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Study the effect of integrated nutrient management on vegetative growth of fenugreek (*Trigonella foenum-graecum*) L

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Abstract
The present investigation entitled "Study the effect of integrated nutrient management on vegetative growth of fenugreek (*Trigonella foenum-graecum* L.) " was conducted during the period from October 2016 to March 2017 at the Department of Plantation, Spices, Medicinal, Aromatic Crops, College of Horticulture Mandsaur, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya Gwalior (M.P.) The experiment was laid out in Randomized Block Design with three replications. Fenugreek cultivar AFG-3 was used for the experiment. Twelve treatments consisting of integrated nutrient management with organic, inorganic and *biofertilizers* along with control. The observations on different growth and yield parameters were recorded and the results obtained are summarized below. On the basis of one year research trial it could be concluded that the treatment (T_{11}) *i.e.* 50% RDF + Neem cake @ 1 ton ha^{-1} + *Rhizobium* + PSB was best at all the stages of growth parameters like plant height 30, 60 and 90 das (cm), number of primary branches per plant at 30, 60 and 90 DAS, number of secondary branches per plant at 60 and 90 DAS, length of internode, days to 50% flowering, fresh and dry weight of the plants and yield parameters like days to first pod formation, days to 50% pod formation, number of pods per plant, weight of pod, pod length at number of seeds per pod, weight of seeds per pod, seed yield per plant, seed yield (q ha^{-1}), harvest index and days taken to maturity showed better performance from other treatments of organic, inorganic and *biofertilizers* applications.

Keywords: Fenugreek, neem cake, rhizobium, PSB, INM, organic and inorganic fertilizers

Introduction
Fenugreek (*Trigonella foenum-graecum* L.), commonly called as 'Greek hay' and also called as 'methi' in Hindi. Fenugreek is an annual crop belonging to the family Fabaceae. The chromosome number is 2n = 16. There are only two important species recognized common Methi & Kasuri Methi. It's an annual herb native to South-East Europe and West Asia. India is the largest producer of fenugreek with an area of 65,000 hectare and production of 90,000 MT. Major fenugreek growing states are Rajasthan, Punjab, Madhya Pradesh, Maharashtra, Uttar Pradesh and Gujarat. Improper nutrient management is one of the factor responsible for the low productivity. Use of organic manures along with inorganic fertilizers not only improve physico-chemical and biological properties of soil but also provides all the nutrients in available form to crop plants, which in turn enhance better growth and finally the yield and quality parameters of *Trigonella foenum-graecum*. Thus, there is an urgent need to formulate integrated nutrient management practices for increasing the productivity and production of *Trigonella foenum-graecum*. Keeping in view the above facts and the paucity of research on these aspects in the Malwa region of Madhya Pradesh

Materials and Methods
A field experiment was conducted on "Study the effect of integrated nutrient management on vegetative growth of fenugreek (*Trigonella foenum - graecum* L.)''at the Research farm College of Horticulture, Mandsaur, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, (M.P.) from 2016 to 2017. The details of the materials used and methods followed during the course of investigation are presented in this chapter. The experiment was carried out at the "Research farm'' College of Horticulture, Mandsaur, Rajmata Vijayraje Scindia Krishi Vishwa Vidyalaya, Gwalior, (M.P.) during 2016-17. The College of Horticulture, Mandsaur is situated in Malwa Plateau in Western part of Madhya Pradesh at 23.450 to 24.130 North Latitude, 74.440 to 75.180 East Longitudes and at an Altitude of 435.02 meters above mean sea level. This region falls under agro climate Zone No.10 State. To ascertain physico-chemical characteristics of the soil during the year of study, soil samples from 0-15 cm depth

