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

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Abstract

The field experiment was laid out in factorial randomised block design with three replication and four levels of biofertilizers as B_0- Control, B_1- Rhizobium meliloti @ 25ml/kg seeds, B_2- PSB @ 10ml/kg seeds and B_3- KMB@10ml/kg seeds inoculation and four levels of growth regulators (foliar spray at 20 and 40 DAS) as G_1 - GA3 @100 ppm, G_2- GA3 @200 ppm, G_3- NAA @100 ppm and G_4- NAA @200 ppm. As per the factor levels, the sixteen treatment combinations were made as B0G1, B0G2, B0G3, $B0G_4$, $B1G_1$, $B1G_2$, B_1G_3, B_1G_4, B_2G_1, B_2G_2, B_2G_3, B_2G_4, B_3G_1, B_3G_2, B_3G_3 and B_3G_4. The crop variety RMt-1 sown with the spacing of 15X10cm^2 and the chemical fertilizers applied as RDF: 25:25:10 kg NPK/ ha. The phenological parameters like days taken to first flower emergence, days taken to 50% flowering and number of flowers per plant was evaluated during the investigation of the phenological parameters.He reported that the application of B_1 (Rhizobium meliloti @ 25ml/kg seeds) significantly highest plant height, number of leaves and number of branches at every growth intervals. The same trend were also followed for application of plant growth regulators at 20 and 40 days after sowing and resulted maximum growth like plant height, number of leaves and number of branches at every growth intervals.

Keywords:plant growth regulators, days taken to first flowering, days taken to 50% flowering

1. Introduction

Fenugreek *(Trigonella foenum-graecum*L.) is a yearly herbaceous versatile crop cultivated during the winter season in Northern India. The seed serves primarily as a condiment and finds applications in the pharmaceutical sector, notably in the production of ayurvedic medicines. Additionally, young plants are utilized as a vegetable and fodder. The fresh, tender leaves, pods, and shoots are abundant in iron, calcium, protein, vitamins, and essential amino acids. As a leguminous spice, it boasts high nutritional value and is utilized in Middle Eastern and Far Eastern cuisines for the preparation of vegetarian diets during social and religious gatherings. Both the leaves and seeds are extensively employed for medicinal purposes, being prescribed for conditions such as chronic dysentery, diarrhoea, persistent coughs, dropsy, dyspepsia, liver and spleen enlargement, arthritis, diabetes, colic issues, abscesses, ulcers, and rickets[8]**.** Fenugreek is believed to have originated in Southeastern Europe and Western Asia and is cultivated in India, parts of North Africa, Argentina, France, Morocco, and Lebanon. India stands as one of the primary fenugreek producers, with its cultivation mainly concentrated in the states of Rajasthan, Madhya Pradesh, Maharashtra, Haryana, Punjab, Gujarat, and Uttar Pradesh. The current yield of fenugreek stands at 70.05 quintals per hectare [1].

Gibberellins (GA3) have been utilized to augment stalk length and vegetative growth, initiate flowering, enlarge fruit size, expedite maturity, enhance fruit quality, and regulate fruit cracking in horticultural crops. GA3 plays a significant role in augmenting growth and yield in fenugreek [2]**.** The influence of NAA in promoting fruit set, growth, and yield characteristics in fenugreek[3] has been documented. Due to the dearth of information concerning these aspects of fenugreek, coupled with the significance of fenugreek for human health and the national economy, this study aims to investigate the impact of bio-fertilizers and plant growth regulators on the growth and seed yield of fenugreek.

