Research Article

Yield and Economics of Finger Millet as Influenced by Crop Residue Composting

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Abstract

A field experiment was conducted during *rabi*, 2018-19 at Student Farm, College of Agriculture. Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad. The experimental soil was sandy clay loam texture with pH 7.46, EC0.36 dS m^{-1} and OC (0.67 %). The soil was low in available nitrogen (260.0 kg ha^{-1}), medium in available phosphorus (45.1 kg ha^{-1}) and high in available potassium (521.0 kg ha^{-1}). The experiment was laid out in a randomized block design with eight treatments and replicated thrice.The results revealed that, conjunctive use of inorganics and organics through crop residue composting significantly influenced the yield and economics of finger millet. Application of 75% RDN (recommended dose of nitrogen) + 25% N through cotton stubbles vermicompost + 2% rockphosphate recorded significantly higher grain (3540 kg ha^{-1}) and straw yield (5899 kg ha^{-1}) and it was on par with 75% RDN (recommended dose of nitrogen) + 25% N through cotton stubbles vermicompost (3402 kg ha^{-1} and 5753 kg ha^{-1} respectively), 75% RDN (recommended dose of nitrogen) + 25% N through redgram stubbles vermicompost + 2% rockphosphate (3231 kg ha^{-1} and 5595 kg ha^{-1} respectively) and 75% RDN (recommended dose of nitrogen) + 25% N through redgram stubbles vermicompost (3114 kg ha^{-1} and 5542 kg ha^{-1} respectively). While the lowest grain (1453 kg ha^{-1}) and straw yield (3737 kg ha^{-1}) were recorded with control plot with no nitrogen application. Similarly highest gross returns (₹ 72931ha^{-1}), net returns (₹ 49772 ha^{-1}) and B: C ratio (3.15) were accrued from T_7- 75% RDN +25% N through cotton stubbles vermicompost + 2% rock phosphate and it was on par with T_5- 75% RDN +25% N through cotton stubbles vermicompost.

Keywords: Finger millet, integrated nutrient management, crop residue composting, redgram and cotton stubbles vermicompost, FYM, vermicompost. yield and economics of finger millet.

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Introduction

Finger millet (*Eleusine coracana* L. Gaertn.) commonly known as "nutritious millet" is the fourth important small millet crop grown globally after sorghum, pearl millet and foxtail millet.It has the pride of place among millets due to highest productivity and is nutritionally superior to many cereals in terms of proteins, minerals, iron, calcium (8-10 times more calcium than wheat or rice) and vitamins.

Grain has unique character of slow digestibility and slow releasing pattern of sugar into blood stream, thus recommended for diabetic patients Karuppaswamy, 2015 [1]. Ragi is low in phytic acid and rich in dietary fibre. As the millets are commonly consumed by the poor, they guard them against food and nutritional deficiency imposed due to various agronomic and socio - economic and political factors. Millets can thus, act as a shield against nutritional deficiency disorders and provide nutritional security. Therefore, millets could be one of the better options for overcoming problem of malnutrition in India in the present context of climate change owing to their drought hardiness, shorter duration and tolerance to high temperatures.

In Telangana state, cotton, red gram and castor are the major *kharif* crops cultivated under rainfed situations. The stubbles of these crops are generally very strong and pose serious problem for removal and hence, burnt for ease and to facilitate towards timely land preparation for the *rabi* crops. Burning of crop residues/stubbles leads to loss of nutrients and organic matter apart from damaging microflora present in the topsoil. Crop residues form the alternate potent organic source for nutrient substitution through composting and it reduces the pollution generated through burning them.

Keeping, the above points in view the present experiment was carried out to evaluate the effect of compost prepared from cotton and redgram stubbles in combination with inorganic fertilizers on yield and economics of finger millet.

