

Original Research Article

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## Effect of INM on Yield, Quality and Economics in Foxtail Millet (*Setaria italica* L.) in Black Soil

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### ABSTRACT

A field experiment was conducted at Main Agricultural Research Station, Raichur, during *kharif* 2018-19 to study the integrated nutrient management on Foxtail millet (*Setaria italica* L.) in black soil. The experiment was laid out with eleven treatments replicated three times in randomized block design. Among all the treatments, application of RDF +2.5 t ha<sup>-1</sup> Vermicompost + Bio-fertilizer + Foliar spray of 19:19:19 at 15, 30 and 45 DAS significantly recorded grain yield and straw yield were significantly recorded (2414 kg ha<sup>-1</sup> and 6034 kg ha<sup>-1</sup>) as compared to absolute control and RDF. The treatment also recorded higher gross returns, net returns, and B C ratio (82677 ha<sup>-1</sup>, 56097 ha<sup>-1</sup>, and 3.11, respectively). It is concluded that the application of RDF + 2.5 t ha<sup>-1</sup> Vermicompost + Bio-fertilizer) + Foliar Spray of 19:19:19 at 15, 30 and 45 DAS is the best treatment in rainfed condition to achieve higher yield, net returns and B C ratio as compared to RDF and absolute control.

#### Keywords

Foxtail millet, Growth and yield attributes, Grain yield, Stover yield

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### Introduction

Foxtail millet grown since time immemorial is predominantly self-pollinated crop belonging to family gramineae. Under condition of low input management, it grows well and produces more than pearl millet. Foxtail millet is one of the world's oldest cultivated crops. It is also called as famine

reserve and it is extensively grown under low rainfall area. Foxtail millet is the second most widely grown species of millet and the most important food crop in East Asia. In India, foxtail millet is important crop in arid and semi-arid regions. In South India, it has been a staple diet among people for a long time and it is a warm season crop, typically grown in late spring season and harvested for grain in

75-90 days (800-900 kg ha<sup>-1</sup>). Foxtail millet is commonly known as Navane in Karnataka (Vinall, 1924).

In this context, it is worth to mention that nutrient management through organics plays a major role in maintaining soil health due to buildup of soil organic matter, beneficial microbes and enzymes besides improving soil physical and chemical properties. In a farming system approach, the nutrient needs are met out through recycling process to achieve sustained soil fertility and crop productivity.

The options available on the farm include use of various organic manures *viz.*, FYM, compost, vermicompost, green manures, bio-fertilizers *etc.* Nutrient management aims at efficient and judicious use of all the major sources of plant nutrients in an integrated manner to get maximum economic yield without any deleterious effects on physico-chemical and biological properties of the soil. Integration of nutrients plays an significant role in better penetration and establishment of sorghum roots, which is responsible for the plant to take up water from deeper layers and to maintain high relative plant water content under soil moisture deficit condition (Jadhao *et al.*, 2002).

## Materials and Methods

The experiment was conducted at Main Agricultural Research Station, Raichur, which is situated between 16° 12' N latitude and 77°20' E longitude with an altitude of 389 meters above the mean sea level and is located in Zone-2 of Karnataka. A composite surface (0-15 cm) soil sample was drawn from the experimental site before initiation of experiment. The soil was air-dried, powdered and passed through 2 mm sieve and was analyzed for physico-chemical properties. The results and analytical techniques employed for their estimation were given in Table 1. The

experiment was conducted with eleven treatments having different sources of organics and recommended dose of fertilizer treatments which were randomly allocated in Randomized Complete Block Design (RCBD) with three replications. the treatment details area

T<sub>1</sub>: Absolute control, T<sub>2</sub>: RDF (30:15:15 kg N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O ha<sup>-1</sup>), T<sub>3</sub>: FYM @ 6 t ha<sup>-1</sup>, T<sub>4</sub>: Vermicompost @ 2.5 t ha<sup>-1</sup>, T<sub>5</sub>: RPP (RDF+FYM @ 6 t ha<sup>-1</sup> + Bio-fertilizer), T<sub>6</sub>: RPP (RDF+ Vermicompost @ 2.5 t ha<sup>-1</sup> + Bio-fertilizer), T<sub>7</sub>: RDF+ Foliar spray of 19:19:19 @ 1 % at 15, 30 and 45 DAS, T<sub>8</sub>: FYM @ 6 t ha<sup>-1</sup>+ Foliar spray of 19:19:19 @ 1 % at 15, 30 and 45 DAS, T<sub>9</sub>: Vermicompost @ 2.5 t ha<sup>-1</sup>+ Foliar Spray of 19:19:19 @ 1 % at 15, 30 and 45 DAS T<sub>10</sub>: RPP (RDF+ FYM @ 6 t ha<sup>-1</sup> + Bio-fertilizer) + Foliar Spray of 19:19:19 @ 1 % at15, 30 and 45 DAS, T<sub>11</sub>: RPP (RDF+ Vermicompost @ 2.5 t ha<sup>-1</sup> + Bio-fertilizer) + Foliar Spray of 19:19:19 @ 1 % at 15, 30 and 45 DAS.