2. Material and methods

The experiment was conducted at Crop Research Centre, School of Agriculture, ITM University, Gwalior, M.P. The research farm is situated at the 26° 13' North latitude and 76° 14' East longitude with an altitude of 211.52 meters above Mean Sea Level. The field of research farm having homogenous fertility and uniform textural make up was selected for the field experimentation. With respect to climatic condition, it is coming under light arid subtropic regions on MP, the maximum temperature goes up to 46ºC during summer and a minimum as low as 2ºC during winter. The average rainfall ranges between 70to80cm,mostofwhichisreceivedinthemonthofJuly,August,andSeptember, with few showers during Rabi season with an average maximumand minimum temperature during the growing period as 28.06°C and 12.1°C,respectively.Thetotalrainfallreceivedduringthecropseasonfrom November 2020 to April 2021 and November 2021 to April 2022 was 05 mm and5.8mm, respectively.The field experiment was laid down in factorial randomised block design with three replications and four levels of biofertilizers as B_0- Control, B_1– *Rhizobium meliloti* @ 25ml/kg seeds, B_2– PSB @ 10ml/kg seeds and B_3– KMB@10ml/kg seeds inoculation and Growth regulators (foliar spray at 20 and 40 DAS) as G_1 - GA3 @100 ppm, G_2- GA3 @200 ppm, G_3- NAA @100 ppm and G_4- NAA @200 ppm. As the treatment levels the sixteen treatment combinations were made as B0G1, B0G2, B0G3, B0G4, B1G1, B1G2, B1G3, B1G4, B2G1, B2G2, B2G3, B2G4, B3G1, B3G2, B3G3 and B3G4. The crop variety RMt-1 sown in 15X10cm^2 and the chemical fertilizers applied as RDF: 25:25:10 kg NPK/ ha. The irrigation was given as per requirement.

3. Result and discussion

4. Plant height

The data at 30 DAS, the application of growth regulators increased the plant height during both the years and in pooled mean. The application of GA3 @100 ppm (G_1) registered significantly maximum plant height12.707cm, 12.836cm and 12.772cm during both the years and in pooled mean, respectively and the corresponding increases were 10.466cm, 8.770cm and 9.602cm per cent higher over G_4 during the years 2021-22, 2022-23 and pooled analysis, respectively. The similar trends were also observed at 60 and 90 ADS.

TABLE 1: PLANT HEIGHT AS INFLUENCED BY VARIOUS BIOFERTILIZERS AND PLANT GROWTH REGULATORS AT 30 DAS

Plant height (cm)															
Years	**At 30 ADS**					**At 60 DAS**					**At 90 DAS**				
Factors	**G_1**	**G_2**	**G_3**	**G_4**	**Mean (B)**	**G_1**	**G_2**	**G_3**	**G_4**	**Mean (B)**	**G_1**	**G_2**	**G_3**	**G_4**	**Mean (B)**
B_0	10.163	10.177	9.507	9.230	9.769	29.193	28.143	27.853	26.170	27.840	67.433	63.267	63.067	62.750	64.129
B_1	14.940	13.627	13.423	13.250	13.810	37.150	36.350	36.160	36.097	36.439	73.950	73.267	72.167	71.557	72.735
B_2	13.197	13.040	12.913	12.847	12.999	35.887	34.973	34.807	32.640	34.577	71.217	70.133	69.813	69.317	70.120
B_3	12.787	12.090	11.470	11.283	11.908	32.247	31.100	29.483	29.413	30.561	68.890	68.700	68.417	68.210	68.554

Mean (G)	12.772	12.233	11.828	11.653		33.619	32.642	32.076	31.080		70.373	68.842	68.366	67.958	
Factors	**C.D.**	**SE(d)**	**SE(m)**	**P value**		**C.D.**	**SE(d)**	**SE(m)**	**P value**		**C.D.**	**SE(d)**	**SE(m)**	**P value**	
Factor (G)	0.476	0.232	0.164	0.00000		0.625	0.305	0.215	0.00000		1.490	0.726	0.513	0.00000	
Factor (B)	0.476	0.232	0.164	0.00018		0.625	0.305	0.215	0.00000		1.490	0.726	0.513	0.01316	
Factor (G X B)	NS	0.463	0.328	0.47439		NS	0.609	0.431	0.09087		NS	1.452	1.027	0.67156	

