International Journal of Plant & Soil Science

Volume 35, Issue 21, Page 912-920, 2023; Article no.IJPSS.107978
ISSN: 2320-7035

Effect of Plant Growth Regulators and Bio-Fertilizer on Growth and Quality of Fenugreek (*Trigonella foenum-graecum* L.)

Jitendra Kumar Chhiroliya [a++], Rahul Morya [b#], Anjali Bhargava [b#*] and P. K. Gupta [a†]

[a] Department of Horticulture, RVSKVV, Gwalior (Madhya Pradesh), India.
[b] Department of Soil Science, RVSKVV, Gwalior (Madhya Pradesh), India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2023/v35i214061

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/107978

Original Research Article

Received: 22/08/2023
Accepted: 28/10/2023
Published: 06/11/2023

ABSTRACT

The present investigation entitled "Effect of plant growth regulators and bio-fertilizer on growth and quality of fenugreek (*Trigonella foenum-graecum* L.)" was carried out at the Experimental field, College of Agriculture, RVSKVV, Gwalior during 2020-21 under agro-climatic and soil conditions of Northern Madhya Pradesh. The experiment was laid out in Randomized Block Design (RBD) with three replications. Each replication consists of ten treatments of biofertilizers viz., Rhizobium, Phosphate solubilizing bacteria (PSB) and Potassium solubilizing bacteria (KSB) and plant growth regulators viz., Gibberellic acid (GA3) and Naphthalene acetic acid (NAA). All the treatments were

[++] M.sc. Scholar;
[#] Ph.D. Scholar;
[†] Senior Scientist;
**Corresponding author: E-mail: anjalibhargava003@gmail.com;*

randomized separately in each replication. Result showed that the different biofertilizers (i.e. Rhizobium, PSB and KSB) and plant growth regulators (i.e. GA3 and NAA) treatments significantly influenced the growth and quality parameters of fenugreek. Treatment T4 (Rhizobium + NAA) gave the maximum growth, it was found best treatment combination as compared to all other treatment combinations of biofertilizers and PGRs, while the minimum growth, yield and economical parameters were recorded in treatment T1 (Control).

Keywords: Fenugreek; biofertilizers; growth regulators; quality; rhizobium.

1. INTRODUCTION

Fenugreek (*Trigonella foenum-graecum* L.) generally known as methi, occupies an important position amongst leafy vegetables and condiment crop largely grown in northern India during Rabi season. Fenugreek is considered to have originated in South-Eastern Europe and West Asia. It is an annual herb belonging to sub family Papilionaceae family Leguminaceae. The genus Trigonella has two species viz., *Trigonella foenum-graecum* and *Trigonella corniculata*. Fenugreek seeds contains alkaloids including trigonelline, saponins, flavonoids, mucilage protein 4.4%, moisture 86%, carbohydrates 6%, mineral matter 1.5%, fiber 1.1%, fat 0.9%, calcium 360.0 mg, sulphur 167.0 mg, sodium 76.1 mg, magnesium 67.0 mg, phosphorous 541 mg, potassium 51 mg, iron 17.2mg, thiamine 0.05 mg, vitamin „A" 6450 IU and vitamin „C" 54 mg. Fenugreek is grown mainly in China, India, Turkey, Canada, Australia, Northern and Southern Africa, and Southern Europe [1]. In India, during 2020-21 fenugreek was cultivated in 133 thousand hectares land with an annual production of 203 thousand metric tons (NHB, 2020-21). The major fenugreek producing states are Rajasthan, Gujrat, Maharashtra, Madhya Pradesh, Haryana and Uttar Pradesh. Fenugreek is grown round the year for fresh vegetable purposes. According to the belief of the ancients, fenugreek stimulates digestive process as well as the metabolism in general. The seeds are used in colic flatulence, dysentery-2-diarrhea, dyspepsia with loss of appetite, chronic cough, dropsy, enlargement of liver and spleen, rickets, gout and diabetes.

In previous years, continued and imbalance use of chemical fertilizers with little or no use of organic manure is leading to poor nutrient use efficiency and low yield of crops. This condition leads to increases cost of production. 12 Hence it has become important to search for other resources of fertilizer of biological origin for integrated nutrient management in fenugreek and manage plant geometry in field. The approach, microbial fertilizer application including Rhizobium, phosphate solubilizing bacteria (PSB)as well as KSB has been found promising to improve soil health and crop production. Gibberellic acid (GA3) and NAA are plant growth hormone and different plant geometry that regulates plant height, no. of branches, stem, diameter, root length, no. of pods/plant pod length pod weight no. of seed/pod and quality of fenugreek leaf.