Note: Recommended Package Of Practices : RDF (30:15:15 kg N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O ha<sup>-1</sup>), FYM @ 6.0 t ha<sup>-1</sup>, Biofertilizer (*Azospirillum* @ 200 g ha<sup>-1</sup>) soil application.

The good quality seeds of foxtail millet variety (HN-46) were sown with spacing of 30 × 10 cm. Five plants from the net plot area were randomly selected and they were tagged to record the periodical observations at 30, 60 days after sowing and also at the time of harvest.

Protein content in the seeds of foxtail millet was estimated by Broad Ford method by using CBB (Comassie brilliant blue) colour as a colouring agent and readings were recorded in spectrophotometer at wavelength 595 nm and results expressed in per cent.the gross returns, Net returns and BC ratio is worked out.

## Results and Discussion

### Grain yield

There was a significant difference in the grain yield, stover yield and Harvest index of foxtail millet due to different treatment combination and the results are shown in the Table 2 and Fig. 1.

Application of RDF (30:15:15 kg N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O ha<sup>-1</sup>) + 2.5 t ha<sup>-1</sup> Vermicompost + Bio-fertilizer) + Foliar spray of 19:19:19 @ 1 % at 15, 30 and 45 DAS (T<sub>11</sub>) recorded significantly higher grain yield (2414 kg ha<sup>-1</sup>) and it was on par with treatments T<sub>10</sub> where RDF (30:15:15 kg N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O ha<sup>-1</sup>) + 6 t ha<sup>-1</sup> FYM + Bio-fertilizer) + Foliar spray of 19:19:19 @ 1 % at 15, 30 and 45 DAS (2252 kg ha<sup>-1</sup>). However, lower grain yield (853 kg ha<sup>-1</sup>) was obtained in (T<sub>1</sub>) absolute control treatment.

Higher grain yield was noticed with application of RDF (30:15:15 kg N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O ha<sup>-1</sup>) + 2.5 t ha<sup>-1</sup> Vermicompost + Bio-fertilizer + Foliar spray of 19:19:19 @ 1 % at 15, 30 and 45 DAS (2414 kg ha<sup>-1</sup>). It might be due to the adequate amount of nutrients availability both macro and micro nutrient results from treatment effect which enhanced the crop growth. The increased availability of N, P, K, Zn, Cu, Mn and Fe as well as the synergistic effect between organic and inorganic forms of nutrients and formation of stable complexes with humic substances supplied through poultry manure in rice crop (Dosani *et al.*, 1999 in groundnut crop and Balaji and Yakadri 2004). The combined application of organic and inorganic sources provided greater availability of nutrients for the development of vegetative structures and increased the number of grain, grain weight and resulted in higher grain yield (Uddin *et al.*, 2008).

### Stover yield

Significantly higher stover yield was recorded in the treatment which received RDF (30:15:15 kg N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O ha<sup>-1</sup>) + 2.5 t ha<sup>-1</sup> Vermicompost + Bio-fertilizer) + Foliar spray of 19:19:19 @ 1 % at 15, 30 and 45 DAS (6034 kg ha<sup>-1</sup>). However, it was on par with treatment which received RDF (30:15:15 kg N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O ha<sup>-1</sup>) + 6 t ha<sup>-1</sup> FYM + Bio-fertilizer) + Foliar spray of 19:19:19 @ 1 % at 15, 30 and 45 DAS (T<sub>10</sub>) (5775 kg ha<sup>-1</sup>). Significantly lower straw yield (2230 kg ha<sup>-1</sup>) was obtained in absolute control (T<sub>1</sub>).