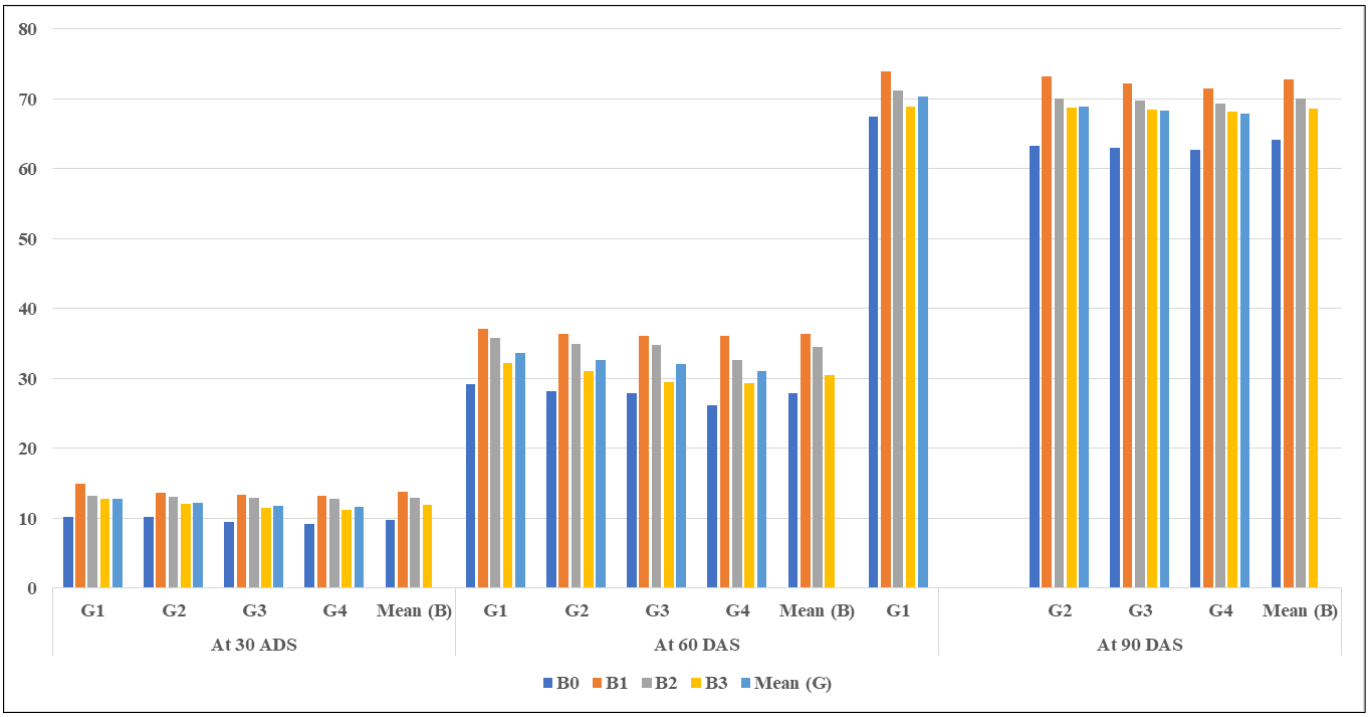

Fig 1: PLANT HEIGHT AS INFLUENCED BY VARIOUS BIOFERTILIZERS AND PLANT GROWTH REGULATORS AT 30 DAS

Number of leaves

The pool of two years (at 30 DAS), the maximum number of leaves (8.980) was noted in the seed inoculation of biofertilizers B_1--*Rhizobium meliloti* @ 25ml/kg seeds while the least (5.680) was recorded in the treatment B_0- no biofertilizers applied. With respect to PGRS, maximum number of leaves (7.635) was noted in the treatment G_1 -foliar application of GA3 @100 ppm while the minimum (6.807) was recorded in G_4 - NAA @200 ppm applied in both years. The silar trends were also followed at succeeding growth stages *viz.*, 60 and 90 DAS.

