



E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; 8(3): 3364-3367
Received: 04-03-2019
Accepted: 06-04-2019

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Effect of bio-stimulants and growth regulators on plant growth and herbage yield of fenugreek (*Trigonella foenum-graecum* L)

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Abstract

A study was conducted to find out the effect of different bio-stimulants and growth regulators on plant growth, herbage yield and quality of fenugreek var CO 2. Foliar spray of bio-stimulants and growth regulators like TNAU Panchagavya (3%), Moringa Leaf Extract (3%), PPFM (1%), Vermiwash (3%), Humic Acid (1000 ppm) and Cytozyme (1000 ppm) were used as a treatments. Among the different treatments, the mean value of number of leaves (62.24), number of primary branches (6.87), leaf area (255.68cm²) and herbage yield per plot (5.49 kg plot⁻¹) was recorded highest in the treatment T₂ (vermiwash @ 3%). While in plant height (30.01cm) PPFM recorded best compared to all other treatments. B:C ratio was also high in treatment T₂ (3.85) compared to control (1.88).

Keywords: Fenugreek, vermiwash, pink pigmented facultative Methylobacteria (PPFM), herbage yield

Introduction

Fenugreek is an annual herbaceous plant botanically known as *Trigonella foenum-graecum* and commonly called as 'Methi'. Fenugreek is mainly cultivated for the purpose of seeds as well as leaves. In many countries leaves are used in food preparation and seeds have the medicinal properties like anti-diabetic, anti-cancer and reduces the blood cholesterol level. In India, it is mainly cultivated in Rajasthan, Gujarat, Madhya Pradesh, Tamil Nadu and Uttar Pradesh under semi-arid condition in the area of 2, 19, 000 ha with the production of 2, 95, 000 MT and the productivity is about 1.4 MT/ ha (Spice board, 2018). Leaves contains 86.1% moisture, 4.4% protein, 0.9% fat, 1.5% minerals, 1.1% fiber and 6% carbohydrates. In addition to that, leaves have calcium, zinc iron, phosphorous, riboflavin, carotene, thiamine, niacin and vitamin C (Rao, 2003) [13]. Yadav and Sehgal (1997) [17] revealed that fresh leaves of fenugreek contain ascorbic acid of 220.97 mg per 100 g of leaves and β-carotene is about 19 mg/100 g. The demand for fenugreek seeds and leaves increased because of its higher medicinal values. Fenugreek seeds contain diosgenin content which is mainly used for the preparation of contraceptive pills. It is used as a substitute for Medicinal Yam. To meet out the demand the production needs to be increased through adoption of improved cultural practices. Beneficial effects of various plant growth regulators has been reported on many spice crops and proved that they also improves yield and quality. Plant growth regulators and bio-stimulants have the ability to increase the yield because it acts as a chemical catalyst in plants and improve the plant height, number of branches per plant, number of leaves, number of pods per plant, pod length, number of grains per pod, yield and grain quality.

Materials and methods

Field experiment was conducted in Tamil Nadu Agricultural University during the month of November and January. This experiment was laid out in Randomized Block Design with four replications with the plot size of 3 × 3 m. Before sowing fertilizers are applied at the rate of 10:12:12 (NPK kg ha⁻¹). Seeds are line sowed at the rate of 25 kg ha⁻¹. Treatment details are given below

T₀ - Control

T₁ - TNAU panchagavya (3%)

T₂ - Vermiwash (3%)

T₃ - Moringa leaf extract (3%)

T₄ - PPFM (Pink Pigmented Facultative Methylobacteria 1%)

T₅ - Cytozyme (1000 ppm)

T₆ - Humic acid (1000 ppm)

TNAU Panchagavya and PPFM are obtained from Tamil Nadu Agricultural University, Humic

acid and Cytozyme are brought from commercial fertilizer shop. Moringa leaf extract prepared by grinding 40 days old young branches and leaves added with water (1litre/10 kg of fresh leaves) and sieved the extract (Yasmeen, 2011) [4]. This extract used within one day or kept in refrigerator to avoid harmful microorganism contaminations. Vermiwash prepared by passage of water through a column of earthworm culture and the spent wash collected through a drainage pipe provided at the bottom of vermicomposting pit (Ismail, 1997) [7]. Bio-stimulants and growth regulators are prepared as per the dose of individual treatment and spray was given one time at 20 days after sowing by using hand sprayer. Harvesting was done in 30 DAS and all the observations are recorded at the day of harvest.

