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Nutrient Management Practices on Growth and Yield of Finger Millet Influcened by Different Factors

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted during Rabi season of 2022-23 in field no new plot 1 at South farm of Karunya Institute of Technology and Sciences, Coimbatore. This study was conducted to assess the growth and yield of finger millet using nutrient management practices. The treatment consists of seven different parameters with control. Results revealed that growth parameters, yield attributes, yield of finger millet were significantly influenced by different treatments of nutrient management. In finger millet, plant height at 90 DAS, LAI at 60 DAS and dry matter accumulation per m^2 at harvest were maximum with 125% seed rate and 100% N through vermicompost. Yield attributes namely, effective tillers per m^2, number of fingers per ear, ear weight, test weight, number of grains per ear, grain yield and straw yield of finger millet were also recorded maximum in the same treatment.

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1. INTRODUCTION

"Finger millet, commonly known as ragi, is grown extensively in various regions of India. It is used as staple food that supplies a major portion of calories and protein for people of low-income group. Finger millet is generally taken in uplands in Jharkhand where they perform poorly due to low soil fertility as well as poor plant stand under direct sowing conditions. In recent decades, emphasis has been shifted from individual crop to cropping system because responses in component crops are influenced by the nutrient application to preceding crops by leaving substantial effect on the succeeding crop as carry over benefit" [1].

"In recent decades, emphasis has been shifted from individual crop to cropping system because responses in component crops are influenced by the nutrient application to preceding crops by leaving substantial effect on the succeeding crop as carry over benefit. Also, taking two crops in a sequence, or intensive cropping in place of mono-cropping in uplands like inclusion of pulses in crop sequence is agronomically very significant. It has been suggested that there is no need to apply fertilizers if moderate nutrient requiring crops like pea succeeds. Deleterious effect of chemical fertilizers in agriculture has led to adopt organic crop production as an alternative method which also maintains soil health and improves overall ecological balance of the production system. Thus, adopting combination of proper plant population and organic nutrient management can lead in better grain production. Information on seed rate in finger millet under organic nutrient management and its residual effect on second crop in sequence is very meager" [2].

"Therefore in this study the use of locally available agro-inputs in agriculture by avoiding or minimizing the use of synthetic agrochemicals appears to be one of the probable options to sustain the agricultural productivity. Various vermicompost nutrient sources are available which contain good amount of major plant nutrients to produce comparable yields. At the same time the food habits of the consumers are changing rapidly. Especially in the developed countries people have become more health conscious. Hence the demand for organic food products is on the rise" [3].

2. MATERIALS AND METHODS

2.1 Experimental Site

"During the Rabi season of 2022–2023, the experiment was conducted in the South Farm, School of Agricultural Sciences, Division of Agronomy, Karunya Institute of Technology and Sciences, Coimbatore. 10.9362° N latitude and 76.744° E longitude are the farm's coordinates. The region experiences a typical warm, muggy environment" [4].

2.2 Soil Characteristics

Prior to the experiment, random soil samples were taken from the experimental field at 5 separate places, ranging in depth from 0 to 15 cm. All of the soil samples were combined to create a typical homogenous composite sample, which was then examined to ascertain the mechanical and physicochemical characteristics of the soil [5].

2.3 Crop and Variety

Finger millet Co_{14} with the duration of 105 - 110 days was used as main crop in this experiment.

Table 1. Experimental design

Design	Randomized Block Design
Replication	3
Treatments	11
Total numbers of plots	33
Gross plot size	4.4 m x 3.0 m = 13.2 m^2
Net plot size	3.6 m x 2.0 m = 7.2 m^2
Variety	NDR-2064
Spacing	20 x 10 cm
Recommended dose of fertilizers	150:60:40: kg ha^{-1} NPK and 25 kg ha^{-1} Zinc sulphate
Field border	1.0 m
Replication border	1.0 m
Main irrigation channel	1.5 m
Sub irrigation channel	1.0 m
Bund	0.5 m

2.4 Experimental Design

The experiment was laid out in randomised block design with ten treatments and replicated three times. The treatments were allotted at random to plots within each replication.