Material and Methods

A field experiment was conducted during *rabi*, 2018-19 at Student Farm, College of Agriculture, Rajendranagar, Professor Jayashankar Telangana State Agricultural University, Hyderabad under irrigated conditions. The farm is located at 17 18'49" North *latitude* and 78 24'42" East Longitude. The soil of the experimental site was sandy clay loam with soil pH (7.46), EC (0.36dS m^{-1}) and OC (0.67 %). The soil was low in available nitrogen (260.0 kg ha^{-1}), medium in available phosphorus (45.1 kg ha^{-1}) and high in available potassium (521.0 kg ha^{-1}). This experiment was laid out in a randomized block design with eight treatments and replicated thrice. The size of gross and net plots were 4.5 m x 4.0 m and 3.3 m x 3.6 m respectively. There were eight treatments comprised of T_1- 100% RDF (60:30:30 - N: P_2O_5: K_2O kg ha^{-1}), T_2- control without nitrogen T_3- 75% RDN + 25% N through FYM, T_4-75% RDN + 25% N through redgram stubbles vermicompost, T_5- 75% RDN + 25% N through cotton stubbles vermicompost, T_6- 75% RDN + 25% N through redgram stubbles vermicompost + 2% rockphosphate, T_7 - 75% RDN +25% N through cotton stubbles vermicompost + 2% rockphosphate, T_8- 75% RDN +25% N through farmers practice vermicompost.The process of vermicompost preparation from cotton and redgram stubbles preparation is depicted in (Plate 1 to 9.).

Ragi variety GPU-28 variety was sown directly on 29th September, 2018 adopting a spacing 30 cm x 10 cm. The RDF for finger millet was 60:30:30 NP and K kg ha^{-1} (Plate 10 to 12). Entire P (SSP) and K (MOP) fertilizer were applied as basal and N (Urea) was applied in two equal splits, 50% as basal and remaining 50% at 30 DAS. In integrated nutrient management treatments (T_3, T_4, T_5, T_6, T_7 & T_8), 25 per cent nitrogen was applied through organic manures as basal and remaining as that of recommended dose of fertilizers (100 % RDF).

The organics were applied as per the treatments (**Table 1**) and incorporated before sowing of the crop. Sowing was done adopting spacing of 30 × 10 cm. A total rainfall of 96.8 mm was received in 7 rainy days during *rabi*, 2018-19. Pre emergence herbicide Pendimethalin (30 % EC) @ 1.0 kg a.i. ha^{-1} was sprayed one day after sowing in optimum soil moisture to prevent the growth of weeds. Two hand weeding's were done at 20 and 40 DAS. as a common practice in all the treatments. The insecticide acephate @ 1.5 g $litre^{-1}$ of water was sprayed at 50 DAS to control stemborer incidence. On an average a total of six irrigations were given during crop growth period. The crop was harvested at physiological maturity when all the earheads turned to brown and seeds were easily detachable. The border rows from each plot were harvested first by leaving the net plot area. Later the earheads from each net plot area was harvested after separating those representative hills for recording biometrical observations.The crop was harvested on 30th January, 2019. Bio-metric observations on the morpho-physiological parameters were taken on tagged five representative plants selected at random from each treatment of net plot and the mean values are presented.

Table 1 Details of the nutrient content and amount of material added in nutrient management treatments

S. No.	Organic source	Nutrient content (%)			Quantity of organics added (t ha^{-1})
		N (%)	P (%)	K (%)	
1.	Vermicompost prepared from redgram stubbles	2.20	2.15	0.98	0.68
2.	Vermicompost prepared from redgram stubbles+2% rockphosphate	2.35	2.60	1.08	0.63
3.	Vermicompost prepared from cotton stubbles	2.0	1.08	0.99	0.75
4.	Vermicompost prepared from cotton stubbles+2% rockphosphate	2.10	1.32	0.98	0.71
5.	Farmers practice of vermicompost	1.68	0.44	0.40	0.88
6.	FYM	0.50	0.22	0.41	3.0