were taken from different spots of the experimental field before application of fertilizer. A representative composite sample was prepared by processing and mixing them together and analysis presented, showed that the soil of experimental site is light black loamy texture, with low in availability of nitrogen, low in phosphorus and high in potassium status. The experiment was laid out in open field with Randomized Block design. There were three replications in the experiment. The plan of layout of the experiment is given. Fenugreek *cv.* AFG-3 (Ajmer Fenugreek-3) developed by National Research Centre on Seed Spices, Tabiji Ajmer (Rajasthan) has been taken for the experiment purpose. The experimental plot was ploughed twice by tractor drawn cultivator and leveled. The clods were crushed; weeds were removed and brought to fine tilth. The land was divided into plots of required size (1.8 m x 2.5 m). Provision was made for bunds and irrigation channels. In inorganic fertilizer treatments (50%, 75% and 100% Recommended Dose of Fertilizers) nitrogen, phosphorus and potassium nutrients were applied in the form of urea, single super phosphate and murate of potash respectively. Nitrogen was applied in two equal split doses i.e. ½ basal and remaining dose at 20 days after sowing. The entire phosphorus and potassium were applied as basal. Vermicompost was obtained by culturing *Eisenia foetida* earthworms on farm waste along with fresh animal dung. Farm yard manure was obtained by composting different crop residues along with animal dung and only fully decomposed manure was used. Poultry droppings were collected from cage type of poultry units and allowed to decompose fully and the neem cake was obtained by crushing neem seed kernels and they are used in experimental plot. Biofertilizers, *viz*., *Rhizobium meloloti* and phosphate solubilizing bacteria (PSB) *Bacillus megatherium* were obtained from commercial formulations of PSB with colony forming unit (CFU) of 1 x 108 were used. PSB @ 5 kg ha-1 was inoculated with the respective organic manures and thoroughly incorporated into soil one week before sowing of the crop. After 24hrs of the bavistin treatment to the seed, *Rhizobium* culture was applied to the seed. The *Rhizobium* culture @ 500g inoculant mixed in sugar syrup and applied to the fenugreek seed (25 kg ha-1) by slurry method. The seeds were soaked overnight and they were treated with Captan 2g/kg seeds. Later they were shade dried for half an hour. The seeds were used with the seed rate of 22 – 25 kg/ha and 2-3 seeds were sown per hole. Seeds were sown on October 17, 2016 at spacing with varieties. Furrows were properly covered with a thin layer of soil and the plots were irrigated lightly. Farm yard manure was applied to soil at the time of land preparation. Phosphorous, potassium and nitrogen was applied in the form of DAP, Murate of potash and urea at the rate of 40:40:30 NPK kg/ha respectively. The experimental plots were provided with the calculated quantity of fertilizers. Half dose of nitrogen and full dose of phosphorous and potassium was supplied as basal dose at the time of sowing. The remaining 50% of nitrogen was given as top dressing at 30 days after sowing. Observations on growth and yield parameters were recorded using five plants per plot selected randomly by avoiding the border plants. The observations on growth parameters were recorded at 30, 60 and 90 days after sowing and at the time of harvest. The various observations recorded are mentioned here under. Five plants were selected at randomly from each plot and labelled for recording the data. The following observations were recorded and their mean values were calculated by standard statistical analysis.

Table 1: Effect of integrated nutrient management on different growth stages of fenugreek

Treatment	Plant Height (cm)			Number of primary Branches			Number of secondary Branches		Length of internode (cm)	Days to 50% flowering	Fresh weight of the plant (g)	Dry weight of the plant (g)
	30	60	90	30	60	90	60	90	`			
T_0	12.86	34.20	46.68	3.39	5.19	5.46	9.97	14.93	2.42	42.50	46.86	6.90
T_1	14.62	41.89	54.22	3.83	6.13	6.36	10.87	15.68	3.18	41.00	48.57	8.92
T_2	12.15	32.98	45.32	3.39	4.96	5.23	9.77	14.93	2.27	42.17	46.21	6.43
T_3	11.86	28.88	41.77	3.26	4.86	5.16	9.70	14.60	2.09	45.67	44.48	6.14
T_4	13.52	37.42	49.75	3.59	5.53	5.89	10.23	15.00	2.77	45.00	47.66	7.82
T_5	13.44	34.97	47.35	3.49	5.53	5.79	10.17	15.00	2.68	44.00	47.47	7.44
T_6	14.54	40.74	53.42	3.73	5.86	6.13	10.70	15.46	2.95	42.97	48.22	8.19
T_7	14.57	41.37	53.69	3.73	6.09	6.19	10.73	15.52	3.08	42.03	48.41	8.42
T_8	12.86	34.26	46.68	3.39	5.49	5.79	10.10	15.00	2.55	45.17	47.14	6.92
T_9	13.70	39.37	51.70	3.36	5.63	5.96	10.30	15.06	2.81	44.33	47.88	7.98
T_{10}	14.49	40.14	52.48	3.36	5.79	6.06	10.37	15.46	2.91	42.73	48.03	8.16
T_{11}	14.63	42.24	54.57	4.09	6.36	6.56	10.93	15.78	3.82	40.70	49.07	8.99
S.Em.±	0.04	0.12	0.12	0.07	0.014	0.014	0.01	0.016	0.0132	0.70	0.4346	0.545
CD at 5%	0.11	0.36	0.35	0.018	0.039	0.037	0.04	0.05	0.0387	2.05	1.2745	1.598