Interaction effect

The data on number of leaves at 60 DAS in 2022-23 as presented in Table 4.6 and graphically illustrated in Fig 4.6 shows that the application of biofertilizers and growth regulators shows significant difference between the various treatment combinations. The application of treatment combination B_1G_1 (*Rhizobium meliloti* @ 25ml/kg seeds+ GA3 @100 ppm) found maximum number of leaves (37.247) and it was 37.139% higher than control and it was at par with the treatment combination.

The data on number of leaves at 90 DAS in 2022-23 as presented in Table 4.7 and graphically illustrated in Fig 4.7 shows that the application of biofertilizers and growth regulators shows significant difference between the various treatment combinations. The application of treatment combination B_1G_1 (*Rhizobium meliloti* @ 25ml/kg seeds+ GA3 @100 ppm) found maximum number of leaves (67.383) and it was 32.808% higher than control and it was at par with the treatment combination.

TABLE 2:NUMBER OF LEAVES AS INFLUENCED BY VARIOUS BIOFERTILIZERS AND PLANT GROWTH REGULATORS (MEAN OF TWO YEARS)

Number of leaves															
Years	**At 30 ADS**					**At 60 DAS**					**At 90 DAS**				
Factors	**G_1**	**G_2**	**G_3**	**G_4**	**Mean (B)**	**G_1**	**G_2**	**G_3**	**G_4**	**Mean (B)**	**G_1**	**G_2**	**G_3**	**G_4**	**Mean (B)**
B_0	6.043	5.880	5.613	5.183	5.680	26.477	25.853	25.423	25.150	25.726	52.667	52.193	50.373	48.803	51.009
B_1	9.393	9.190	8.757	8.580	8.980	36.063	35.493	34.763	33.647	34.992	67.143	65.903	62.900	62.737	64.671
B_2	8.010	7.870	7.547	7.220	7.662	33.317	32.593	32.097	31.263	32.318	61.900	61.377	60.107	58.683	60.517
B_3	7.093	6.953	6.750	6.243	6.760	30.163	28.990	28.500	27.560	28.803	56.637	55.970	55.357	53.600	55.391
Mean (G)	7.635	7.473	7.167	6.807		31.505	30.733	30.196	29.405		59.587	58.861	57.184	55.956	
Factors	**C.D.**	**SE(d)**	**SE(m)**	**P value**		**C.D.**	**SE(d)**	**SE(m)**	**P value**		**C.D.**	**SE(d)**	**SE(m)**	**P value**	
Factor (G)	0.288	0.140	0.099	0.00000		0.311	0.152	0.107	0.00000		0.763	0.372	0.263	0.00000	
Factor (B)	0.288	0.140	0.099	0.00001		0.311	0.152	0.107	0.00000		0.763	0.372	0.263	0.00000	
Factor (G X B)	N/A	0.280	0.198	0.99936		NS	0.303	0.214	0.18767		NS	0.744	0.526	0.33695	