The maximum plant height (98.32cm) at 105 DAS and primary branches (5.41) at 45 DAS with GA3 100 ppm but maximum number of seed pod-1 (15.18) and plant height (41.26) at 45 DAS were recorded with GA3 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 recorded with NAA 75 ppm [2].

2. MATERIALS AND METHODS

a. Location and Place of working: The experiment was conducted at Experimental field, College of Agriculture, Gwalior during Rabi 2020-21 under agro-climatic and soil conditions of Northern Madhya Pradesh.

b. Experimental details: The experiment was laid out in Randomized Block Design (RBD) with three replications. Each replication consists of ten treatments of biofertilizers (viz., Rhizobium, PSB and KSB) and plant growth regulators (viz., GA3 and NAA). All the treatments were randomized separately in each replication. The details of experiment are given below:-

Name of crop: Fenugreek (*Trigonella foenum-graecum* L.) ,Variety : RMT-354 Design : RBD No. of Treatments : 10 Replications : 03 Total no. of treatments : 30 Gross plot size : 2.5 m x 2.5 m Net plot size : 2 m x 2 m Distance between

replications : 1.5 m x 1.5 m Distance between rows : 30 cm x 10 cm.

Detail of treatments:

T1 – Control
T2 – Rhizobium
T3 – Rhizobium + GA3
T4 – Rhizobium + NAA
T5 – PSB
T6 – PSB + GA3
T7 – PSB + NAA
T8 – KSB
T9 – KSB + GA3
T10 – KSB + NAA

Note: 1. RDF/basal dose N,P,K (30:25:40 kg/ha) is common for all the treatment 2. Bio-fertilizers dose Rhizobium @ 5g/kg seed treatment, PSB @ 5g/kg seed treatment and KSB @ 5g/kg seed treatment 3. Plant growth regulators dose GA3 @ 100 ppm and NAA @ 100 ppm.

d. Quality parameters-

Protein content in leaf (%): The protein content was determined by using conventional micro Kjeldahl digestion and distillation process. To calculate the protein percentage following equation was used.

Total protein = Total nitrogen x 5.75

Ascorbic acid content in leaf (mg/100g): For estimation of ascorbic acid contain in leaf, Assay method was followed as given by Ranganna [7].

Chlorophyll content in leaf (mg/100g): The chlorophyll content in leaf was estimated by spectrophotometrically method.

e. Statistical analysis: SPSS-27.0 software was used for statistical analysis. The data obtained were subjected to ANOVA (ANOVA in the RBD design) of Fisher (1958) and Panse and Sukhatme [8], means of significance separated by a critical difference (CD) of 0.05% (CDP = 0 .05%) level of importance.

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

Days required for seed germination: Result clearly shows that biofertilizers (like- Rhizobium, PSB and KSB) and plant growth regulators (like- GA3 and NAA) were non- significantly influenced on days required for seed germination for fenugreek. The result showed that treatment T4 (Rhizobium + NAA) gave the minimum (4.00) days required for seed germination and it was found 46 significantly superior as compared to all other treatments, while the maximum days required for seed germination (6.67) was recorded in treatment T1 (Control). The results are in confirmation with the results achieved by Meena et al. [9] and Sharanya et al. [10].

Plant height and Number of branches: The results clearly indicate (Fig. 2) that the different treatment combination of biofertilizers and plant growth regulators were significantly influenced the plant height of fenugreek. The maximum plant height (14.04, 45.05 47 and 65.01 cm) at 30, 60 and 90 DAS was recorded in treatment T4 (Rhizobium + NAA), it was found significantly superior treatment as compared to other treatments and was at par to treatment T7 (PSB + NAA) at 30 DAS and treatment T3 (Rhizobium + GA3) and T7 (PSB + NAA) at 60 and 90 DAS. However, the treatment T1 (Control) gave the minimum plant height (11.02, 40.07 and 55.04 cm) at 30, 60 and 90 DAS.

