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Growth and yield of fenugreek as affected by integrated nutrient management in fenugreek-fodder sorghum cropping sequence

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Abstract
A field experiment entitled "Growth and yield of fenugreek as affected by integrated nutrient management in fenugreek-fodder sorghum cropping sequence" was conducted at college farm of N. M. College of Agriculture, Navsari Agricultural University, Navsari (Gujarat) during the years 2019-20 and 2020-21. The field experiment consisted of integrated nutrient management treatments *viz.*, T_1: Biocompost 2.5 t/ha, T_2: Biocompost 5 t/ha, T_3: Biocompost 2.5 t/ha + 50% RDF, T_4: Biocompost 2.5 t/ha + 75% RDF, T_5: Biocompost 2.5 t/ha + 100% RDF, T_6: Biocompost 5 t/ha + 50% RDF, T_7: Biocompost 5 t/ha + 75% RDF, T_8: Biocompost 5 t/ha + 100% RDF to fenugreek in *rabi* season and replicated three times in randomized block design. On the basis of two year pooled results, the growth attributes *viz.*, plant height, number of branches/plant and plant dry matter, yield attributes *viz.*, number of pods per plant, pod length, number of seed per pod, seed weight per plant and seed yield (1763 kg/ha) and stover yield (2884 kg/ha) were significantly influenced by the various INM treatments imposed on fenugreek. Among all the INM treatments, the treatment T_8 (Biocompost 5 t/ha + 100% RDF) was found to be significantly superior with respect to growth, yield attributes and yield as compared to rest of the treatments while, the lowest values were obtained under the treatment T_1 (Biocompost 2.5 t/ha). Almost all these growth, yield attributes and yield remained in the $T_8 > T_7 > T_6 > T_5 > T_4 > T_3 > T_2 > T_1$ order of their significance.

Keywords: Fenugreek, integrated nutrient management, biocompost

1. Introduction

Pulses constitute an important component of prevailing cropping sequences followed by across the country with region specific variations in preferences and suitability to agro-production situation. Pulses as a candidate crop, contributes immensely towards doubling farmers' income through diminishing cost of production, scaling per unit productivity, efficient marketing networks and successful technology delivery mechanisms by giving emphasis sustainable intensification and crop diversification, climate resilient production technologies backed with strong research outputs in pulses can contribute towards doubling the farmers' income (Singh, 2018) [15].

In India, pulses are grown in an area of 29.99 million hectares with total production of 25.23 million tonnes with productivity of 841 kg/ha. While in Gujarat, it is grown over an area of 0.91 million hectares with an annual production of 0.93 million tonnes with the productivity of 1022 kg/ha (Anon., 2018) [4]. Pulses occupy an important place in Indian agriculture. Indian population is predominantly vegetarian. Pulses and its products are a rich source of essential nutrients like protein, minerals and vitamins *viz*., carotene, thiamine, riboflavin and niacin. Pulses can easily meet the protein requirement of a vegetarian diet. It contains 22 to 25 percent protein, which is almost twice than wheat and thrice that of rice.

Fenugreek (*Trigonella foenum-graecum* L.) is an annual dicotyledonous plant belonging to the family Fabaceae (subfamily Papilionaceae). The genus name Trigonella means tri angled may be because of triangular shape of its flowers and the word foenum graecum means "Greek hay" indicating its use as a forage crop in the past. Fenugreek known as one of the oldest medicinal plants recognized in recorded history (Lust, 1986) [8]. Chemical analysis of fenugreek seed revealed that it contains 13.7 percent water, 26.2 percent protein, 5.8 percent fat, 3 percent mineral matter, 7.2 percent fiber, 4.41 percent carbohydrate, 0.16 percent calcium, 0.37 percent phosphorus, 14.1 mg iron, 333 calories and 160 IU carotene per 100 gm (Agrawal, 2002) [1].

India is the largest seed spice producing and exporting country in the world. Indian spices have earned high reputation in the international market. India occupied 4528.176 thousand ha area with 10679.221 tonnes of spices, of which 1.20 million tonnes valued Rs. 22,062.80 crore exported in 2020-21(Anon., 2021) [5]. In Gujarat fenugreek occupies an area of about 7000 ha, producing 13579 tons of seeds (Anonymous, 2021) [5]. Banaskantha and Mehasana district contributes 80 percent of total production of the Gujarat (Anon., 2017) [3].

Fenugreek is cultivated during *rabi* season on light textured and somewhat poorly fertile soil of North Gujarat. In South Gujarat region bean, gram and fenugreek crops are extensively grown during *rabi* after harvest of rice. Fenugreek cultivated on heavy textured soils of South Gujarat. Moreover, because of better market prices, it may be more remunerative than bean and gram crops.