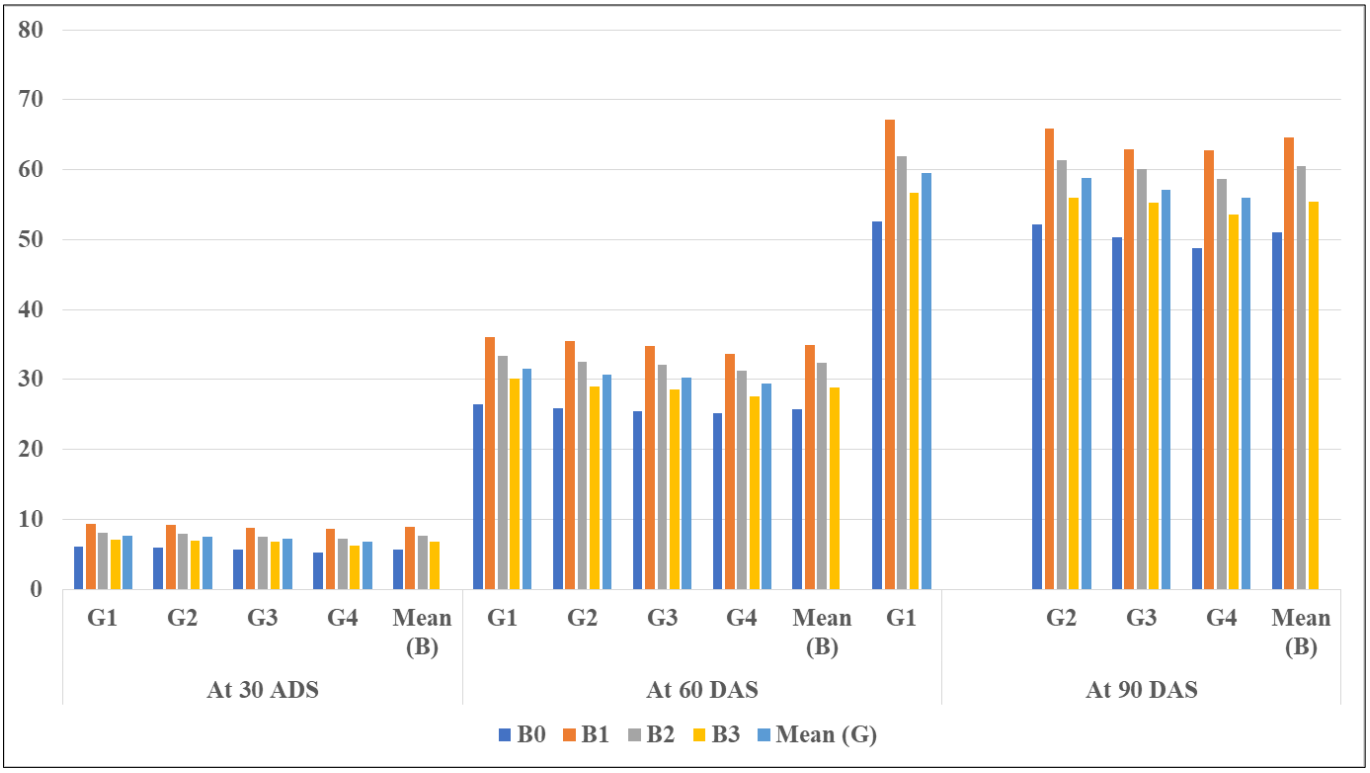

FIG 2:NUMBER OF LEAVES AS INFLUENCED BY VARIOUS BIOFERTILIZERS AND PLANT GROWTH REGULATORS (MEAN OF TWO YEARS)

3. Number of branches

The data on mean of two years, the maximum number of leaves (8.980) was noted in the seed inoculation of biofertilizers B_1--*Rhizobium meliloti* @ 25ml/kg seeds while the least (5.680) was recorded in the treatment B_0- no

biofertilizers applied. With respect to PGRS, maximum number of leaves (7.635) was noted in the treatment G_1 -foliar application of GA3 @100 ppm while the minimum (6.807) was recorded in G_4 - NAA @200 ppm applied in both years. Similar trends were also recorded at 60 and 90 DAS

Interaction effect

The data on number of branches at 30 DAS in pooled as presented in Table 3 and graphically illustrated in Fig 3 shows that the application of biofertilizers and growth regulators shows significant difference between the various treatment combinations. The application of treatment combination B_1G_1 (*Rhizobium meliloti* @ 25ml/kg seeds+ GA3 @100 ppm) found maximum number of branches (4.020) and it was 104.788% higher than control and it was at par with the treatment combination. The same pattern of intraction also recognised for 60 DAS.