Table 1. Chemical properties of experimental field

S. No.	Soil constituents	Value obtain	Method of determination
1.	Mechanical composition		Bouyoucous Hydrometer method
	Sand (%)	60.68	(Piper, 1950)
	Silt (%)	22.25	
	Clay (%)	17.07	
2.	Soil pH (1:2 soil- water ratio)	7.8	pH meter [3]
3.	Electrical conductivity (ds/m)	0.14	Conductivity meter at 25ºC [3]
4.	Organic carbon (g/kg)	4.83	Walkley and Black method [4]
5.	Available nitrogen (kg/ha)	218.0	Alkaline potassium permanganate method [5]
6.	Available phosphorus P_2o_5(kg/ha.)	15.12	Olsen's method [6]
7.	Available potassium K_2O (kg/ha)	192.0	Flame photometer [3]

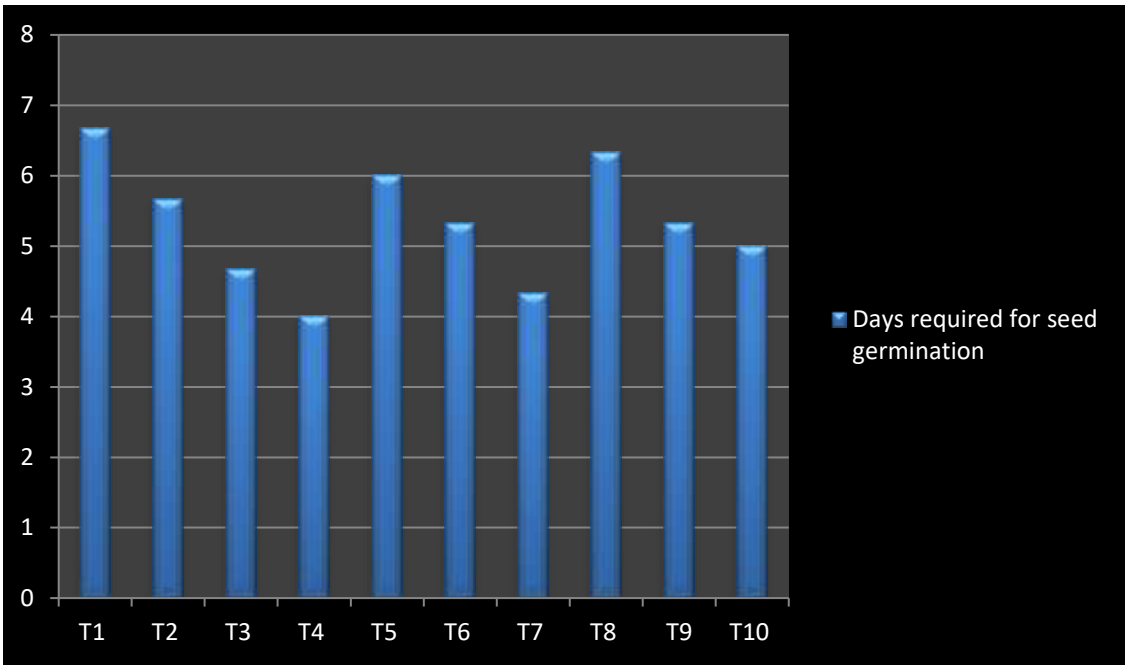

Fig. 1. Effect of plant growth regulators and biofertilizer on days required for seed germination of fenugreek

The result revealed that (Fig. 3) the treatment combination of biofertilizers (like- Rhizobium, PSB and KSB) and PGRs (like- GA3 and NAA) significantly influenced the number of branches in fenugreek. The maximum number of branches at 30, 60, 90 DAS and at harvest were observed in treatment T4 (Rhizobium + NAA). While the treatment T1 (Control) gave the minimum number of branches at 30, 60, 90 DAS and at harvest. Findings are in agreement with those of Meena et al. [9], Singh et al. [11], Shivran et al. [12], Kumawat et al. [13], Raiyani et al. [14], Saxena and Singh (2019) and Reddy et al. [2].