Result and Discussion

In this chapter an attempt has been made to evaluate the possible reasons of the variability obtained due to treatment differences in the present investigation entitled "Study the effect of integrated nutrient management on vegetative growth of fenugreek (*Trigonella foenum-graecum* L.)" The findings described in the preceding chapter have been critically discussed here in detail. The results of the present investigation are discussed in the light of available literature.

Growth parameter of fenugreek

The result as reported in the preceding chapter revealed integrated nutrient management significantly influenced all the growth attributes. At 30, 60, and 90 DAS, Application of 50% RDF + Neem cake @ 1 ton ha^{-1} + Rhizobium + PSB (T_{11}) recorded maximum plant height, while minimum plant height was recorded under the treatment (T_3) 50% RDF + Rhizobium + PSB. The increase in height of plant is due to the rapid availability of nutrients though chemical fertilizers application and more nitrogen fixation by bacteria which in turn helped in better absorption and subsequent utilization of nitrogen for synthesis of chlorophyll, as nitrogen is an integral part of chlorophyll results in higher photosynthesis there by producing more photosynthesis leading to more plant height by exerting synergistic effect by organic, inorganic and bio-fertilizers. These results are in accordance with the findings of Jain *et al*. (2003), Bhunia *et al*. (2006) [1], Mehta *et al*. (2012) and Rizvi *et al*. (2013) [8] in fenugreek. Rhizobium lives in

root hairs of the legumes forming root nodules, where it fixes atmospheric nitrogen which is the major nutrient available for the growth of the plant the synergistic effect of Rhizobium as well as Neem cake which is having the nitrification regulative property resulted in increased vegetative growth (Singhal and Mudgal, 1982). The results of the investigation are in agreement with the findings of verma *et al*. (1991), Purbey and Sen (2005) [7], Singh *et al*. (2010) [9] in fenugreek. Early flowering was observed under the treatment (T_{11}) 50% RDF + Neem cake @ 1 ton ha $^{-1}$ + Rhizobium + PSB, while late flowering was observed under the treatment (T_3) 50% RDF + Rhizobium + PSB. The early flowering was due to sufficient balanced vegetative growth and availability of certain micronutrients with higher doses of organic manures in combination of inorganic fertilizers led the plants to enter into reproductive phase early as reported by Umesha *et al*. (2011) in Makoi. Whereas, plants supplied with lower doses of organic manures, with low supply of nutrients for their growth resulted in reduced growth and delayed flowering. These results are in agreement with the findings of Gizaway *et al*. (1992) in spinach, Mandal and Maiti (1992), Kaswan *et al*. (1995), Jagdale and Dalve (2010) and Bommi *et al*. (2010) in fenugreek and Renuka and Ravishankar (2001) in tomato.The maximum number of primary branches of per plant at 30, 60 and 90 DAS, Secondary branches per plant at 60and 90 DAS, length of internodes, fresh weight of plant and dry weight of plant, was recorded in treatment (T_{11}) 50% RDF + Neem cake @ 1 ton ha^{-1} + Rhizobium + PSB, wheras it was recorded minimum under the treatment (T_3) 50% RDF + Rhizobium + PSB. This might be due to the source of organic manures and inorganic sources of nutrients ensured readily available nutrients for initial requirement though inorganic source and longer period availability though organic source. Bio-fertilizers improves root nodulation and provided the congenial soil environment for plant *rhizosphere* increases nitrogen fixation and phosphorous solubilization, increased more growth there by increased number of primary branches per plant, secondary branches per plant at 60 and 90 DAS, length of internodes, fresh weight of the plant and dry weight of the plant. Increase in the plant spread per branching might be due to organic manures along with inorganic fertilizers not only supply major nutrients but also sufficient quantity of required micro nutrients and minerals besides, the bio-fertilizers which have the ability to mobilize the nutritionally important elements from non usable from to usable from. Use of bio-fertilizers creates the favorable environment in rhizosphere, increased the microbial population at tremendous rate. The decomposed organic matter in the soil and biological nitrogen fixation though bio-fertilizers and subsequent release of nitrogen increased the growth. The continuous availability of nutrients resulted in more nutrient uptake by plant ensures more dry matter accumulation at all growth stages. Similar combined beneficial effect of organic manures, inorganic fertilizers and bio-fertilizers on growth parameters was recorded by Singh and Verma (2002) in French bean, Bhunia *et al*. (2006) [1] in fenugreek, Bahadur *et al*. (2004) in cabbage, Pawan *et al*. (2006) in okra, Chand *et al*. (2001) in Mentha arvensis, Kumarvel (2003) in Artemesia annua, Umesha *et al*. (2011) in Makoi, Choudhary *et al*. (2011) [2] in fenugreek, Singh and Verma (2002) in French bean and Das *et al*. (2012) in Senna.