The data on mean of two years (at 90 DAS), the maximum number of branches (9.557) was noted in the seed inoculation of biofertilizers B_1-*Rhizobium meliloti* @ 25ml/kg seeds while the least (7.708) was recorded in the treatment B_0-no biofertilizers applied. With respect to PGRS, maximum number of branches (8.764) was noted in the treatment G_1 -foliar application of GA3 @100 ppm while the minimum (8.301) was recorded in G_4 - NAA @200 ppm applied in both years.

TABLE 3: NUMBER OF BRANCHES AS INFLUENCED BY VARIOUS BIOFERTILIZERS AND PLANT GROWTH REGULATORS (MEAN OF TWO YEARS)

Number of branches															
Years	**At 30 ADS**					**At 60 DAS**					**At 90 DAS**				
Factors	**G_1**	**G_2**	**G_3**	**G_4**	**Mean (B)**	**G_1**	**G_2**	**G_3**	**G_4**	**Mean (B)**	**G_1**	**G_2**	**G_3**	**G_4**	**Mean (B)**
B_0	2.450	2.323	2.247	1.963	2.246	7.027	6.870	6.650	5.590	6.534	7.840	7.790	7.703	7.500	7.708
B_1	4.020	3.987	3.963	3.943	3.978	9.273	9.057	8.870	8.783	8.996	9.847	9.693	9.493	9.193	9.557
B_2	3.827	3.653	3.467	3.407	3.588	8.597	8.523	8.310	8.167	8.399	8.960	8.873	8.637	8.530	8.750
B_3	3.033	2.817	2.740	2.640	2.808	7.980	7.747	7.520	7.150	7.599	8.410	8.243	8.150	7.980	8.196
Mean (G)	3.333	3.195	3.104	2.988		8.219	8.049	7.838	7.422		8.764	8.650	8.496	8.301	
Factors	**C.D.**	**SE(d)**	**SE(m)**	**P value**		**C.D.**	**SE(d)**	**SE(m)**	**P value**		**C.D.**	**SE(d)**	**SE(m)**	**P value**	
Factor (G)	0.079	0.038	0.027	0.00000		0.214	0.105	0.074	0.00000		0.200	0.097	0.069	0.00000	
Factor (B)	0.079	0.038	0.027	0.00000		0.214	0.105	0.074	0.00000		0.200	0.097	0.069	0.00031	
Factor (G X B)	0.157	0.077	0.054	0.02300		0.429	0.209	0.148	0.03417		NS	0.195	0.138	0.98672	