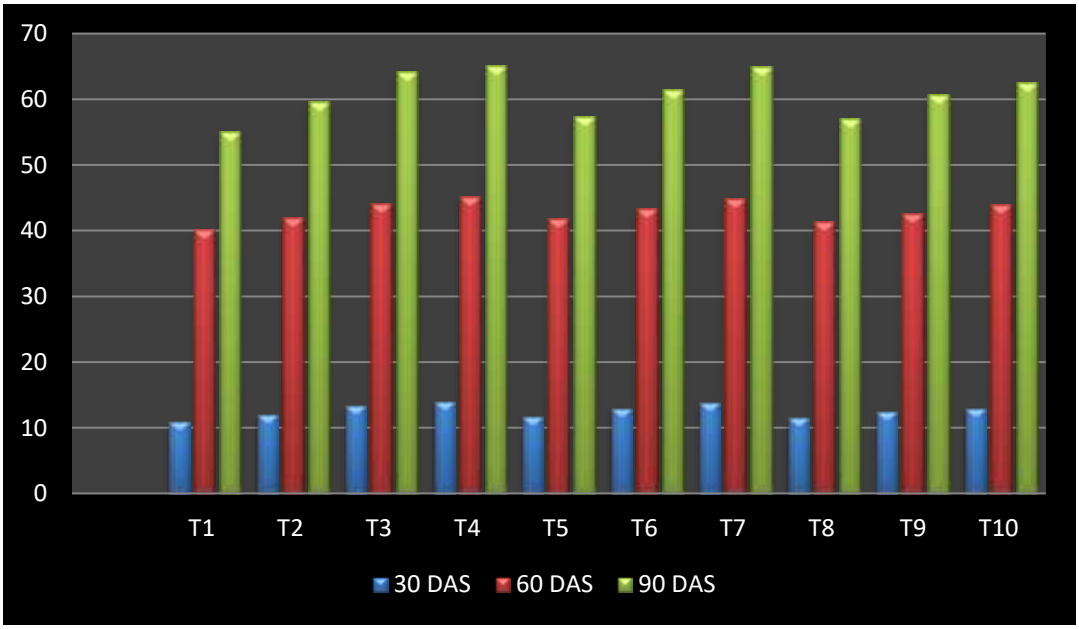

Fig. 2. Effect of plant growth regulators and bio fertilizer on plant height of fenugreek

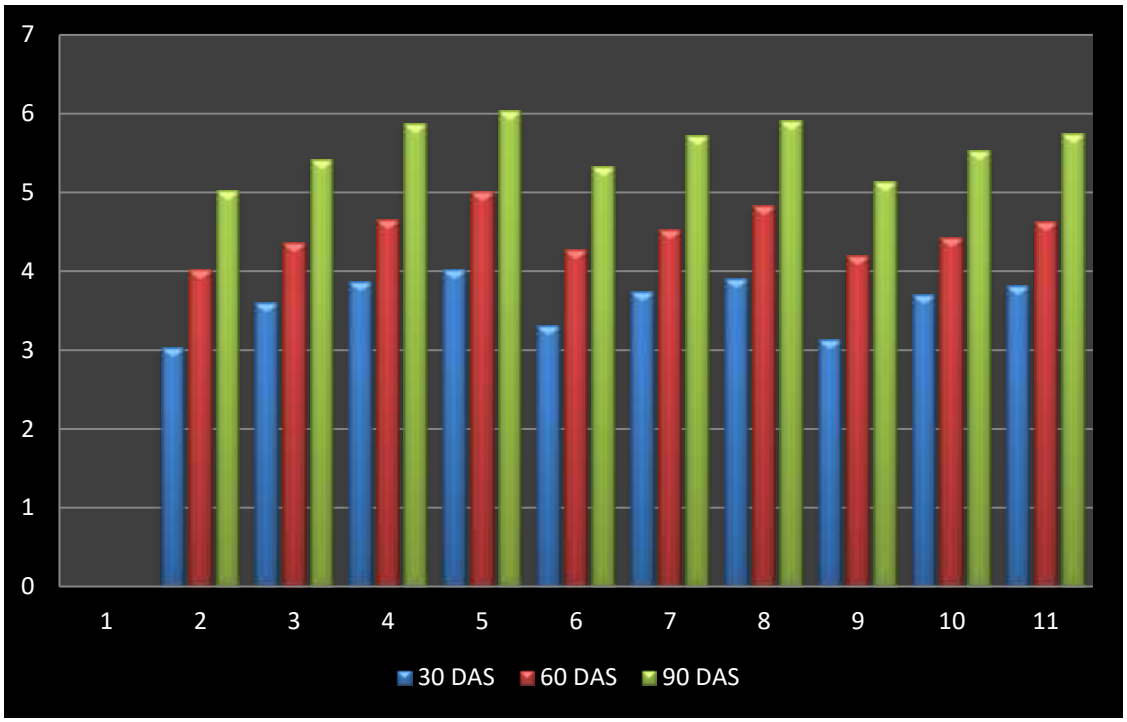

Fig. 3. Effect of plant growth regulators and bio fertilizer on number of branches of fenugreek

Days taken to 50% flowering and Number of flower per plant: The data regarding days taken to 50% flowering and number of flower per plant is presented in Fig. 4.