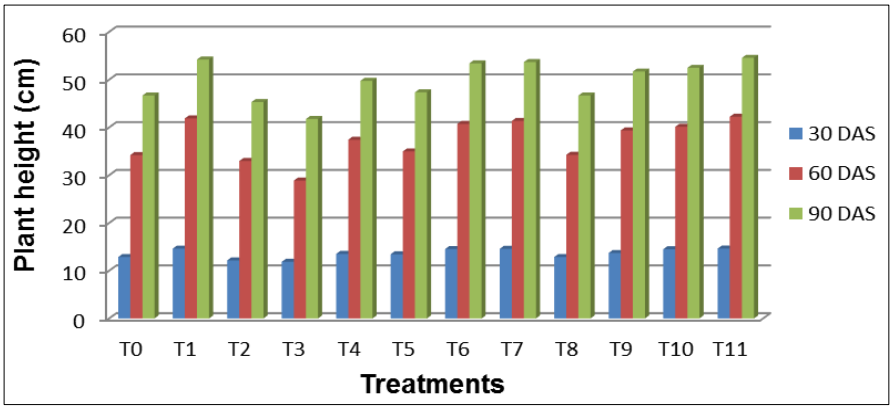

Fig 1: Effect of integrated nutrient management on plant height (cm) at different stages of fenugreek.

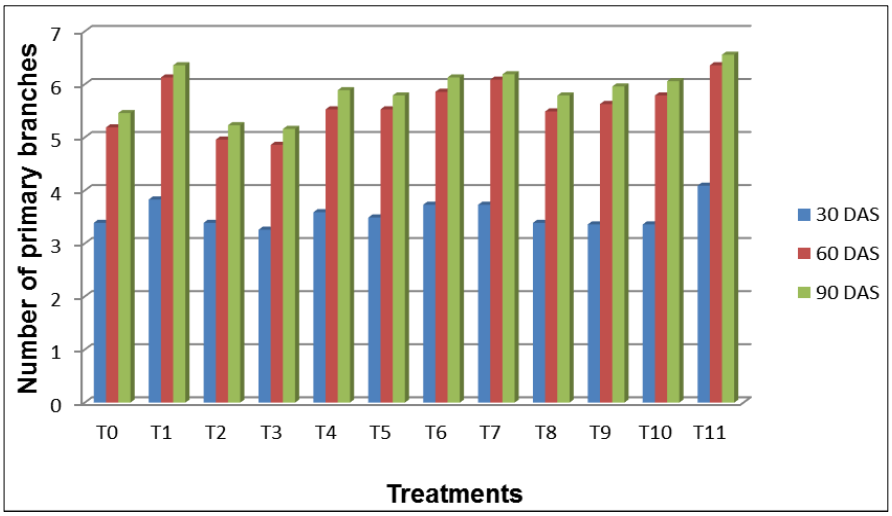

Fig 2: Effect of integrated nutrient management on number of primary branches at different stages of fenugreek.