Higher the stover yield was recorded with application of RDF (30:15:15 kg N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O ha<sup>-1</sup>) + 2.5 t ha<sup>-1</sup> Vermicompost + Bio-fertilizer) + Foliar spray of 19:19:19 @ 1 % at 15, 30 and 45 DAS (6034 kg ha<sup>-1</sup>). This was mainly because of increasing in the levels and source of nutrients with organic manures significantly increased the straw yield of hybrid rice which might due to the integrated effect of N, P and K levels and different sources of organic manures on N, P and K availability and their uptake as well as grain and straw yield of hybrid rice. The supply of inorganic and organic manures increased the grain and straw yield of hybrid rice. The addition of organic manure might influence N, P and K availability by maintaining good physical condition of soil for plant growth and yield. The increase in straw yield of hybrid rice with combined application of fertilizer and manure was reported by Rahman *et al.*, (2005), Gupta *et al.*, (2006) and Bajpai *et al.*, (2006).

### Harvest index

Higher harvest index (33.20 %) was recorded with application of FYM (6 t ha<sup>-1</sup>). However, lower harvest index was recorded in T<sub>6</sub> (27.10 %) as compared to absolute control (T<sub>1</sub>).

**Table.1** Grain yield, stover yield and harvest index of foxtail millet as influenced by nutrient management practices

Treatment	Grain yield (kg ha <sup>-1</sup> )	Stover yield (kg ha <sup>-1</sup> )	Harvest index (%)
T <sub>1</sub> : Absolute control	853	2230	27.7
T <sub>2</sub> : RDF(30:15:15 kg ha <sup>-1</sup> )	1448	3534	29.1
T <sub>3</sub> : FYM 6 t ha <sup>-1</sup>	1285	2590	33.2
T <sub>4</sub> : Vermicompost 2.5 t ha <sup>-1</sup>	1348	3469	28.0
T <sub>5</sub> : RPP (RDF+ 6 t ha <sup>-1</sup> FYM + Bio-fertilizer)	1853	4530	29.0
T <sub>6</sub> : RPP (RDF+ 2.5 t ha <sup>-1</sup> Vermicompost + Bio-fertilizer)	2024	5458	27.1
T <sub>7</sub> : RDF+ Foliar Spray of 19:19:19 @ 1 % at 15, 30 and 45 DAS	1595	3668	30.3
T <sub>8</sub> : FYM 6 t ha <sup>-1</sup> + Foliar Spray of 19:19:19 @ 1 % at 15, 30 and 45 DAS <sup>1</sup>	1679	4261	28.3
T <sub>9</sub> : Vermicompost 2.5 t ha <sup>-1</sup> + Foliar Spray of 19:19:19 @ 1 % at 15, 30 and 45 DAS	1838	4691	28.2
T <sub>10</sub> : RPP (RDF+ 6 t ha <sup>-1</sup> FYM+ Bio-fertilizer) + Foliar Spray of 19:19:19 @ 1 % at 15, 30 and 45 DAS	2252	5775	28.1
T <sub>11</sub> : RPP (RDF+ 2.5 t ha <sup>-1</sup> Vermicompost + Bio-fertilizer) + Foliar Spray of 19:19:19 @ 1 % at 15, 30 and 45 DAS	2414	6034	28.6
S.Em ±	95.19	128.60	0.01
CD at 5%	280.80	379.36	NS

**Table.2** Protein content of foxtail millet nutrient management practices at harvest stage

Treatment	Protein (%)
T <sub>1</sub> - Absolute control	6.14
T <sub>2</sub> - RDF(30:15:15)	7.63
T <sub>3</sub> - FYM 6 t ha <sup>-1</sup>	7.36
T <sub>4</sub> - Vermicompost 2.5 t ha <sup>-1</sup>	7.50
T <sub>5</sub> - RPP (RDF+ 6 t ha <sup>-1</sup> FYM + Bio-fertilizer)	8.63
T <sub>6</sub> - RPP (RDF+ 2.5 t ha <sup>-1</sup> Vermicompost + Bio-fertilizer)	9.13
T <sub>7</sub> - RDF+ Spray of 19:19:19 @ 1 % at 15, 30 and 45 DAS	8.31
T <sub>8</sub> - FYM 6 t ha <sup>-1</sup> + Spray of 19:19:19 @ 1 % at 15, 30 and 45 DAS <sup>1</sup>	8.50
T <sub>9</sub> -Vermicompost 2.5 t ha <sup>-1</sup> + Spray of 19:19:19 @ 1 % at 15, 30 and 45 DAS	9.00
T <sub>10</sub> -RPP (RDF+ 6 t ha <sup>-1</sup> FYM+ Bio-fertilizer) + Spray of 19:19:19 @ 1 % at 15, 30 and 45 DAS	9.31
T <sub>11</sub> -RPP (RDF+ 2.5 t ha <sup>-1</sup> Vermicompost + Bio-fertilizer) + Spray of 19:19:19 @ 1 % at 15, 30 and 45 DAS	9.56
SE(m) ±	<b>0.39</b>
CD at 5%	<b>1.14</b>