Table 2. Treatment details

S No.	Treatment	Dose(kg/ha)	Legends
1.	100% (recommended dose of fertilizer)	40:20:20(N:P:K)	T_1
2.	75% of RDF +25% of FYM/ha (2 tonn)	30:15:15(N:P:K) 2 t FYM	T_2
3,	50% of RDF +50% of FYM/ha(4tonn)	20:10:10(N:P:K) 4 t FYM	T_3
4.	25% of RDF +75% of FYM/ha (6 tonn)	10:05:05(N:P:K) 6 t FYM	T_4
5.	75% of RDF+ 25% of vermicompost/ha (0.5 tonn)	30:15:15(N:P:K) 0.5 t Vermicompost	T_5
6.	50% of RDF+ 50% of vermicompost/ha (1tonn)	20:10:10(N:P:K) 1 t Vermicompost	T_6
7.	25% of RDF+ 75% of vermicompost/ha (1.5 tonn)	10:05:05(N:P:K) 1.5 t Vermicompost	T_7
8.	Control	00-00-00	T_8

2.5 Growth Attributes

Five plants are selected at random from the net plot area of each treatment and tagged. The following parameters are recorded in those tagged plants at different days.

2.5.1 Plant height

“Plant height was measured at 30, 60 DAS and at harvest stage in the five tagged plants from the ground level to tip of the plant and the value is expressed in cm” [6].

2.5.2 Number of tillers plant^{-1}

Number of tillers were manually counted at 30, 60 DAS and at harvest stage in the five tagged plants [7].

2.5.3 Dry matter production

“Five plants selected at random at all stages from each plot outside the net plot but within the border rows were cut close to the ground level and the samples were collected. These samples were shades dried and then oven dried at 800C for 72 hours. The dry matter production was computed per unit area and expressed in kg ha^{-1}” [8].

2.6 Yield Attributes of Crop

2.6.1 Number of productive tillers hill^{-1}

Five plants in each net plot were selected at random and the number of productive tillers per plant were counted and averaged [9].

2.6.2 Number of fingers earhead^{-1}

Five plants in each plot were selected random and number of fingers per ear head were counted and averaged [10].

2.6.3 Number of tillers m^{-2}

The number of tillers were counted from randomly tagged plants in net plot area and averaged to compute number of tillers m^{-2} [11].

2.6.4 Thousand grain weight

“Three composite samples of each 1000 grains were drawn from the net plot yield of each treatment and weight of these samples was recorded, averaged and expressed as 1000 grain weight in grams” [12].

2.6.5 Grain yield

The matured ear heads are collected from the net plot by harvesting followed by threshing. Finally the grains were collected and later it was cleaned, sun dried, weighed and grain yield was calculated and expressed in kg ha^{-1} [13].

2.6.6 Straw yield

After harvest of the ear head, the whole plants inside the net plot are cut above the ground level. Later it was sun dried for three days and weighed. The straw yield was calculated and expressed in kg ha^{-1} [14].

3. RESULTS

The data on plant height (cm) at different stages of growth are given in Table 3 and the analysis of variance.

At 60 DAT, T_6 (38.17) recorded the highest plant height and there was no significant difference between treatments. The lowest plant height (35.18) was observed in T_8.

At 90 DAT, the plant height was significantly influenced by the treatments, maximum plant height (61.02) was observed in T_6 and it was at par with T_4, T_5, T_7 and T_8 and was significantly superior over T_1, T_2, T_3 and T_8. The lowest plant height (53.43) was observed in T_8 and was at par with T_1, T_3, T_4 and T_7.

At Harvest, also maximum plant height was observed in T_6 (78.34) and it was at par with T_4, T_5, T_7 and T_8 and was significantly superior over T_1, T_2, T_3 and T_7. The lowest plant height (70.55) was observed in T_8 and was at par with T_1, T_3, T_4 and T_5. In general T_6 produced taller plants then other treatments at all times [15].

The data on numbers of tillers at different stages of growth are given in Table 4 and the analysis of variance.

At 60 DAT, T_6 (36.46) recorded the highest numbers of tillers and there was no significant difference between treatments. The lowest numbers of tillers (29.32) was observed in T_8.