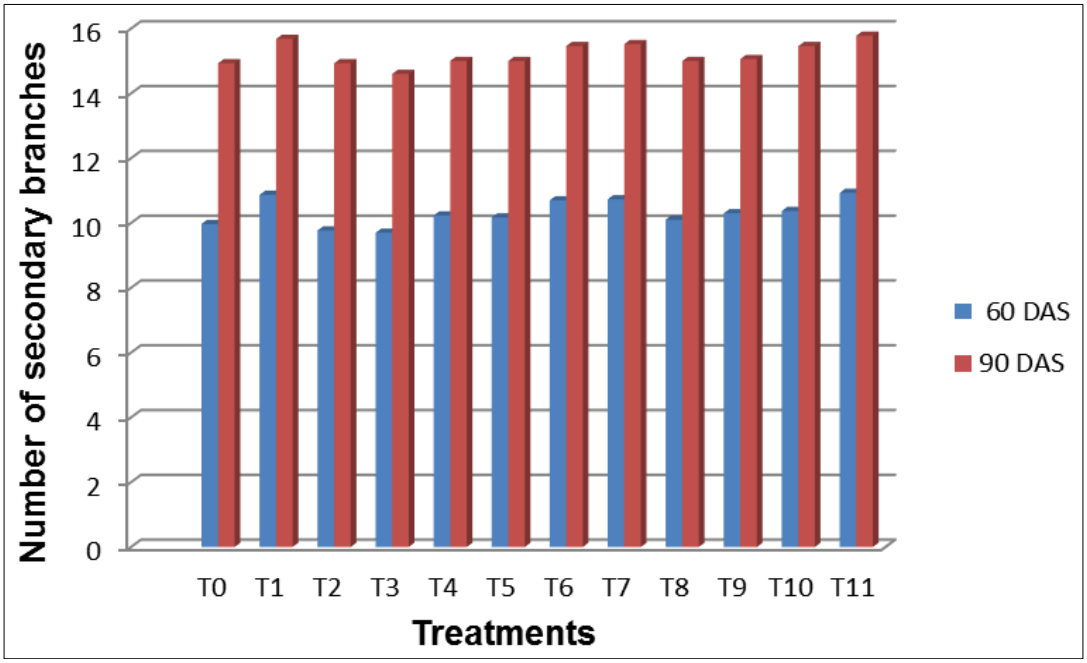

Fig 3: Effect of integrated nutrient management on number of secondary branches at different stages of fenugreek.

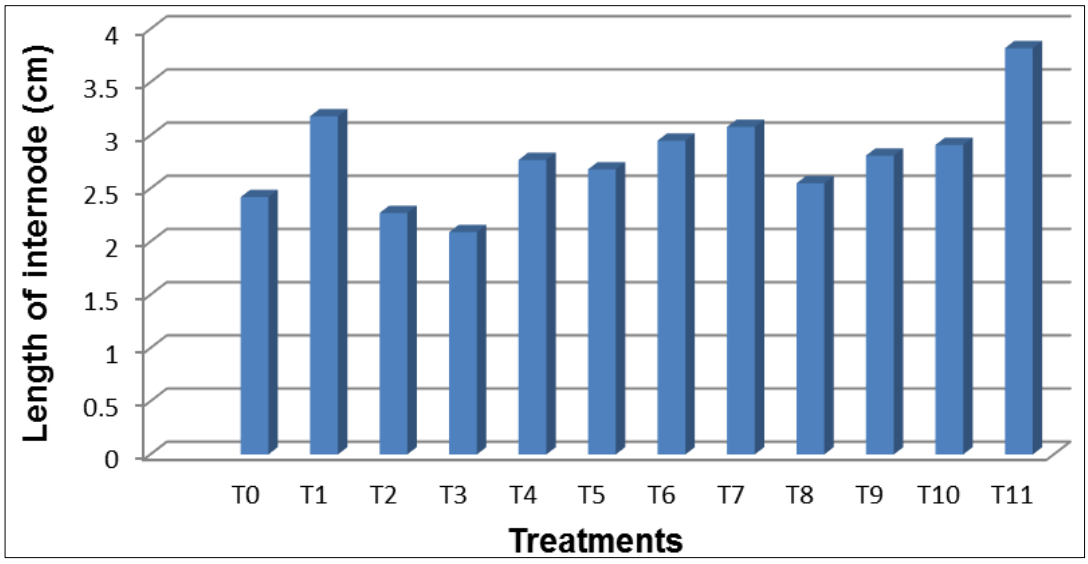

Fig 4: Effect of integrated nutrient management on length of internode (cm) of fenugreek.