Results & Discussion

Effect of treatments on growth parameters

Among the different treatments, T₂ (vermiwash @ 3%) recorded the increased growth effect in both the seasons. The mean values of primary branches (6.87), number of leaves (62.24) and number of nodules (20.13) were showed in Table 1. While in plant height T₄ (PPFM @ 1%) registered best in season I (33.10 cm), season II (26.92 cm) with the overall mean of 30.01 cm. Higher plant height may be due to increased cell division and cell elongation because PPFM have the ability to produce growth regulators like Auxin and Cytokinin (Lee *et al.*, 2006 and Nadali *et al.*, 2010) [9, 11]. Similarly Lokesh *et al.*, 2018 [10] reported that application of PPFM showed higher plant height in coriander. Vermiwash generally improves the uptake of nutrients like Nitrogen, Phosphorous and Potassium (Azizi *et al.*, 2005) [3]. Abbott and Parker (1981) [1] reported that vermiwash can increase the uptake of nutrients through aerial parts of plant and improves the growth of plant. This may be the reason for high number of leaves and more number of primary branches in fenugreek compared to all other treatments. Vermiwash contains nitrogen fixing bacteria like *Azotobacter*, *Agrobacterium*, *Rhizobium* and some phosphate solubilizing bacteria (Kaur *et al.*, 2015) [8]. This may be the reason for high number of nodules per plant in fenugreek.

Effect of treatments on physiological parameters

Among the treatments, T₂ (vermiwash @ 3%) recorded the highest mean value of leaf area (255.68 cm²) and leaf area index (0.96) in both the seasons (Table 2). Increased leaf area and LAI may be presence of coelomic fluid in vermiwash.

Coelomic fluid is the source for soluble forms of phosphates, sulphates and chlorides of potassium, sodium and magnesium. This will generally increase the nutrients availability and absorption efficiency of the leaves leads to more number of leaves, large leaf area and LAI. (Zambare *et al.*, 2008; Vijayanathan *et al.*, 2004; Buckerfield *et al.*, 1999) [18, 16, 5]. These results are in line with the findings of Elumalai *et al.*, 2013 in bhendi which recorded the highest plant height, length, and diameter, number of leaves and leaf area.

Total chlorophyll

Foliar spray of vermiwash 3% (T₂) observed increased mean value of total chlorophyll content in both the seasons (2.47 mg g⁻¹) and lowest total chlorophyll content was observed in season I (1.50 mg g⁻¹) and season II (1.36 mg g⁻¹) in control plant. Similar results were observed by Thangaraj (2015) [15] and reported that application of vermiwash nourish the plant growth and increased chlorophyll content in fenugreek. Quaik *et al.*, (2012) [12] also reported that spray of vermiwash increased the chlorophyll content in *Borago officinalis* leaves.

Effect of treatments on yield parameters

Among the different treatments T₂ (vermiwash @ 3%) spray respectively showed highest herbage yield in the season I (5.90 kg plot⁻¹) and season II (5.09kg plot⁻¹) respectively and the lowest herbage yield was recorded in control (2.90kg plot⁻¹) and (2.32kg plot⁻¹) (Table 3). Estimated herbage yield per hectare and benefit cost ratio was also high in vermiwash treated plants. Increased yield per plot may be due to more number of leaves, more number of primary branches and increased leaf area. Generally in plants presence of high photosynthetic area leads to an increased photosynthesis and this will directly influence the biomass production of plants. Apart from that total chlorophyll content, single plant weight and number of nodules was also high in vermiwash treated plots. Generally leguminous crops fix the atmospheric nitrogen in their root nodules and this nitrogen will be utilized for growth of plant. Presence of more nodules in fenugreek crop may be the reason for increased herbage yield. Abdullah Adil Ansari (2008) [2] reported the effect of vermiwash on spinach and onion crop resulted that yield was significantly increased in both crops. Sundararasu and Jeyasankar (2014) [14] reported that foliar spray of vermiwash had increased the growth and yield in brinjal and this may be due to the higher level of macro and micro nutrients present in vermiwash.