Results and Discussion

Yield attributes

The yield attributes *viz*., of number of panicles $hill^{-1}$, number of fingers ear $head^{-1}$, ear head length (cm), number of seeds ear $head^{-1}$, 1000- seed weight, grain yield, straw yield and harvest index differed significantly due to nutrient management practices through crop residue composting. Higher number of panicles m^{-2} (158), fingers ear $head^{-1}$ (8.5), ear head length (9.1 cm), number of grains $panicle^{-1}$ (854), weight of ear head (11.7 g), and test weight (3.29 g) was recorded with T_7-75% RDN +25% N through cotton stubbles vermicompost + 2% rockphosphate over farmers practice, inorganics alone and control plot. The treatment T_7 was comparable with T_5, T_6 and T_4 that consisted of 75 % N through RDN and remaining 25 % N substitution of N through cotton stubbles vermicompost,redgram stubbles vermicompost + 2% rockphosphate and redgram stubbles vermicompost respectively (**Table 2**). Improved yields attributes in treatments consisting of 25% N substitute through organics might be due to prolonged and adequate supply of nutrients coinciding with the critical crop growth stages in comparision to 100 % N through inorganics alone and control plots Ananda *et al*. 2017 [2] and Basavaraj Naik *et al*. 2017 [3].

Table 2 Yield attributes of finger millet as influenced by crop residue composting

Treatments	Panicles m^{-2}	No. of fingers ear head^{-1}	Ear head length (cm)	No. of grains panicle^{-1}	Weight of ear head (g)	Test weight (g)
T_1- 100% RDF	138	7.3	8.4	782	9.5	2.90
T_2- control without nitrogen	103	6.2	7.3	621	7.4	2.45
T_3- 75% RDN + 25% N through FYM	140	7.8	8.5	792	9.6	3.13
T_4- 75% RDN + 25% N through redgram stubbles vermicompost	149	8.1	8.7	822	10.6	3.15
T_5- 75% RDN + 25% N through cotton stubbles vermicompost	154	8.4	9.0	842	11.1	3.22
T_6-75% RDN + 25% N through redgram stubbles vermicompost + 2% rockphosphate	151	8.2	8.7	830	10.6	3.16
T_7- 75% RDN + 25% N through cotton stubbles vermicompost + 2% rockphosphate	158	8.5	9.1	854	11.7	3.29
T_8- 75% RDN + 25% N through farmers practice vermicompost	144	7.8	8.6	795	9.8	3.04
S.Em ±	3.0	0.2	0.3	21.4	0.4	0.10
CD (P=0.05)	9.0	0.5	1.1	55.6	1.0	0.30

*RDF: 60:30:30 - N: P2O5: K2O kg ha^{-1}

Yield and harvest index

The treatment T_7- 75% RDN +25% N through cotton stubbles vermicompost + 2% rockphosphate maintained its superiority and registered significantly higher grain, straw yield and harvest index (3540, 5899 kg ha^{-1} and 37.5% respectively) over farmers practice (2917, 5252 kg ha^{-1} and 35.6%), inorganics alone (2551, 4868 kg ha^{-1} and 34.5 %) and control plot (1453, 3737 kg ha^{-1} and 27.9 %) respectively (**Table 3**).

However, T_7 treatment was on par with T_5- 75% RDN +25% N through cotton stubbles vermicompost, T_6- 75% RDN +25% N through redgram stubbles vermicompost + 2% rockphosphate and T_5- 75% RDN +25% N through redgram stubbles vermicompost. Improved yield in the treatments consisting of conjunctive application of inorganics + 25% N through organics was probably due to reduced loss of nutrients coupled with the slow and steady release of nutrients throughout the growing period of crop coupled with reduced nutrient losses through volatilization and leaching that are common with application of inorganics alone.

Further, improved nutrient availability led to better translocation of photosynthates from source to sink and reflected in improved yield attributes over farmers practice, inorganics alone and control plots with no N application Narayan Hebbal *et al*. 2018 [4] and Prakasha *et al*. 2018 [5] The crop performance to different treatments in terms of growth, yield attributes and yield is depicted in plates 13 to 21.