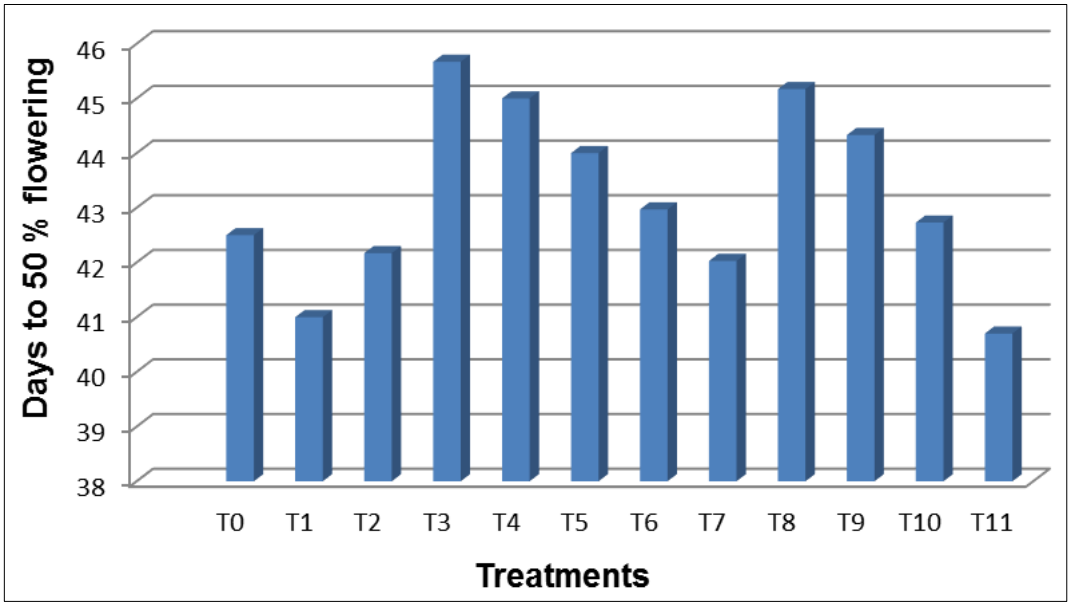

Fig 5: Effect of integrated nutrient management on days to 50% flowering of fenugreek

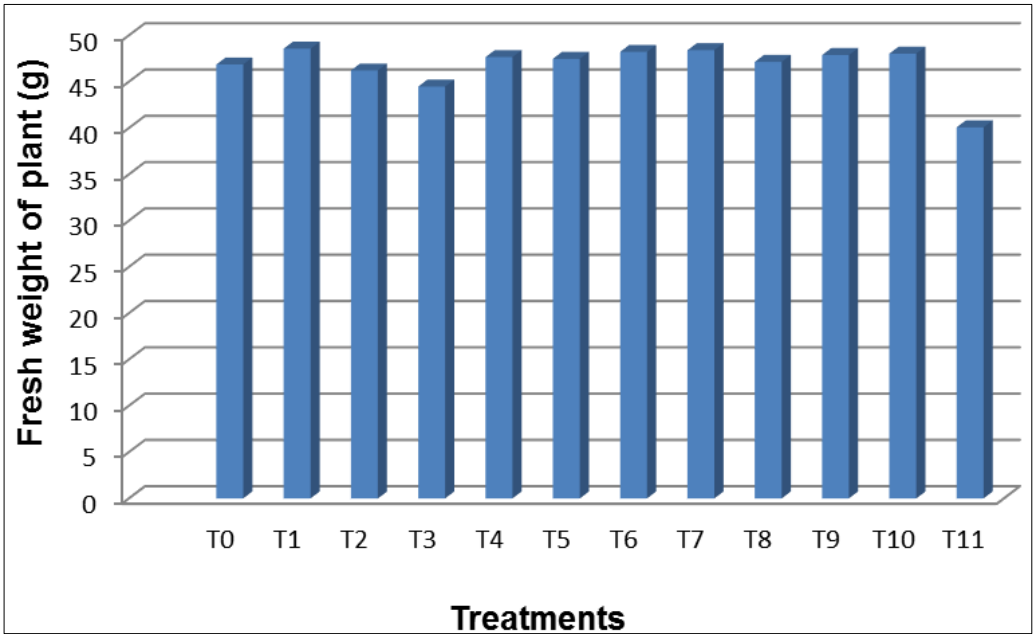

Fig 6: Effect of integrated nutrient management on fresh weight of plant (g) of fenugreek.