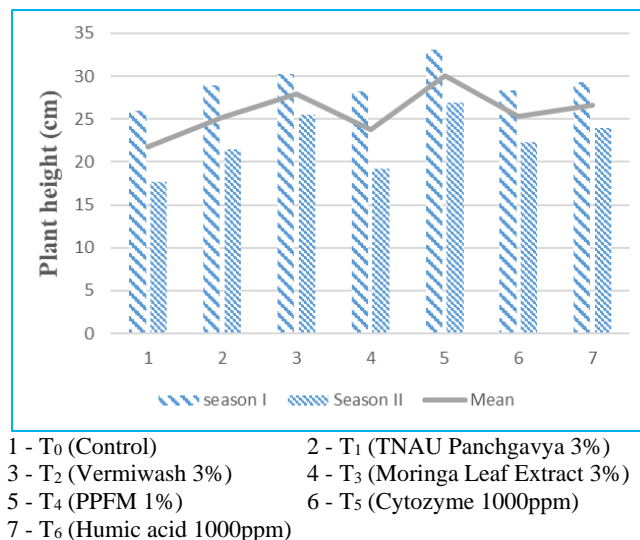
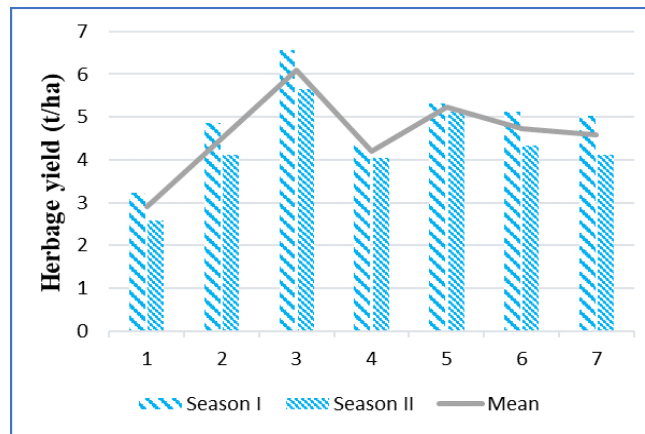


Fig 1: Effect of bio-stimulants and growth regulators on plant height (cm) of fenugreek



1 - T₀ (Control) 2 - T₁ (TNAU Panchgavya 3%)
 3 - T₂ (Vermiwash 3%) 4 - T₃ (Moringa Leaf Extract 3%)
 5 - T₄ (PPFM 1%) 6 - T₅ (Cytozyme 1000ppm)
 7 - T₆ (Humic acid 1000ppm)

Fig 2: Effect of bio-stimulants and growth regulators on herbage yield (t ha⁻¹) of fenugreek

Table 1: Effect of bio stimulants and growth regulators on growth parameters of fenugreek

| Treatments | Plant height (cm) | | | Primary branches | | | Number of leaves | | | Number of nodules | | |
|----------------|-------------------|-----------|-------|------------------|-----------|------|------------------|-----------|-------|-------------------|-----------|-------|
| | Season I | Season II | Mean | Season I | Season II | Mean | Season I | Season II | Mean | Season I | Season II | Mean |
| T ₀ | 25.98 | 17.62 | 21.80 | 5.72 | 5.15 | 5.44 | 52.65 | 46.45 | 49.55 | 12.00 | 11.63 | 11.82 |
| T ₁ | 28.93 | 21.42 | 25.18 | 5.80 | 5.79 | 5.79 | 54.92 | 49.92 | 52.42 | 15.25 | 15.25 | 15.25 |
| T ₂ | 30.27 | 25.52 | 27.90 | 7.08 | 6.66 | 6.87 | 68.95 | 55.52 | 62.24 | 21.25 | 19.00 | 20.13 |
| T ₃ | 28.22 | 19.25 | 23.74 | 6.35 | 6.10 | 6.35 | 55.65 | 48.15 | 51.90 | 17.50 | 14.50 | 16.00 |
| T ₄ | 33.10 | 26.92 | 30.01 | 6.92 | 6.43 | 6.68 | 57.60 | 53.60 | 55.60 | 20.00 | 17.25 | 18.63 |
| T ₅ | 28.34 | 22.28 | 25.31 | 6.20 | 5.83 | 6.01 | 54.85 | 49.55 | 52.20 | 19.75 | 12.50 | 16.13 |
| T ₆ | 29.24 | 23.92 | 26.58 | 6.60 | 5.92 | 6.13 | 56.30 | 52.35 | 54.33 | 21.25 | 15.50 | 18.38 |
| SEd | 1.16 | 1.00 | - | 4.27 | 0.34 | - | 0.41 | 0.36 | - | 1.59 | 1.89 | - |
| CD @ 5% | 2.45 | 2.11 | - | 8.98 | 0.71 | - | 0.87 | 0.75 | - | 3.35 | 3.97 | - |

T₀ – Control T₁ – TNAU Panchgavya (3%) T₂ – Vermiwash (3%)
 T₃ – Moringa Leaf Extract (3%) T₄ – PPFM (1%) T₅ – Cytozyme (1000ppm)
 T₆ – Humic acid (1000ppm)