Table 3 Grain, straw yield (kg ha^{-1}) and harvest index (%) of finger millet as influenced by crop residue composting

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index (%)
T_1- 100% RDF	2551	4868	34.5
T_2- control without nitrogen	1453	3737	27.9
T_3- 75% RDN + 25% N through FYM	2895	5254	35.5
T_4- 75% RDN + 25% N through redgram stubbles vermicompost	3114	5542	36.1
T_5- 75% RDN + 25% N through cotton stubbles vermicompost	3402	5753	37.2
T_6-75% RDN + 25% N through redgram stubbles vermicompost + 2% rockphosphate	3231	5595	36.6
T_7- 75% RDN + 25% N through cotton stubbles vermicompost + 2% rockphosphate	3540	5899	37.5
T_8- 75% RDN + 25% N through farmers practice vermicompost	2917	5252	35.6
S.Em ±	201	312	1.2
CD (P=0.05)	522	811	3.1

*RDF: 60:30:30 - N: P_2O_5: K_2O kg ha^{-1}

Addition of rockphosphate to stubbles showed more rapid decrease in C: N ratio than that of untreated compost. It was due to the fact that addition of rockphosphate during vermicomposting has a positive effect in degradation of crop stubbles. The addition of rockphosphate to stubbles at the time of composting had further increased the total nitrogen content. This was done by reduction in loss of nitrogen through the immobilisation of nitrogen or formation of nitrogen complexes with the inorganic constituents of the rock phosphate Satisha and Devarajan, 2006 [6] and Rama Lakshmi *et al*. 2013 [7]. Reduction in C: N ratio of vermicompost was due to respiratory activity of earthworms and microorganisms and increase in nitrogen was due to the mineralization of organic matter and excretion of nitrogenous wastes.

Improved yield attributes and yield under T_7 treatment was due to the fact that cotton substrate used in present study is known to hold more moisture that allows quick microbial activity leading to better decomposition and higher recovery of compost from stubbles as compared to redgram Giraddi, 2008 [8].

Economics

Cost of cultivation (C ha^{-1})

From the data, it is evident that the cost of cultivation gradually increased in various nutrient management treatments in comparision to the control (No N application) treatment (C 18320 **ha^{-1})** owing to the additional cost incurred on the nitrogen (**Table 4**). The cost of cultivation in treatments consisting of 25 % N substitution with organics was higher over inorganics (C 19759 **ha^{-1})** alone due to relatively higher cost of FYM and amount spent on vermicompost preparation from the crop residues (cotton and redgram) and that incurred on rockphosphate. Among the treatments the cost of cultivation was highest with T_8 -75% RDN + 25% N through farmers practice vermicompost (24250 **Cha^{-1}**) due to higher cost incurred on FYM.

Table 4 Economics of finger millet as influenced by crop residue composting

Treatments	Cost of cultivation (C ha^{-1})	Gross returns (C ha^{-1})	Net returns (C ha^{-1})	B: C ratio
T1- 100% RDF	19759	52557	32798	2.66
T_2- control without nitrogen	18320	29939	11619	1.63
T_3- 75% RDN + 25% N through FYM	23184	59630	35446	2.57
T_4- 75% RDN + 25% N through redgram stubbles vermicompost	22989	64148	41159	2.79
T_5- 75% RDN + 25% N through cotton stubbles vermicompost	23334	70088	46754	3.00
T_6-75% RDN + 25% N through redgram stubbles vermicompost + 2% rockphosphate	22774	66552	43778	2.92
T_7- 75% RDN + 25% N through cotton stubbles vermicompost + 2% rockphosphate	23159	72931	49772	3.15
T_8- 75% RDN + 25% N through farmer's practice vermicompost	24250	60097	35847	2.48
S.Em.±	-	4149	6534	0.17
CD (P=0.05)	-	8879	13982	0.43