At 90 DAT, the numbers of tillers was significantly influenced by the treatments, maximum numbers of tillers (58.98) was observed in T_6 and it was at par with T_4, T_5, T_7 and T_8 and was significantly superior over T_1, T_2, T_3 and T_4. The lowest numbers of tillers (50.32) was observed in T_8 and was at par with T_1, T_3, T_4 and T_5.

Table 3. Effect of integrated nutrient management on plant height (cm) at various growth stages of Finger Millet

Treatments		**Plant height (cm)**		
		60 DAT	**90 DAT**	**At Harvest**
T_1	100% (recommended dose of fertilizer)	36.19	55.32	74.43
T_2	75% of RDF +25% of FYM/ha (2 tonn)	36.03	54.42	70.17
T_3	50% of RDF +50% of FYM/ha(4tonn)	37.12	56.74	76.28
T_4	25% of RDF +75% of FYM/ha (6 tonn)	37.01	56.03	71.32
T_5	75% of RDF+ 25% of vermicompost/ha (0.5 tonn)	37.43	57.98	72.19
T_6	50% of RDF+ 50% of vermicompost/ha (1tonn)	38.17	61.02	78.34
T_7	25% of RDF+ 75% of vermicompost/ha (1.5 tonn)	36.16	58.12	73.38
T_8	Control	35.18	53.43	70.55
SEm±		0.33	0.85	1.01
C.D. (5%)		NS	2.32	2.78

Table 4. Effect of integrated nutrient management on numbers of tillers (m^{-2}) at various growth stages of Finger Millet

Treatments		**Plant height (cm)**		
		60 DAT	**90 DAT**	**At Harvest**
T_1	100% (recommended dose of fertilizer)	34.23	56.25	68.73
T_2	75% of RDF + 25% of FYM/ha (2 tonn)	30.11	52.39	64.38
T_3	50% of RDF + 50% of FYM/ha(4tonn)	35.28	57.63	69.29
T_4	25% of RDF + 75% of FYM/ha (6 tonn)	31.82	53.28	65.34
T_5	75% of RDF + 25% of vermicompost/ha (0.5 tonn)	32.38	54.32	66.18
T_6	50% of RDF + 50% of vermicompost/ha (1tonn)	36.46	58.98	70.87
T_7	25% of RDF + 75% of vermicompost/ha (1.5 tonn)	33.28	55.43	67.22
T_8	Control	29.32	50.32	63.23
SEm ±		0.86	1.00	0.92
C.D. (5%)		NS	2.12	1.89

At Harvest, also maximum numbers of tillers was observed in T_6 (70.87) and it was at par with T_4, T_5, T_7 and T_8 and was significantly superior over T_1, T_2, T_3 and T_7. The lowest numbers of tillers (63.23) was observed in T_8 and was at par with T_1, T_3, T_4 and T_5. In general T_6 produced more numbers of tillers then other treatments at all times [16].

The data on days of first flowering at different stages of growth are given in Table 5 and the analysis of variance.

The highest Days to first flowering was occurred in T_6 (45.55) and there was no significant difference between treatments. The lowest Days to first flowering was occurred in (39.21) was observed in T_8.

The data on Days to 50% flowering at different stages of growth are given in Table 6 and the analysis of variance.

The highest Days to 50% flowering was occurred in T_6 (75.45) and there was no significant difference between treatments. The lowest Days to 50% flowering was occurred in (69.46) was observed in T_8 [17].

The data on total Dry matter production at different stages of growth are given in Table 7 and the analysis of variance.

At 60 DAT, T_6 (41.25) recorded the highest total Dry matter production and there was no significant difference between treatments. The lowest total Dry matter production (32.11) was observed in T_8.

At 90 DAT, the total Dry matter production was significantly influenced by the treatments, maximum total Dry matter production (63.23) was observed in T_6 and it was at par with T_4, T_5, T_7 and T_8 and was significantly superior over T_1, T_2, T_3 and T_5. The lowest total Dry matter production (55.23) was observed in T_8 and was at par with T_1, T_3, T_4 and T_5.