**Table.3** Economics of foxtail millet production as influenced by nutrient management practices

Treatment	Cost of cultivation (Rs. ha <sup>-1</sup> )	Gross Returns (Rs. ha <sup>-1</sup> )	Net Returns (Rs. ha <sup>-1</sup> )	B:C
<b>T<sub>1</sub> : Absolute control</b>	19862	29459	9596	1.48
<b>T<sub>2</sub> : RDF(30:15:15 kg ha<sup>-1</sup>)</b>	21264	49379	28114	2.32
<b>T<sub>3</sub> : FYM 6 t ha<sup>-1</sup></b>	25662	42455	16792	1.65
<b>T<sub>4</sub> : Vermicompost 2.5 t ha<sup>-1</sup></b>	24662	46416	21754	1.88
<b>T<sub>5</sub> : RPP (RDF + 6 t ha<sup>-1</sup> FYM + Bio-fertilizer)</b>	27294	63209	35914	2.32
<b>T<sub>6</sub> : RPP (RDF + 2.5 t ha<sup>-1</sup> Vermicompost + Bio-fertilizer)</b>	26294	70317	44022	2.67
<b>T<sub>7</sub> : RDF+ Foliar Spray of 19:19:19 @ 1 % at 15, 30 and 45 DAS</b>	21549	53830	32280	2.50
<b>T<sub>8</sub> : FYM 6 t ha<sup>-1</sup> + Foliar Spray of 19:19:19 @ 1 % at 15, 30 and 45 DAS<sup>1</sup></b>	25947	57664	31717	2.22
<b>T<sub>9</sub> : Vermicompost 2.5 t ha<sup>-1</sup> + Foliar Spray of 19:19:19 @ 1 % at 15, 30 and 45 DAS</b>	24947	63219	38272	2.53
<b>T<sub>10</sub> : RPP (RDF + 6 t ha<sup>-1</sup> FYM + Bio-fertilizer) + Foliar Spray of 19:19:19 @ 1 % at 15, 30 and 45 DAS</b>	27579	77483	49904	2.81
<b>T<sub>11</sub> : RPP (RDF + 2.5 t ha<sup>-1</sup> Vermicompost + Bio-fertilizer) + Foliar Spray of 19:19:19 @ 1 % at 15, 30 and 45 DAS</b>	26579	82677	56097	3.11

### Quality parameter of foxtail millet

The data on protein content differed significantly due to different treatment combinations and the results are shown in the Table 3 and Fig. 2

Among the different treatment combinations, the RDF (30:15:15 kg N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O ha<sup>-1</sup>) + 2.5 t ha<sup>-1</sup> Vermicompost + Bio-fertilizer) + Foliar spray of 19:19:19 @ 1 % at 15, 30 and 45 DAS (T<sub>11</sub>) recorded significantly higher protein content in seed (9.56 %). and which was on par with application of RDF (30:15:15 kg N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O ha<sup>-1</sup>) + 6 t ha<sup>-1</sup> FYM + Bio-fertilizer) + Foliar spray of 19:19:19 @ 1 % at 15, 30 and 45 DAS (T<sub>10</sub>) (9.31 %), T<sub>6</sub> which received RPP (RDF + 2.5 t ha<sup>-1</sup> Vermicompost + Bio-fertilizer). However, significantly lower dry matter accumulation was recorded in T<sub>1</sub> (6.14 %).

Higher the protein content was obtained with application of RDF (30:15:15 kg N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O ha<sup>-1</sup>) + 2.5 t ha<sup>-1</sup> Vermicompost + Bio-fertilizer) + Foliar spray of 19:19:19 @ 1 % at 15, 30 and 45 DAS. Increase in protein content of foxtail millet was mainly due to higher uptake of nitrogen and phosphorous through slow and continuous supply of N, P and K through organic manures. Since phosphorus improves quality parameter by regulating the photosynthesis, respiration, root enlargement and carbohydrate metabolism, thus increased protein content. Similar results were found by Tanwar and Shaktawat (2003) in soyabean crop.