*Price of finger millet: (C 20.6 kg^{-1} grain) MRP of finger millet in 2019 – C 2060 q^{-1}

Gross returns (C ha^{-1})

Highest gross returns were accrued with T_7 - 75% RDN + 25% nitrogen through cotton stubbles vermicompost + 2% rockphosphate (C 72,931 ha^{-1}) and it was found on par with T_5 - 75% RDN + 25% nitrogen through cotton stubbles vermicompost (C 70,088 ha^{-1}), T_6 - 75% RDN + 25% nitrogen through redgram stubbles vermicompost + 2% rockphosphate (C 66,552 ha^{-1}) and T_4 - 75% RDN + 25% nitrogen through redgram stubbles vermicompost (C 64,148 ha^{-1}). While, the lowest gross returns were realized from the treatment T_2 –Control with no nitrogen application (C 29,939 ha^{-1}) (Table 4).

Higher gross returns with conjunctive application of nutrients was due to the improved yield attributes and yield over farmers practice, inorganics alone and control. Narayan Hebbal *et al*. 2018 [4] and Prakasha *et a*l. 2017 [6] also registered higher gross returns with conjunctive application of organic and inorganic nutrients over inorganics and control.

Net returns (C ha^{-1})

Among the different treatments, T_7 - 75% RDN + 25% nitrogen through cotton stubbles vermicompost + 2% rockphosphate recorded highest net returns (C 49,772 ha^{-1}) and was found on par with T_5 - 75% RDN + 25% nitrogen through cotton stubbles vermicompost (C 46,754ha^{-1}), T_6 - 75% RDN + 25% nitrogen through redgram stubbles vermicompost + 2% rockphosphate (C 43,778 ha^{-1}), T_4 - 75% RDN + 25% nitrogen through redgram stubbles vermicompost (C 41,159 ha^{-1}) and T_8 - 75% RDN + 25% nitrogen through farmers practice vermicompost (C 35,847 ha^{-1}) followed by T_3 with 75% RDN + 25% nitrogen through FYM (C 35,446 ha^{-1}) and 100% RDF (C 32,798 ha^{-1}). While, the lowest net returns were recorded from the treatment T_2 (control) with no nitrogen application (C 11,619 ha^{-1}). Higher net returns in treatments with 25 % N substitution of organics was due to the higher gross returns over farmers practice, 100 % inorganics and control plots. The results are in conformity with Pallavi *et al*. 2014 [9] and Malla Reddy *et al*. 2016 [10].

B: C ratio

The results indicated that highest B: C ratio was realized withT_7 - 75% RDN + 25% nitrogen through cotton stubbles vermicompost + 2% rockphosphate (3.15) and was found on par with T_5 - 75% RDN + 25% nitrogen through cotton stubbles vermicompost (3.0), T_6 - 75% RDN + 25% nitrogen through redgram stubbles vermicompost + 2% rockphosphate (2.92) and T_4 - 75% RDN + 25% nitrogen through redgram stubbles vermicompost (2.79) followed by 100% RDF (2.66), T_3 - 75% RDN + 25% nitrogen through FYM (2.57) and T_8 - 75% RDN + 25% nitrogen through farmers practice vermicompost (2.48). While, the lowest B: C ratio was recorded with T_2 - control with no nitrogen application (1.63). Higher B:C ratio in conjuctive application of nutrients was due to higher gross returns over rest of the treatments. These findings are in line with those earlier reported by Basvaraj Naik *et al*. 2017 [3] and Prakasha *et a*l. 2017 [11].

Conclusions

From the present study it could be concluded that on red soils of Southern Telanagana region, application of 75% RDN +25% N through cotton stubbles vermicompost + 2% rockphosphate to finger millet results in improved yield attributes, grain, straw yield coupled with higher monetary returns.