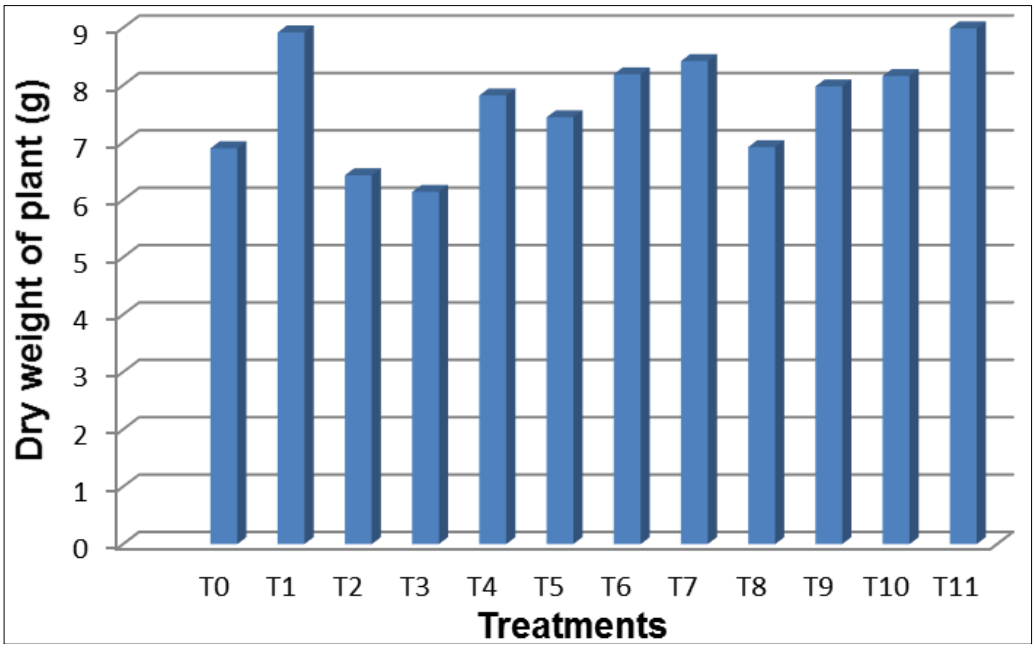

Fig 7: Effect of integrated nutrient management on dry weight of plant (g) of fenugreek.

Conclusions

The present investigation entitled "Study the effect of integrated nutrient management on vegetative growth of fenugreek (*Trigonella foenum-graecum* L.)" was conducted during the period from October 2016 to March 2017 at the Department of Plantation, Spices, Medicinal and Aromatic Crops, College of Horticulture, Mandsaur, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (M.P.). The experiment was laid out in Randomized Block Design with three replications. Fenugreek cultivar AFG-3was used for the experiment. Twelve treatments consisting of integrated nutrient management with organic, inorganic and *biofertilizers* along with control. The observations on different growth and yield parameters were recorded and the results obtained are summarized below. On the basis of one year research trial it could be concluded that the treatment (T_{11}) *i.e.* 50% RDF + Neem cake @ 1 ton ha^{-1} + *Rhizobium* + PSB was best at all the stages of growth parameters like plant height 30, 60 and 90 das (cm), number of primary branches per plant at 30, 60 and 90 DAS, number of secondary branches per plant at 60 and 90 DAS, length of internode, days to 50% flowering, fresh and dry weight of the plants and yield parameters like days to first pod formation, days to 50% pod formation, number of pods per plant, weight of pod, pod length at number of seeds per pod, weight of seeds per pod, seed yield per plant, seed yield (q ha^{-1}), harvest index and days taken to maturity showed better performance from other treatments of organic, inorganic and *biofertilizers* applications.

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