### Economics of foxtail millet production

Economic analysis is one of the major criteria for evaluating efficient and economically available nutrient management practices. The data on cost of cultivation, gross returns, net returns and benefit cost ratio of foxtail millet production as influenced by various treatments is depicted in Table 4

### Cost of cultivation

Significantly higher cost of cultivation was recorded with the application of T<sub>10</sub>: RDF (30:15:15 kg N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O ha<sup>-1</sup>) + 2.5 t ha<sup>-1</sup> Vermicompost + Bio-fertilizer) + Foliar spray of 19:19:19 @ 1 % at 15, 30 and 45 DAS (₹ 27579.5 ha<sup>-1</sup>) followed by T<sub>5</sub> (₹ 27294 ha<sup>-1</sup>), T<sub>11</sub> (Rs 26579 ha<sup>-1</sup>), T<sub>6</sub> (₹ 26294 ha<sup>-1</sup>), T<sub>8</sub> (₹ 25947 ha<sup>-1</sup>), T<sub>3</sub> (₹ 25662 ha<sup>-1</sup>) and T<sub>9</sub> (₹ 24947 ha<sup>-1</sup>) compared to absolute control. Similar findings were reported by Patil and Udmale (2016).

### Gross returns

Significantly higher gross returns was noticed in T<sub>11</sub>: RDF (30:15:15 kg N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O ha<sup>-1</sup>) + 2.5 t ha<sup>-1</sup> Vermicompost + Bio-fertilizer) + Foliar spray of 19:19:19 @ 1 % at 15, 30 and 45 DAS (₹ 82677. ha<sup>-1</sup>) followed by T<sub>10</sub> (₹ 77483 ha<sup>-1</sup>), T<sub>6</sub> (₹ 70317 ha<sup>-1</sup>), T<sub>9</sub> (₹ 63219 ha<sup>-1</sup>), T<sub>5</sub> (₹ 63209 ha<sup>-1</sup>), T<sub>8</sub> (₹ 57664 ha<sup>-1</sup>), T<sub>7</sub> (₹ 53830 ha<sup>-1</sup>) and T<sub>2</sub>(₹ 49379 ha<sup>-1</sup>) owing to higher economic yields obtained in these treatments, whereas, lower net returns was recorded in control due to lower yields.

Similar findings also reported by Ashoka *et al.*, (2008) that, significantly highest gross return (Rs. 96,838 ha<sup>-1</sup>) were recorded with the application of RDF +35 kg Vermicompost, this could be mainly attributed to the higher yield of maize and chickpea crops.

### Net returns

Significantly higher net returns was recorded with the application of T<sub>11</sub>: RDF (30:15:15 kg N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O ha<sup>-1</sup>) + 2.5 t ha<sup>-1</sup> Vermicompost + Bio-fertilizer) + Spray of 19:19:19 @ 1 % at 15, 30 and 45 DAS(₹ 56097 ha<sup>-1</sup>) followed by T<sub>10</sub> (₹ 49904 ha<sup>-1</sup>), T<sub>6</sub> (₹ 44022 ha<sup>-1</sup>), T<sub>9</sub> (₹ 38272 ha<sup>-1</sup>), T<sub>5</sub> (₹ 35914.5 ha<sup>-1</sup>), T<sub>7</sub> (₹ 32280 ha<sup>-1</sup>) and T<sub>8</sub> (₹ 31717 ha<sup>-1</sup>).

### Benefit cost ratio (B:C)

The interaction effects of foxtail millet as influenced by different nutrient management practices on benefit cost ratio were found non-significant. Significantly higher benefit cost ratio (3.11) was noticed in T<sub>11</sub>: RDF (30:15:15 kg N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O ha<sup>-1</sup>) + 2.5 t ha<sup>-1</sup> Vermicompost + Bio-fertilizer + Spray of 19:19:19 @ 1 % at 15, 30 and 45 DAS) as compared to other treatments, viz., T<sub>10</sub> (2.81), T<sub>6</sub> (2.67), T<sub>9</sub> (2.53), T<sub>7</sub> (2.50), T<sub>5</sub> (2.32), T<sub>2</sub> (2.3) and T<sub>8</sub> (2.22), Absolute control T<sub>1</sub>(1.48).The results are in accordance with the findings of Jawadagi *et al.*, (2012), Bekek (2014) in hybrid maize reported that the application of organic nutrient and inorganic nutrient management are mainly because higher gross return and benefit cost ratio.

In conclusion, low cost technology like organic sources of nutrients and use of Foliar sprays of NPK can help in augmenting yield and quality of produce. The Foliar sprays of 19:19:19 @ 1 % at 15, 30 and 45 DAS increased yield to the upto 20.10 %.In modern agriculture, along with inorganic fertilizers, organic fertilizers are required for crops to get satisfactory yield and quality produce as nutrients are key elements for amino acid synthesis, protein synthesis, grain filling, *etc.*, This study on effect of nutrient management in Foxtail millet is useful for deciding the suitable combination of nutrient sources for sustainable production and profitability.

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