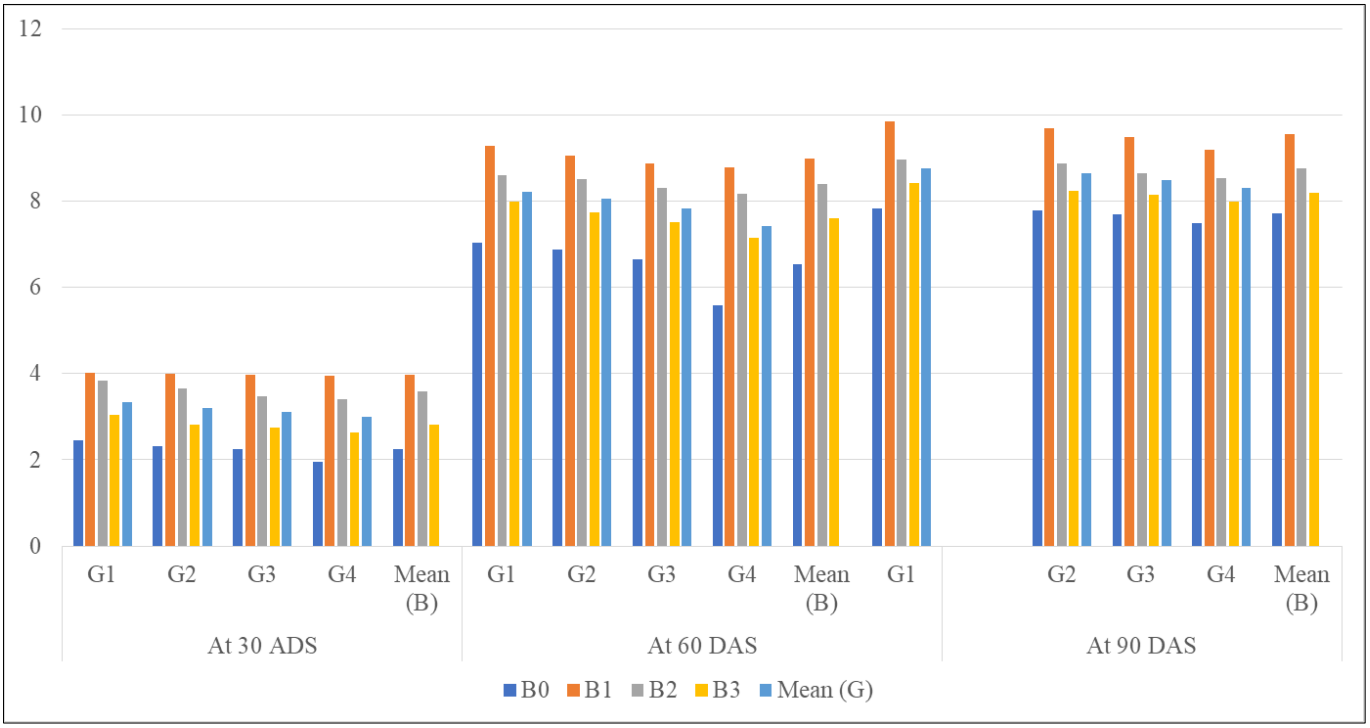

FIG 3: NUMBER OF LEAVES AS INFLUENCED BY VARIOUS BIOFERTILIZERS AND PLANT GROWTH REGULATORS (MEAN OF TWO YEARS)

Effect of biofertilizers

The application of biofertilizer treatment B1 (*Rhizobium meliloti* @ 25ml/kg seeds) significantly increased the plant height, number of leaves, number of branches, stem diameter and dry matter at every growth interval over control during both the years and in pooled analysis. The basic and beneficial function of the rhizobium is to fix atmospheric stable nitrogen into useful form of nitrogen to the plants by their symbiotic association in root nodules. The beneficial response of Rhizobium meliloti @ 25ml/kg seeds to growth parameters and growth might be due to rhizobium convert more nutrients as compare to the other biofertilizers and this nitrogen involve in vital physiological process. Nitrogen is important nutrient for synthesis of amino acids, nucleotides bonds and proteins. When the seeds are treated with rhizobium biofertilizer, it helps the seeds for better germination, nutrient uptake, and formation more root nodules in fenugreek. The root nodules consisting leghemoglobin for synthesis of nitrogen. The nitrogen promotes the growth of the plants, increase the leaf size, plant height, number of leaves and number of branches Parakhia *et al.* (2000). It is also might be due to the rhizobia may synthesis the indole 3 acetic acids that increase the plant height, number of leaves, number of branches and overall growth (Zhao, 2010).

5.1.2. Effect of Growth regulators

The two growth regulators were evaluated with the different doses at various growth stages *viz.*, 30, 60, 90 and at harvest to evaluate the growth and growth parameters. The significantly maximum increase in plant height, number of leaves, number of branches, stem diameter and dry matter accumulation of the crop increase with increase the concentration was also observed with the application of GA3 @100 ppm (G_1) over G_4 during both the years and in pooled analysis. This is might be due to the 100 ppm of the GA3 induced the multiplication of the cell and cell elongation because this the basic function the gibberellins. The gibberellins were foliar sprayed at 20 and 40 DAS and resulted that the plant height, leaves, branches were highest recorded in the treatment application of 100ppm GA3 because this hormone induce the multiplication of the cells and same time it is also induce the cell elongation (Purbey and Sen, 2005). The more cells facilitate the synthesis of DNA, RNA, amino acids, proteins and other metabolites. These all attributes facilitate formation of more chlorophylls in the cell and improve the photosynthesis reaction. The resulted that the assimilation of more starch in the plant. The close findings are Panda *et al.* (2007) and Vasudevan *et al.* (2008). The higher level of nutrients helped in the elongation of stem due to development of cells, rapid cell division and cell elongation in meristematic region of plant which ultimately improving the number of branches per plant of fenugreek.The results are in confirmation with the results achieved by Shivran *et al.* (2013a), Kumawat *et al.* (2017), Raiyani *et al.*(2018), Saxena and Singh (2019) and Reddy *et al.* (2020).