It is evident from the data that the treatment combination of biofertilizers (like- Rhizobium, PSB and KSB) and PGRs (like- GA3 and NAA) were found significantly influenced on the days taken to 50% flowering in fenugreek. The minimum days taken to 50% flowering (48.00) was noted in treatment T4 (Rhizobium + NAA),it was found significantly superior treatment as compared to other treatments and was at par to treatment T3 (Rhizobium + GA3), T6 (PSB + GA3), T7 (PSB + NAA) and T10 (KSB + NAA). However, the maximum days taken to 50% flowering (55.00) was observed in treatment T1 (Control). Similar results for most of the characters were also reported by Yugandhar et al. [15], Meena et al. [9], Maryhaokip et al. (2016), Yugandhar et al. [16], Pavankumar et al. [17], Raiyani et al. [14] and Reddy et al. [2].

The investigation revealed that the maximum number of flower per plant(45.00) was noted in treatment T4 (Rhizobium + NAA), it was found significantly superior treatment combination of plant growth regulators and bio fertilizer as compared to other treatments and it was at par to treatment T3 (Rhizobium + GA3), T7 (PSB + NAA) and T10 (KSB + NAA). However, the minimum number of flower per plant (38.00) was recorded in treatment T1 (Control). These results are supported by the findings of Meena et al. [9] and Kumawat et al. [13].

3.2 Quality Parameters

Protein content (%),Ascorbic acid (mg/100g) and Chlorophyll content (mg/100g): The results indicated (Figs. 5 or 6) that the different treatment combination of biofertilizers and plant growth regulators were significantly influenced the protein content, ascorbic acid and chlorophyll content in fenugreek. The maximum protein content, ascorbic acid and chlorophyll content were recorded in treatment T4 (Rhizobium + NAA), it was found significantly superior treatment as compared to other treatments. However, the treatment T1 (Control) gave the minimum protein content, ascorbic acid and chlorophyll content in fenugreek. Similar results for most of the characters were also reported by Singh et al. [11], Yugandhar et al. [15], Talab et al. [18], Yugandhar et al. [16],Govind et al. [19] and Sharanya et al. [10,20].