The INM helps to restore and sustain soil fertility and crop productivity. It may also help to check the emerging deficiency of nutrients other than NPK. It brings economy and efficiency in fertilizer use and favorably affects the physical, chemical and biological environment of soil. adoption of appropriate integrated nutrient management strategies holds a great potential in boosting the fenugreek production. Therefore, integrated nutrient management is crucial not only for increasing the yield but also for the improvement of soil health.

2. Materials and Methods

A field experiment was carried out on "Growth and yield of fenugreek as affected by integrated nutrient management in fenugreek-fodder sorghum cropping sequence" at college farm of N. M. College of Agriculture, Navsari Agricultural University, Navsari (Gujarat) during the year 2019-20 and 2020-21. The data of soil analysis revealed that the soil of experimental plot was clay in texture, Low in organic carbon (0.39%) and available nitrogen (198.60 kg/ha), medium in available phosphorus (37.50 kg/ha) and high in available potassium (314.30 kg/ha). The soil was found slightly alkaline (pH 8.1) with normal electric conductivity (0.30 dS/m). The field experiment consisted of integrated nutrient management treatments *viz*., T_1: Biocompost 2.5 t/ha, T_2: Biocompost 5 t/ha, T_3: Biocompost 2.5 t/ha + 50% RDF, T_4: Biocompost 2.5 t/ha + 75% RDF, T_5: Biocompost 2.5 t/ha + 100% RDF, T_6: Biocompost 5 t/ha + 50% RDF, T_7: Biocompost 5 t/ha + 75% RDF, T_8: Biocompost 5 t/ha + 100% RDF to fenugreek in *rabi* season and replicated three times in randomized block design. The recommended dose of fertilizers for *rabi* fenugreek is 20 N + 40 P_2O_5 + 00 K_2O kg/ha.

The fenugreek *cv.* Gujarat Methi-2 was sown with spacing 30 cm between two rows in the month of November and harvested in the month of March during both the years. The required quantity of well decomposed biocompost was incorporated and mixed well within the soil at the time of land preparation during both the years while, nitrogen was applied through urea (46% N) as per the treatments and common dose of 40 kg P_2O_5 was applied through single super phosphate (16% P_2O_5) as well as required quantity of both the fertilizer was applied as a basal dose in previously opened shallow furrows and seeds were inoculated with biofertilizers (*Rhizobium* + PSB each of 10 ml/kg) and dried under shade and were sown as per the treatments during both the years.

The sowing was done manually in previously opened furrows at a depth of 2 cm on 22nd and 23rd November in 2019 and 2020, respectively using seed rate 20 kg/ha. The plots were irrigated immediately after sowing to ensure uniform germination. In order to record various quantitative observations, five plants were selected from each net plot by using random table for periodical observations. The selected plants were labelled with proper notations and observations on growth and yield attributing characters were recorded. However, for recording the dry matter production per plant, samples were taken randomly from sample rows (two from either side) of each plot. Total biological yield, seed yield and strover yield were recorded from net plot area.

3. Results and Discussion

Various growth attributes (Table.1) of fenugreek *viz.*, plant height, number of branches/plant and plant dry matter recorded at various growth stages were differed significantly among each other except at 30 DAS during both the years of experimentation and in pooled results. In pooled results of two years the plant height was found to higher in the treatment T_8 (Biocompost 5 t/ha + 100% RDF) at all the stages of crop growth but it was statistically at par with the treatment T_7, T_6 and T_5 at 60 DAS and 90 DAS. Likewise, highest plant height, number of branches/plant and plant dry matter were also obtained in the same treatment i.e. treatment T_8 at 60 DAS and 90 DAS.

Almost all these growth attributes remained in $T_8 > T_7 > T_6 > T_5 > T_4 > T_3 > T_2 > T_1$ order of their significance. Significantly higher plant height due to combined application of organic and inorganic sources might be due to the application of nitrogen and phosphorous through the chemical fertilizer which enhanced its availability which resulted in increased photosynthetic activity and translocation of the photosynthates from sources to sink which help toward higher plant height and availability of the sufficient nutrients for longer periods which results to stimulate cell division in the meristematic tissue and increase in vegetative growth of plant and favour the maximum growth of branches. plant nutrients in adequate quantity leading to better root growth and enhanced nutrient uptake resulting in improved plant dry matter in fenugreek. The results lend support to the earlier findings of Patel *et al.* (2010) [10], Choudhary *et al.*, 2011, Sunanda *et al.* (2014) [6, 17], Naher *et al.* (2016) [9], Lunagariya *et al.* (2018) [7], Raiyani *et al.* (2018) [12], Amitha and Thumminkantti (2019) [2] and Sahu *et al.* (2020) [13] in fenugreek.

