E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2024; SP-7(10): 541-543
Received: 18-07-2024
Accepted: 22-08-2024

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Influence of organic amendments and PPFM on enhancing the productivity of foxtail millet *Setaria italica* L. under rainfed condition

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DOI: https://doi.org/10.33545/2618060X.2024.v7.i10Sh.1838

Abstract
Organic agriculture is a holistic production management system which promotes and enhances agro-ecosystsem health, including biodiversity, biological cycles and soil biological activity. Millets are better adapted to dry infertile soils than most other crops often cultivated under extremely harsh conditions. Laboratory and Field experiments were conducted at Agricultural College and Research Institute, Vazhavachanur to evaluate the effects of organic amendments on the productivity of organic foxtail millet under rainfed condition with the application of PPFM (Pink Pigmented Facultative Methylotroph) @ 500 ml/ha on 30, 45 and 60 days after sowing Panchakavya @ 3% on 30, 45 and 60 days after sowing, arbuscular mycorrhiza @ 50 kg/ha as basal, weed mulching @ 5 t/ha and *in-situ* composting. The maximum grain yield was recorded with the application of PPFM @ 500 ml/ha with 1802 (kg/ha) followed by the application of Arbuscular Mycorrhiza @ 50 kg/ha as basal with 1345 (kg/ha). The minimum grain yield was recorded with the application of control with 433 (kg/ha).

Keywords: Fox tail millet, organic amendments, PPFM, panchakavya, arbuscular mycorrhizae

Introduction
Millet is a collective term referring to a number of small seeded grasses that are cultivated as grain crops. Primarily on marginal lands in dry areas in temperate, subtropical and tropical regions. Millets are better adapted to dry infertile soils than most other crops often cultivated under extremely harsh conditions. Most millets have strong, deep rooting system, short life cycle and can grow rapidly when moisture is available. It is a very good source of nutrients, vitamins and organic compounds. Organic agriculture is a holistic production management system which promotes and enhances agro-ecosystsem health, including biodiversity, biological cycles and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems. This accomplished by using, agronomic, biological and mechanical methods, as opposed to using synthetic materials, to fulfill any specific function within the system. Taking into consideration of the above facts the present study was designed with the following objectives are to assess the microbial dynamics and nutrient status of soil under organic management, to study the growth and yield parameters of organic foxtail millet under rainfed condition, to work out the economics.

Materials and Methods
Laboratory and Field experiments were conducted at Agricultural College and Research Institute, Vazhavachanur to evaluate the effects of organic amendments on the productivity of organic foxtail millet under rainfed condition. The details of the experiments, materials used and methodologies adopted were presented in this chapter. Laboratory and field experiments were conducted in Randomised Block Design with four replications. PPFM and Panchakavya were applied as foliar spray.

Treatment Details

T_1 - PPFM (Pink Pigmented Facultative Methylotroph) @ 500 ml/ha on 30, 45 and 60 days after sowing
T_2 - Panchakavya @ 3% on 30, 45 and 60 days after sowing
T_3 - Arbuscular Mycorrhiza @ 50 kg/ha as basal
T_4 - Weed Mulching @ 5 t/ha and in-situ composting
T_5 - Control

Common practice in all Treatments

1. Basal application of FYM @ 12.5 t/ha or vermicompost @ 5 t/ha
2. Seed treatment with Azospirillum and phosphobacteria @ 200 g each/kg of seed
3. Soil application of Azospirillum and phosphobacteria @ 1kg/acre

Growth Parameters

Observations in different plots were taken using Quadrants. The growth parameters such as plant height was recorded at 30th, 45th and 60th DAS and root length at harvest stage using a meter scale and expressed in cm. Leaf area/plant were recorded and expressed in cm^2. No. of tillers/plant at harvest stage were recorded.

Yield Parameters

The Yield Parameters such as Grain yield and Straw yield were recorded and expressed in kg/ha.

Microbial Population

Enumeration of *Azospirillum* was done using Nitrogen –free malic acid medium and expressed as (x 10^5 cfu/ml) and for Phosphobacteria were analysed through Sperber's Hydroxy Apatite medium and expressed as (x 10^4 cfu/ml)

Nutrient Status

Soil sample were collected at harvest stage and nutrient status of the soil were analysed through different methods. Organic carbon content in the soil was estimated through Walkley – Black method. Nitrogen content in the soil were estimated through kjeldhal method. Phosphorus content in the soil were estimated through Olsen and Bray method. Potassium content in the soil were estimated through Stanford method.

Economics

Cost of Economics for different treatments were worked out and analysed the efficient method.

Statistical Analysis

Data on various characters were studied during the course of investigation was statistically analysed. Whenever statistical significance was observed, Critical difference at 5% level of probability was worked out for comparison.

Results and Discussion

The experimental results on various aspects of growth and yield parameters of organic foxtail millet (*Setaria italica.* L) influenced by application of various organic amendments are presented in Table 1.