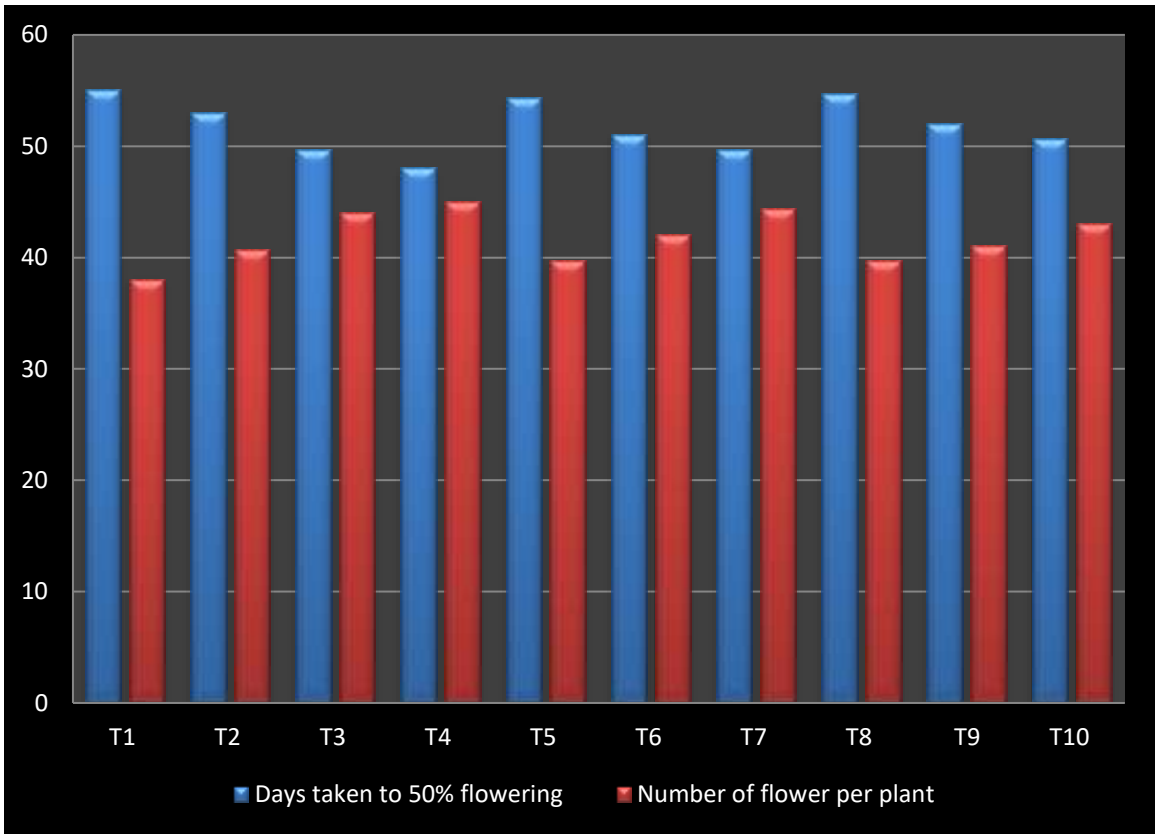

Fig. 4. Effect of plant growth regulators and biofertilizer on days taken to 50% flowering and no. of flowers per plant of fenugreek

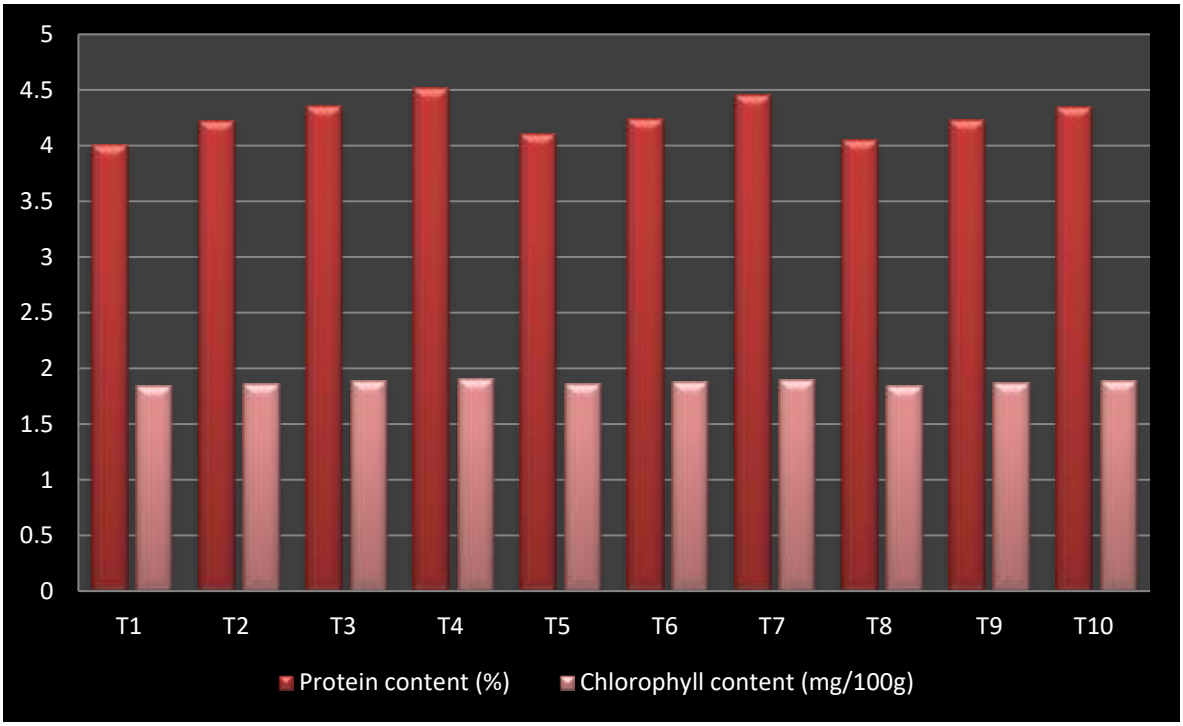

Fig. 5.Effect of plant growth regulators and biofertilizer on protein content (%) and chlorophyll content (mg/100g) of fenugreek