Table 2: Effect of bio-stimulants and growth regulators on physiological parameters of fenugreek

| Treatments | Leaf area (cm ²) | | | Leaf area index | | | Total chlorophyll content (mg g ⁻¹) | | |
|----------------|------------------------------|-----------|--------|-----------------|-----------|------|---|-----------|------|
| | Season I | Season II | Mean | Season I | Season II | Mean | Season I | Season II | Mean |
| T ₀ | 248.31 | 223.56 | 235.94 | 0.78 | 0.75 | 0.77 | 1.50 | 1.36 | 1.43 |
| T ₁ | 253.85 | 229.60 | 241.73 | 0.81 | 0.77 | 0.79 | 1.89 | 1.71 | 1.80 |
| T ₂ | 270.87 | 240.49 | 255.68 | 0.98 | 0.94 | 0.96 | 2.76 | 2.18 | 2.47 |
| T ₃ | 254.94 | 233.68 | 244.31 | 0.84 | 0.81 | 0.83 | 1.92 | 1.74 | 1.83 |
| T ₄ | 268.93 | 238.69 | 253.81 | 0.94 | 0.88 | 0.91 | 2.42 | 2.02 | 2.22 |
| T ₅ | 256.60 | 229.63 | 243.12 | 0.84 | 0.82 | 0.83 | 1.86 | 1.87 | 1.87 |
| T ₆ | 267.43 | 235.34 | 251.39 | 0.89 | 0.87 | 0.88 | 2.18 | 1.96 | 2.07 |
| SEd | 2.85 | 3.72 | - | 0.06 | 0.03 | - | 0.33 | 0.21 | - |
| CD @ 5% | 5.99 | 7.83 | - | 0.13 | 0.05 | - | 0.69 | 0.45 | - |

T₀ – Control T₁ – TNAU Panchgavya (3%) T₂ – Vermiwash (3%)
 T₃ – Moringa Leaf Extract (3%) T₄ – PPFM (1%) T₅ – Cytozyme (1000ppm)
 T₆ – Humic acid (1000ppm)

Table 3: Effect of bio-stimulants and growth regulators on yield parameters of fenugreek

| Treatments | Yield per plot (kg/plot) | | | Estimated yield per ha (t/ha) | | | B:C Ratio | | |
|----------------|--------------------------|-----------|------|-------------------------------|-----------|------|-----------|-----------|------|
| | Season I | Season II | Mean | Season I | Season II | Mean | Season I | Season II | Mean |
| T ₀ | 2.90 | 2.32 | 2.61 | 3.22 | 2.58 | 2.90 | 2.09 | 1.67 | 1.88 |
| T ₁ | 4.37 | 3.71 | 4.04 | 4.86 | 4.12 | 4.49 | 2.72 | 2.31 | 2.52 |
| T ₂ | 5.90 | 5.09 | 5.49 | 6.56 | 5.65 | 6.10 | 4.13 | 3.56 | 3.85 |
| T ₃ | 3.91 | 3.64 | 3.77 | 4.34 | 4.04 | 4.19 | 2.65 | 2.47 | 2.56 |
| T ₄ | 4.79 | 4.62 | 4.70 | 5.32 | 5.13 | 5.22 | 2.98 | 2.76 | 2.87 |
| T ₅ | 4.61 | 3.91 | 4.26 | 5.12 | 4.34 | 4.73 | 2.95 | 2.50 | 2.73 |
| T ₆ | 4.53 | 3.71 | 4.12 | 5.03 | 4.12 | 4.57 | 2.79 | 2.29 | 2.54 |
| SEd | 0.15 | 0.12 | - | 0.66 | 0.15 | - | - | - | - |
| CD @ 5% | 0.31 | 0.25 | - | 1.39 | 0.32 | - | - | - | - |

T₀ – Control T₁ – TNAU Panchgavya (3%) T₂ – Vermiwash (3%)
 T₃ – Moringa Leaf Extract (3%) T₄ – PPFM (1%) T₅ – Cytozyme (1000ppm)
 T₆ – Humic acid (1000ppm)

Conclusion

The present study revealed that the foliar application of vermiwash 3% at 20 days after sowing significantly increase the growth and physiological characters which directly influence the higher herbage yield of fenugreek. The BCR (3.85) was also high in this treatment. Hence, the spray of vermiwash 3% at 20 DAS will be recommended to get more herbage yield in fenugreek.

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