At Harvest, also maximum total Dry matter production was observed in T_6 (81.26) and it was at par with T_4, T_5, T_7 and T_8 and was significantly superior over T_1, T_2, T_3 and T_5. The lowest total Dry matter production (72.32) was observed in T_8 and was at par with T_1, T_3, T_4 and T_5. In general T_6 produced more Dry matter production then other treatments at all times [18].

Table 5. Effect of integrated nutrient management on days to first flowering of finger millet

Treatments		**Days to first flowering**
T_1	100% (recommended dose of fertilizer)	43.22
T_2	75% of RDF + 25% of FYM/ha (2 tonn)	40.21
T_3	50% of RDF + 50% of FYM/ha(4tonn)	44.32
T_4	25% of RDF + 75% of FYM/ha (6 tonn)	41.01
T_5	75% of RDF + 25% of vermicompost/ha (0.5 tonn)	41.52
T_6	50% of RDF + 50% of vermicompost/ha (1tonn)	45.55
T_7	25% of RDF + 75% of vermicompost/ha (1.5 tonn)	42.48
T_8	Control	39.21
S.E. (m±)		0.75
CD (p=0.05)		1.73

Table 6. Effect of integrated nutrient management on Days to 50% flowering of Finger Millet

Treatments		**Days to 50% flowering**
T_1	100% (recommended dose of fertilizer)	73.27
T_2	75% of RDF + 25% of FYM/ha (2 tonn)	70.21
T_3	50% of RDF + 50% of FYM/ha(4tonn)	74.32
T_4	25% of RDF + 75% of FYM/ha (6 tonn)	71.02
T_5	75% of RDF + 25% of vermicompost/ha (0.5 tonn)	71.27
T_6	50% of RDF + 50% of vermicompost/ha (1tonn)	75.45
T_7	25% of RDF + 75% of vermicompost/ha (1.5 tonn)	72.33
T_8	Control	69.46
S.E. (m±)		0.73
CD (p=0.05)		2.12

Table 7. Effect of integrated nutrient management on Total Dry matter production (kg/ha) at various growth stages of Finger Millet

Treatments		Total Dry matter production (kg/ha)		
		60 DAT	90 DAT	At Harvest
T_1	100% (recommended dose of fertilizer)	39.28	61.98	78.39
T_2	75% of RDF +25% of FYM/ha (2 tonn)	34.98	57.47	74.32
T_3	50% of RDF +50% of FYM/ha(4tonn)	40.26	62.87	79.03
T_4	25% of RDF +75% of FYM/ha (6 tonn)	36.52	58.72	75.38
T_5	75% of RDF+ 25% of vermicompost/ha (0.5 tonn)	37.33	59.83	76.63
T_6	50% of RDF+ 50% of vermicompost/ha (1tonn)	41.25	63.23	81.26
T_7	25% of RDF+ 75% of vermicompost/ha (1.5 tonn)	38.22	60.12	77.38
T_8	Control	32.11	55.23	72.32
SEm±		1.05	0.97	0.99
C.D. (5%)		NS	2.12	2.56

3.1 Yield Parameters

The various yield parameters majorly contributing in the treatments can be determined, No. of fingers/head in yield parameters contributing T_6 (12.56) recorded the highest and there was no significant difference between treatments. The lowest (5.43) was observed in T_8.

No. of productive tillers/plant in yield parameters contributing T_6 (120.27) recorded the highest and there was no significant difference between treatments. The lowest (110.43) was observed in T_8.

No. of ear head/plant in yield parameters contributing T_6 (10.27) recorded the highest and there was no significant difference between treatments. The lowest (7.55) was observed in T_8.

The various yield parameters majorly contributing in the treatments can be determined, 1000 grain weight (g) in yield parameters contributing T_6 (3.87) recorded the highest and there was no significant difference between treatments. The lowest (3.16) was observed in T_8.

Grain yield (kg/ha) in yield parameters contributing T_6 (2650) recorded the highest and there was no significant difference between treatments. The lowest (1990) was observed in T_8.

Straw yield (kg/ha) in yield parameters contributing T_6 (5753) recorded the highest and there was no significant difference between treatments. The lowest (5023) was observed in T_8 [19].