Various yield attributes (Table. 2) *viz*., number of pods per plant, pod length, number of seed per pod, seed weight per plant and seed yield and stover yield were influenced by the various INM treatments imposed on crop. On two year pooled basis, number of pods per plant, pod length, number of seed per pod, seed weight per plant were found to be significantly higher with treatment T_8 (Biocompost 5 t/ha + 100% RDF) and remained at par with application of Biocompost 5 t/ha + 75% RDF (T_7), Biocompost 5 t/ha + 50% RDF (T_6) and Biocompost 2.5 t/ha + 100% RDF (T_5) during both the years of pooled analysis. Despite this, treatment T_1 reported lower values in all the yield attributes.

Superiority of these treatments could be attributed to the improvement in growth parameters due to increased availability of plant nutrients throughout the life cycle of the crop. The increased and balanced supply of nitrogen to plants promotes flowering and fruiting and supply of food material and its subsequent partitioning in the sink. The organic manures also improve the availability of phosphorus which plays a unique role in energy conservation and transfer. The balanced supply of nitrogen by integrated nutrient sources throughout the life cycle of the crop reduced leaf senescence and able to furnish the increased assimilate demand of plant sinks which resulted in higher yield attributes.

Similarly, the treatment T_8 (Biocompost 5 t/ha + 100% RDF) reported the higher values of seed and stover yield (1763 and 2884 kg/ha, respectively) and remained at par with application of Biocompost 5 t/ha + 75% RDF (T_7), Biocompost 5 t/ha + 50% RDF (T_6) and Biocompost 2.5 t/ha + 100% RDF (T_5) during both the years of pooled analysis as well as percent increase (48.19% and 40.14%, respectively) over Biocompost 2.5 t/ha (T_1) were found in two year pooled findings (Table. 2) The results of various interacting growth factors and yield contributing characters increased consistently and significantly with combination of inorganic and organic sources. It may also due to the adequate uptake of major nutrients, which are required in greater quantities and the use of biocompost in treatment T_8 served as a reserve for macro and micro nutrients that are released during the mineralization process and finally it improved the seed and stover yield. These results were in accordance with those of Patel *et al.* (2010) [10], Choudhary *et al.* (2011) [6], Raghuwanshi (2013) [11], Shivran *et al.* (2016) [14], Lunagariya *et al.* (2018) [7], Raiyani *et al.* (2018) [12], Amitha (2019) [2], Somdutt *et al.* (2019) [16] and Thumminkantti (2019) [18] in fenugreek.

Table 1: Growth attributes of fenugreek as influenced by different INM treatments (Two year pooled results)

Treatments	Plant height (cm)		Number of branches/plant		Plant dry matter (g)	
	60 DAS	At harvest	60 DAS	At harvest	60 DAS	At harvest
T_1	28.62	45.21	5.29	6.62	4.94	8.61
T_2	31.74	49.97	5.77	7.23	5.20	9.59
T_3	35.30	53.28	6.30	8.01	5.53	10.57
T_4	37.97	55.82	6.51	8.27	5.66	10.94
T_5	40.20	57.99	6.88	8.87	5.88	11.75
T_6	40.55	60.00	7.11	9.06	6.05	11.97
T_7	41.70	60.76	7.32	9.42	6.13	12.44
T_8	43.74	62.82	7.43	9.72	6.23	13.04
S.Em±	1.23	1.83	0.19	0.31	0.12	0.45
CD (P=0.05)	3.56	5.32	0.56	0.89	0.35	1.30
CV (%)	8.02	8.06	7.22	8.95	5.16	9.88
General mean	37.48	55.73	6.58	8.40	5.70	11.11

Table 2: Yield attributes and yield of fenugreek as influenced by different INM treatments (Two year pooled results)

Treatments						Number of pods/plant
T_1	19.77	Pod length (cm)	Number of seed /pod	Seed weight/plant (g)	Seed yield (kg/ha)	Stover yield (kg/ha)
T_2	22.31	9.26	11.38	3.695	1190	2058
T_3	24.04	10.43	13.26	4.355	1378	2331
T_4	24.83	11.24	13.87	4.527	1440	2426
T_5	26.56	11.60	14.24	4.695	1510	2505
T_6	27.35	12.60	15.12	4.988	1608	2642
T_7	27.93	12.80	15.51	5.092	1657	2775
T_8	29.02	13.12	16.08	5.313	1717	2847
S.Em±	0.85	13.71	16.59	5.472	1763	2884
CD (P=0.05)	2.46	0.39	0.51	0.17	55.61	84.94
CV (%)	8.25	1.13	1.48	0.485	161	246
General mean		8.07	8.62	8.60	8.89	8.13

Conclusion

In fenugreek, growth, yield attributes and yield were found highest with the application of Biocompost 5 t/ha + 100% RDF (T_8) at the end of two-year fenugreek-fodder sorghum sequence with respect to INM treatments.

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