5.1.3 Interaction effect between biofertilizers and growth regulators

The interaction between biofertilizers and growth regulator were evaluated in this experiment and the number of leaves at 60 and 90 DAS, number of branches at 30 and 60 DAS, stem diameter at 90 DAS and dry matter accumulation at

90 DAS were found significant. The significantly maximum increase in number of leaves, number of branches, stem diameter and dry matter of the crop was also observed with the application of treatment combination B_1G_1 (*Rhizobium meliloti* @ 25ml/kg seeds+ GA3 @100 ppm) higher than control. This is might be due to the biofertilizer and gibberellic acid to gather induced the positive effect on plant height, number of leaves, number of branches and dry matter accumulation because the factor are responsible increasing the overall growth of the fenugreek plant.

Conclusion

Based on the data, it is concluded that the application of biofertilizer rhizobium responds very well to all the growth parameters in northern Madhya Pradesh. It is also concluded that the application of Growth regulator gibberellic acid at 20 and 40 days after sowing gives the highest growth of fenugreek.

Reference

[1] Kumawat, K., Patel P. P., Dambiwal, D., Reddy, T. V.and HaklaChouthu, R. (2017). 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, 5(4): 239-242.

[2] Panda, M.R., R. Chatterjee, A. Pariari, P.K. Chattopadhyay, A.B. Sharangi and K. Alam, (2007). Effect of growth regulators on growth, yield and quality of fenugreek. Indian Journal of Horticulture, 64(3): 369-371.

[3] Parakhia, A. M.; Akbari, L. F. and Andharia, J. H. (2000). Seed bacterization for better quality and more yield of fenugreek. GujaratAgril University Research Journal.25 (2): 34-38.

[4] Peddaveeri, Pravalika Reddy and J.K. Hore. 2020. Role of Growth Regulators on Fenugreek (*Trigonella foenum-graecum* L.). Int.J. Curr. Microbiol. App. Sci. 9(07): 25-32.

[5] Purbey, S.K. and N.L. Sen, (2005). Response of fenugreek (*Trigonellafoenum-graecum* L.) to bioinoculants and plant bioregulators. Indian Journal of Horticulture, 62(4): 416-418.

[6] Raiyani, V. N., Kathiriya, R. K., Thummer, V. M. and Rupareliya, V.V. (2018) 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

[7] Saxena, A. K. and Singh, S. (2019). Growth and Yield of fenugreek (*Trigonella foenum-graecum*L.) as influenced by liquid and solid biofertilizers (Rhizobium, PSB and KSB). Res J. Chem. Environ. Sci., 7(3): 52-55.

[8] Vasudevan, S.N., J.S. Sudarshan, M.B. Kurdikeri and P. R. Dharmatti, (2008). Influence of pinching of apical bud and chemical sprays on seed yield and quality of fenugreek. Karnataka Journal of Agriculture Sciences, 21(1): 26-29.

[9] Zhao, Y. (2010). Auxin biosynthesis and its role in plant development. Annu. Rev. Plant Biol. 61, 49–64. DOI: 10.1146/annurev-arplant-042809-112308.

[10] Shivran, A.C. and N.L. Jat, (2013a). Influence of bioregulators and their time of application on growth, yield and economics of fenugreek (*Coriandrum sativum*). Ann. Agric. Res. New Series, Vol. 34(4): 310-314.