Table 8. Effect of integrated nutrient management on Yield Parameters (No. of fingers/head, No. of productive tillers/plant, No. of ear head/plant) of Finger Millet

Treatments		No. of fingers/head	No. of productive tillers/plant	No. of ear head/plant
T_1	100% (recommended dose of fertilizer)	10.42	117.88	8.75
T_2	75% of RDF +25% of FYM/ha (2 tonn)	6.43	112.22	4.19
T_3	50% of RDF +50% of FYM/ha (4tonn)	11.21	118.28	9.23
T_4	25% of RDF +75% of FYM/ha (6 tonn)	7.62	113.27	5.53
T_5	75% of RDF+ 25% of vermicompost/ha (0.5 tonn)	8.27	115.12	6.21
T_6	50% of RDF+ 50% of vermicompost/ha (1tonn)	12.56	120.27	10.27
T_7	25% of RDF+ 75% of vermicompost/ha (1.5 tonn)	9.33	116.23	7.55
T_8	Control	5.43	110.43	2.77
SEm±		0.85	1.18	0.92
C.D. (5%)		NS	3.23	1.58

Table 9. Effect of integrated nutrient management on Yield Parameters (100 grain weight (g), Grain yield (kg/ha), Straw yield (kg/ha)) of Finger Millet

Treatments		1000 grain weight (g)	Grain yield (kg/ha)	Straw yield (kg/ha)
T_1	100% (recommended dose of fertilizer)	3.64	2478	5532
T_2	75% of RDF +25% of FYM/ha (2 tonn)	3.28	2037	5122
T_3	50% of RDF +50% of FYM/ha(4tonn)	3.75	2543	5635
T_4	25% of RDF +75% of FYM/ha (6 tonn)	3.31	2127	5213
T_5	75% of RDF+ 25% of vermicompost/ha (0.5 tonn)	3.44	2283	5321
T_6	50% of RDF+ 50% of vermicompost/ha (1tonn)	3.87	2650	5753
T_7	25% of RDF+ 75% of vermicompost/ha (1.5 tonn)	3.52	2387	5483
T_8	Control	3.16	1990	5023
SEm±		0.08	86.10	90.93
CD (p=0.05)		NS	112.32	125.27

4. DISCUSSION

4.1 Growth Parameter

4.1.1 Plant height

Previous studies suggest that Plant height, number of tillers/m2, dry matter production and LAI increased with the age of plant. Vegetative growth parameters were recorded maximum at 125% seed rate with 50% N through FYM + 50% N through vermicompost being at par with 25% N through FYM + 75% N through vermicompost and 75% N through FYM + 25% N through vermicompost. Use of FYM alone resulted lower values than combination of FYM and vermicompost.

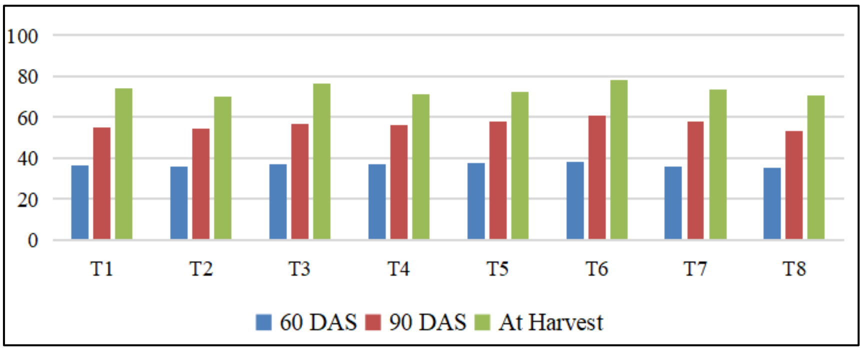

Fig. 1. Effect of integrated nutrient management on plant height (cm) at various growth stages of finger millet