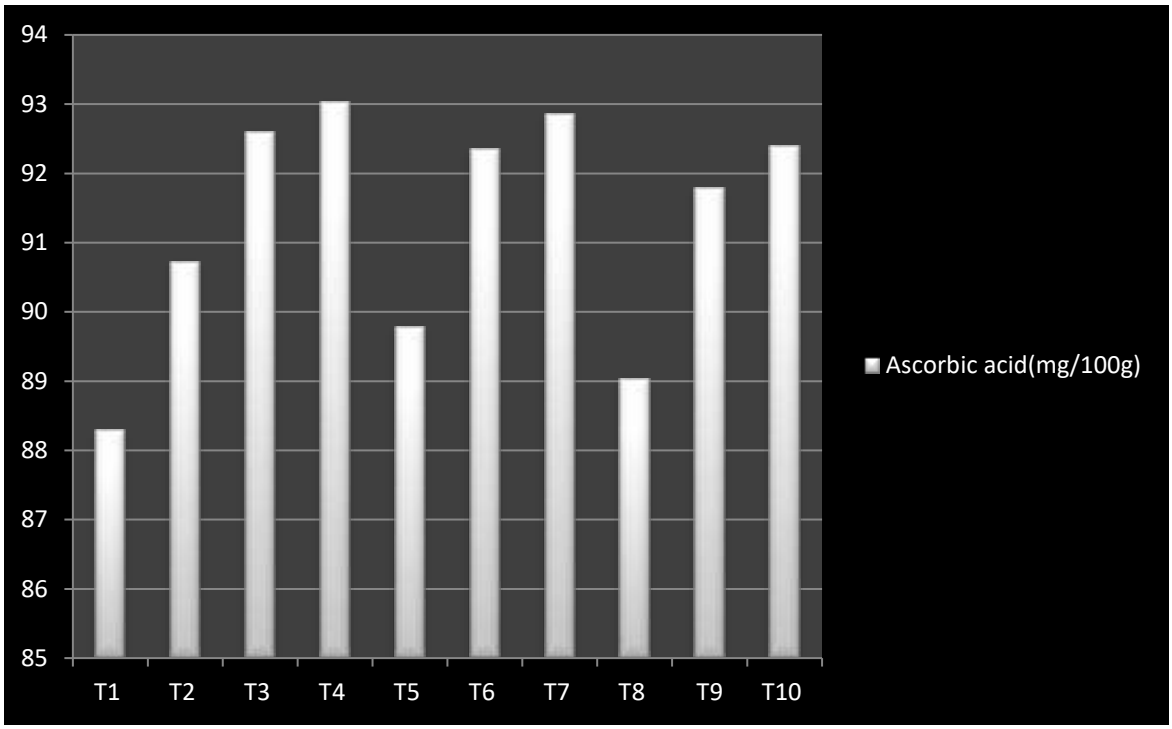

Fig. 6. Effect of plant growth regulators and biofertilizer on Ascorbic acid(mg/100g) of fenugreek

4. CONCLUSION

In summary, the study found that the combination of biofertilizers (Rhizobium, PSB, and KSB) and plant growth regulators (GA3 and NAA) had a significant impact on various aspects of fenugreek growth and development:

Seed Germination: Treatment T4 (Rhizobium + NAA) resulted in the shortest time for seed germination, significantly outperforming all other treatments. Treatment T1 (Control) required the most extended time for seed germination.

Plant Height: Treatment T4 (Rhizobium + NAA) produced the tallest plants at 30, 60, and 90 days after sowing (DAS), significantly surpassing other treatments. The control group (Treatment T1) yielded the shortest plants at these stages.

Branching: Treatment T4 (Rhizobium + NAA) resulted in the maximum number of branches at 30, 60, 90 DAS, and at harvest. The control group (Treatment T1) had the fewest branches at these stages.

Days to 50% Flowering: Treatment T4 (Rhizobium + NAA) led to the quickest time to 50% flowering, while the control group (Treatment T1) took the longest.

Flower Production: Treatment T4 (Rhizobium + NAA) had the highest number of flowers per plant, significantly exceeding other treatments. The control group (Treatment T1) had the fewest flowers per plant.

Nutrient Content: Treatment T4 (Rhizobium + NAA) exhibited the highest protein content, ascorbic acid content, and chlorophyll content in fenugreek, significantly outperforming other treatments. Treatment T1 (Control) had the lowest levels of protein, ascorbic acid, and chlorophyll in fenugreek.
These findings demonstrate the significant influence of the combination of biofertilizers and plant growth regulators on various growth parameters and nutrient content in fenugreek plants, with Treatment T4 consistently showing superior results compared to the control group (Treatment T1).