Plant height (cm)

The plant height was recorded at 30th, 60th days after sowing and at harvest stage. The results revealed that the maximum plant height was recorded with the application of PPFM @ 500 ml/ha on 30th, 45th and 60th DAS with 25.4 cm, 48.5 cm and 65.0 cm at 30th, 60th DAS and at harvest stage respectively followed by the application of Arbuscular Mycorrhiza @ 50 kg/ha as basal with 24.7 cm, 45.3 cm and 58.9 cm respectively. The minimum plant height was recorded in control plots. Nitrate reductase activity was estimated by following the method of Nicholas *et al*., (1976) [14] and the enzyme activity was expressed as µmol NO_2/g/h. Proline accumulation in the leaf was estimated by the method of Bales *et al.* (1973) [15]. *P*roline is the drought hormone which helps to withstand drought.

Leaf area/plant (cm^2)

The leaf area/plant was recorded at harvest stage. The results revealed that the maximum leaf area/plant was recorded with the application of weed mulching @ 5 t/ha with 70.4 cm^2 followed by the application of PPFM @ 500 ml/ha with 68.3 cm. The minimum leaf area/plant was recorded with the application of Panchakavya @ 3%. The total chlorophyll content was estimated at flowering.

Root length (cm)

The root length was recorded at harvest stage. The results revealed that the maximum root length was recorded with the application of weed mulching @ 5 t/ha with 5.21 cm followed by application of Panchakavya @ 3% with 4.80 cm. The minimum root length was recorded with the application of PPFM @ 500 ml/ha with 3.62 cm. Plants develop defence strategies against salt stress adjustment and induction and induction of anti-oxidant enzymes.

No. of Tillers/m^2

The No. of Tillers/m^2 was recorded at harvest stage. The results revealed that the maximum No. of Tillers/m^2 was recorded with the application of PPFM @ 500 ml/ha with 56.7/m^2 followed by the application of weed mulching @ 5 t/ha with 56.4/m^2. The minimum No. of Tillers/m^2 was recorded with the application of control plots with 43.9/m^2. Plant height and number of tillers were recorded at 40 and 60 DAS and harvest. The LAD and LAI were computed following formulae proposed by Watson (1952) [16] respectively.

Yield Parameters

The results revealed that the maximum grain yield was recorded with the application of PPFM @ 500 ml/ha with 1802 (kg/ha) followed by the application of Arbuscular Mycorrhiza @ 50 kg/ha as basal with 1345 (kg/ha). The minimum grain yield was recorded with the application of control with 433 (kg/ha). In this study, the proline accumulation was highest at grain development stage in all the small millets and the maximum was observed in foxtail millet at grain development stage. This shows that the foxtail millet cultivars able to tolerate under stress and proline accumulation is the highest at grain development stage. Samundeswari *et al*. (2017) [9]. The results revealed that the minimun straw yield was recorded with the application of Arbuscular Mycorrhiza @ 50 kg/ha as basal with 3358 (kg/ha) followed by the application of weed mulching @ 5 t/ha with 3222 (kg/ha). The minimum straw yield was recorded with the application of control plots with 1442 (kg/ha).

Economics

The results revealed that the maximum B: C ratio was revealed with the application of PPFM (1.61 B:C Ratio) followed by the application of Arbuscular mycorrhiza (1.57 B:C ratio). The minimum was recorded in Panchakavya (1.5 B: C ratio) respectively. The data collected on the different parameters was

statistically analysed by the 'F' test for significance as suggested by Gomez and Gomez (2010) [17]. The critical difference (CD) was computed at 5% probability.

Table 1: Effect of treatments on growth and yield parameters of Tenai:

Treatments	Plant height at harvest (cm)	Leaf area/plant (cm^2)	Root length (cm)	No. of tillers/m^2	Grain yield (kg/ha)	Straw yield (kg/ha)	B:C ratio
T1 – PPFM	60.0	68.3	3.62	56.7	1088	3162	1.50
T2 – Panchagavya	48.2	42.3	4.80	52.6	1102	3358	1.61
T3 – Arbuscular Mycorrhiza	52.9	61.8	4.25	47.8	1060	2625	1.45
T4 – Weed mulching	70.6	70.4	5.21	56.4	1135	3222	1.54
T5 – Control	48.6	47.5	3.88	43.9	985	1442	1.44
SEd	2.816	6.141	0.328	3.433	58	207	
CD (P=0.05)	6.136	13.38	0.716	7.48	122	452	

Conclusion

Under rainfed condition, the maximum grain yield 1802 (kg/ha) and net returns (7748) from organic foxtail millet cultivation could be obtained by application of PPFM sprayed plots followed by VAM. The minimum grain yield 433(kg/ha) and net returns (6221) from organic foxtail millet cultivation could be obtained by application of control plots. A positive synergistic effect of *Azospirillum* and phosphobacteria is responsible for the higher accumulation of N and higher yield. PPFM under drought conditions, it produces an enzyme ACC Deaminase (1- Amino cyclopropane 1- carboxylate) which inhibits ethylene production. This ethylene hormone is only responsible for senescence in the plant. By inhibiting this ethylene production, can protect the plant from senescence. This PPFM is cost effective and eco-friendly. It mitigates drought and also helps to increase yield by 10%.

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