4.2 Physiological Parameter

4.2.1 Leaf area Index

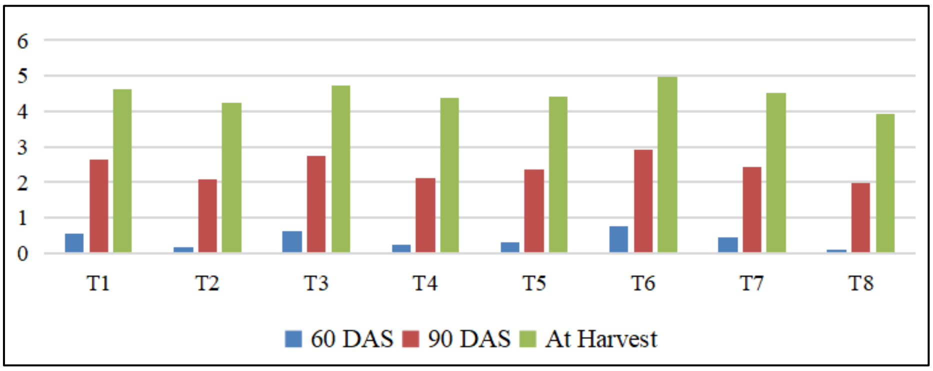

Fig. 2. Effect of integrated nutrient management on leaf area index (LAI) at various growth stages of finger millet

4.3 Crop Growth Rate

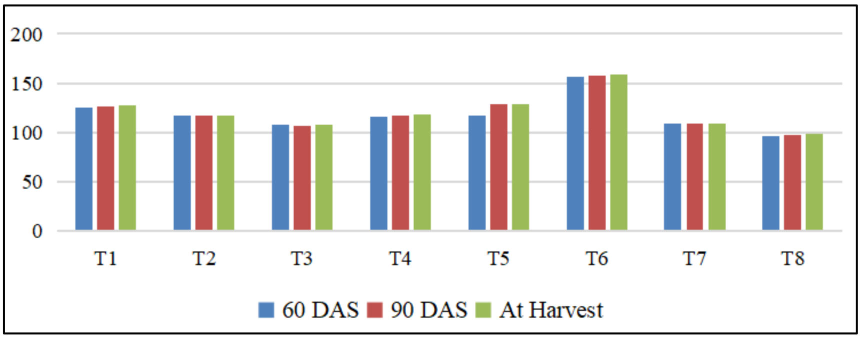

Fig. 3. Effect of integrated nutrient management on crop growth rate (gm m-1) of finger millet

4.4 Relative Growth Rate

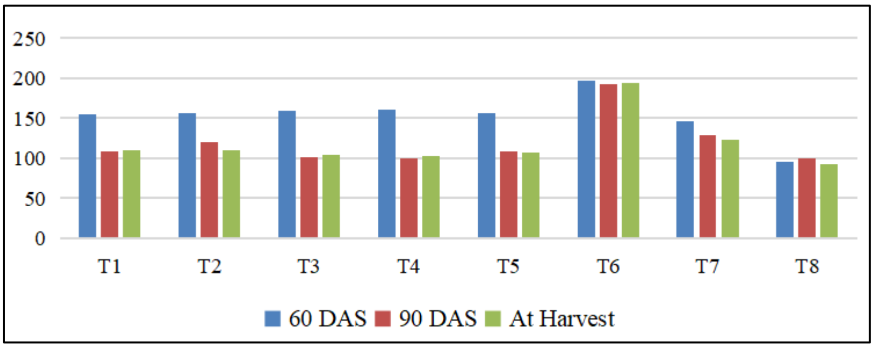

Fig. 4. Effect of integrated nutrient management on relative growth rate (g g day) of finger millet

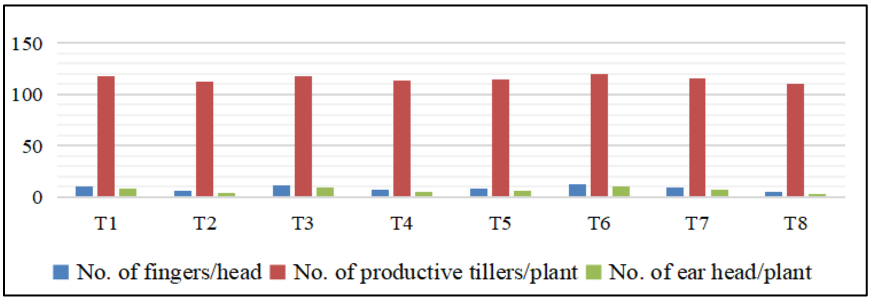

Fig. 5. Effect of integrated nutrient management on yield parameters (no. of fingers/ head, no. of productive tillers/ plant, no. of ear head/ plant) of finger millet