ACKNOWLEDGEMENTS

The Authors are thankful to Department of Horticulture and Department of Soil Science and Agricultural Chemistry, RVSKVV, college of Agriculture, Gwalior (M.P) for taking their keep interest and encouragement to carry out the research work.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Ahmad A, Alghamdi SS, Mahmood K, Afzal M. Fenugreek–A multipurpose crop : Potentialities and improvements. Saudi J. Biol. Sci. 2016;23:300- 310.
2. Reddy PP, Hore JK. Role of Growth Regulators on Fenugreek (*Trigonella foenum- graecum* L.). Int. J. Curr. Microbiol. App. Sci. 2020;9(7):25-32.
3. Jackson ML. Soil Chemical Analysis. Advanced course, Second edition, Madison, Wisconsin, USA. 1973;511.
4. Walkley A, Black IA. An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method. Soil science. 1934 Jan 1;37(1):29-38.
5. Subbiah BV, Asija RM. A rapid procedure for estimation of available nitrogen in soils. Current Science. 1956;25:259-260.
6. Olsen SR, Cole CV, Watnabe PS, Dean LA. Estimation of available phosphorus in soil by extraction with sodium bicarbonate. U.S. Department of Agriculture Circular. 1954;939.
7. Ranganna S. Manual of analysis of fruit and vegetable products. Tata McGraw Hill Publishing Corn. Ltd., New Delhi. 1977;9-15.
8. Panse VG, Sukhatme PV. Statistical Methods for Agricultural Workers. ICAR, New Delhi. 1978;68-75.
9. Meena JK, Sanjay K, Sutanu M, Manoj K, Devendra K. Studies on effect of biofertilizers with chemical fertilizers on growth, yield and quality of fenugreek (*Trigonella foenum-graecum* L.). International Journal of Agricultural Sciences. 2015;11:198-200.
10. Sharanya BR, Naruka IS, Shaktawat RPS, Kushwah SS, Singh OP, Singh D. Effect of plant geometry on growth, yield and quality of different varieties of fenugreek (*Trigonella foenum-graecum* L.). Indian J. Agric. Res; 2018.
11. Singh M, Kakralya BL, Mahala P. Influence of Brassinolide in Mitigating the Adverse Effect of Drought on Physiological attributes in Fenugreek (*Trigonella foenum-graecum* Linn) Genotypes. Jour Pl Sci Res. 2016;32(2):107-110.
12. Shivran AC, Jat NL, Sight, Rajput EVD. response of fenugreek (*Trigonella foenum- graecum* L.) to plant growth regulators and their time of application. Journal of and Aromatic Crops. 2016;25(1): 169-174.
13. Kumawat K, Patel PP, Dambiwal D, Reddy TV, Hakla Chouthu R. Effect of liquid and solid bio-fertilizers (Rhizobium and PSB) on growth attributes, yield and economics of fenugreek (*Trigonella foenum-graecum* L.). International Journal of Chemical Studies. 2017;5(4):239-242.
14. Raiyani VN, Kathiriya RK, Thummer VM, Rupareliya VV. Effect of FYM and biofertilizers on growth, yield attributes and yield of fenugreek (*Trigonella foenum-graecum* L.). International Journal of Chemical Studies. 2018;6(4):746-748.
15. Yugandhar V, Sundar R, Thanuja SG, Srinivasa R. Effect of growth regulators on growth, seed yield and Quality of coriander (*Coriandrum sativum*) Cv. Sudha. Plant Archives. 2014;14(2):1083-1086.
16. Yugandhar V, Reddy PSS, Sivaram GT, Ramesh E. Impact of pre-soaking and foliar application of plant growth regulators on growth and seed yield of coriander (*Coriandrum sativum* L.). Journal of Crop and Weed. 2017;13(1):100-102.
17. Pavankumar DS, Maruthi Prasad BN, Umesha K, Shivanna M, Shankarappa TH, Halesh GK. Influence of plant growth promoting rhizobacteria and plant growth regulators on growth and yield of black cumin (*Nigella sativa* L.) VAR. NS44. Journal of Pharmacognosy and Phytochemistry. 2018;3: 01-04.
18. Tandon HLS. Methods of analysis of soils, plants, waters, fertilisers & organic manures. Fertiliser Development and Consultation Organisation; 2005.
19. Govind S, Narayanlal, Barcchiya J. Effect of Different Levels of Phosphorus and biofertilizers on yield and quality of fenugreek (*Trigonella foenum-graecum* L.). Advances in Life Sci. 2016;5(21): 10059-10063.

20. Kumar V, Singh KP. Enriching vermicompost by nitrogen fixing and phosphate solubilizing bacteria. Biores. Technol. 2001;76:73-175.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/107978