176.8	2124.8
5.	Benzyl adenine @ 10 ppm	16.8	17.2	17.0	2107.2	2025.9	2066.6
6.	Benzyl adenine @ 20 ppm	17.4	18.1	17.8	2112.0	2084.2	2098.1
7.	Brassinosteroid @ 0.50 ppm	16.7	16.7	16.7	2067.4	1981.5	2024.5
8.	Brassinosteroid @ 1.00 ppm	16.0	17.5	16.8	2088.6	2180.1	2134.4
9.	Water Spray	17.1	16.1	16.6	1873.0	1858.3	1865.7
	CD at 5%	1.4	1.6	1.5	148.9	149.9	149.4
	C.V. (%)	4.7	5.0	4.9	4.0	4.1	4.05

CONCLUSION

On the basis of two years pooled data, it may be concluded that maximum number of branches per plant (6.0), pods per plant (65.7), number of seeds per pod (19.1) and seed yield (2432 kg/ha) was recorded with foliar spray of salicylic acid @ 100 ppm while applied 45 and 60 days after sowing (DAS) followed by with the application of jasmonic acid @ 50 ppm in fenugreek seed crop.

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