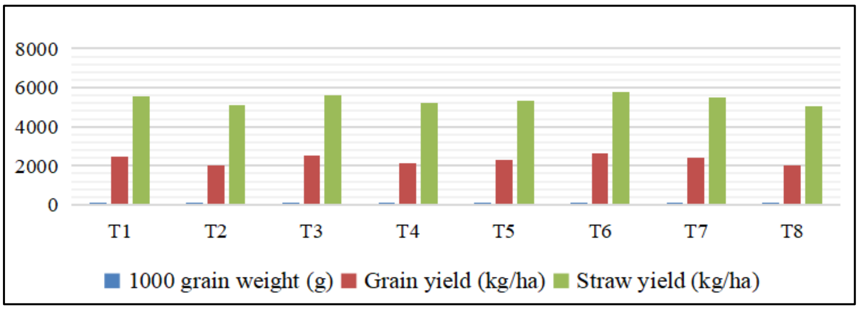

Fig. 6. Effect of integrated nutrient management on yield parameters (100 grain weight (g), grain yield (kg/ha)), straw yield (kg/ha) of finger millet

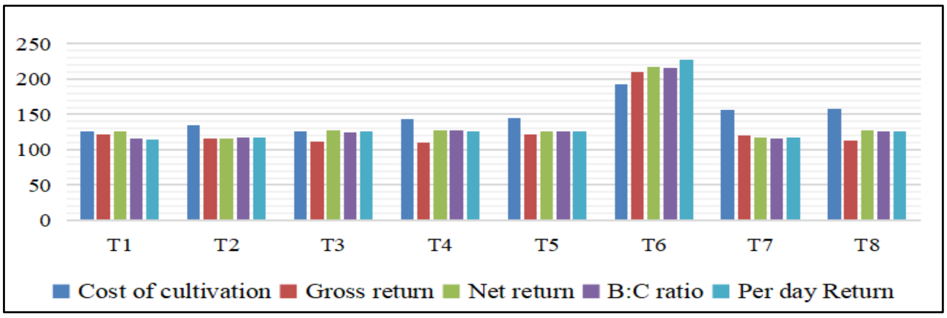

Fig. 7. Effect of integrated nutrient management on economic analysis of finger millet

4.5 Yield Parameters

"Integrating organic nutrient sources with inorganics was observed to enhance the productive tiller count and finger length of finger millet in the clay loam soils of Coimbatore" (Jagathjothi et al., 2008). Adesemoye et al. (2008) reported that "plant growth promoting rhizobacteria (PGPR) promoted plant growth, yield and nitrogen content in grain". The field experiment undertaken by Govindappa *et.al.,* (2009) "red sandy loam soils of Bengaluru, registered superior grain and straw yields for rainfed finger millet when nutrients were applied totally as inorganic in conjunction with recommended dose of FYM (7.5 t ha-1)". "Yield parameters of finger millet were observed to improve significantly in response to application of 75 per cent RDF along with FYM (5 t ha-1) and s" (Ahiwale et al., 2011).

4.6 Economic Analysis

"Substituting 50 percent of the recommended dose of fertilizers with organic sources on N equivalent basis resulted in the highest net returns and BCR (2.39) in finger millet" (Dass et.al., 2013). The study carried out by Thimmaiah et al., (2016) "on the effect of INM on finger millet revealed that gross returns, net returns and benefit cost ratio (BCR) varied significantly with diverse sources of nutrients like inorganic fertilizers, organic manures".

5. CONCLUSION

Among the nutrient management practices 50% of recommended dose of fertilizer with 50% of vermicompost was best in yield and yield attributing parameter. As per the uptake of nutrients and economic point of view, the application of 50% RDF with 50% vermicompost was superior as compare to all treatments. The present study concluding that 50 % NPK through inorganic and 50 % through vermicompost may be suggest to take good yield, economical and good soil health advantages of finger millet crop under rainfed condition.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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