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APPENDIX

Plate 1 Collection of cotton and redgram stubbles for vermicompost

Plate 2 Chopping of redgram and cotton stubbles by chaff cutter

Plate 3 Vermicomposting of cotton stubbles by pit method

Plate 4 Vermicomposting of redgram stubbles by pit method

Plate 5 An overview of earthworms in cotton stubbles pit

Plate 6 An overview of earthworms in redgram stubbles pit

Plate 7 Transformation of stubbles to vermicompost

Plate 8 Harvesting and shade drying of vermicompost.

Plate 9 Sieving and packing of vermicompost

Plate 10 An overview of layout of the field

Plate 11 Application of organic manures (treatment imposition)

Plate 12 Sowing operation in the field

Plate 13 An overview of the crop at 30 DAS

Plate 14 An overview of the crop at active tillering stage

Plate 15 An overview of the crop at flowering stage

Plate 16 An overview of the crop at grain filling stage

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Plate 17 An overview of the crop at harvesting stage

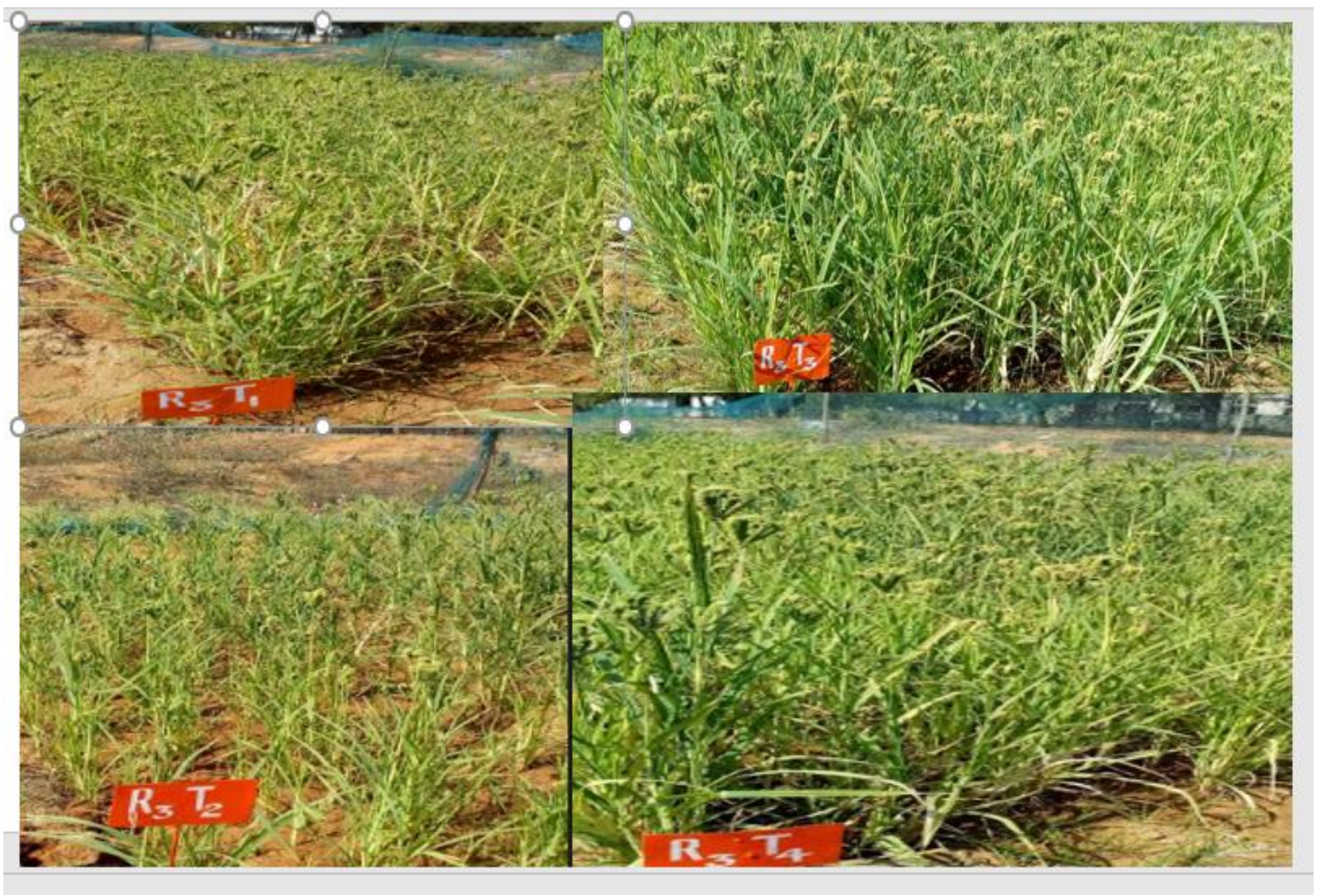

Plate 18 Grain filling stage in T_1, T_2, T_3 and T_4 treatments

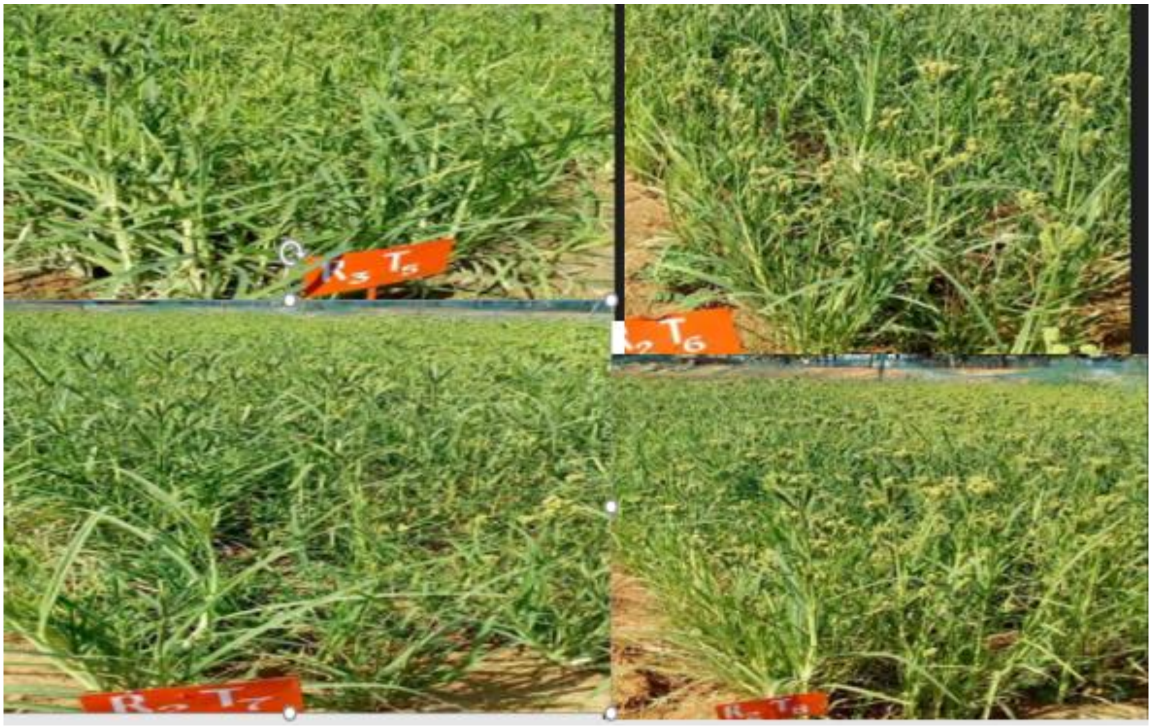

Plate 19 Grain filling stage in T_5, T_6, T_7 and T_8 treatments

Plate 20 Harvesting and threshing of finger millet

Plate 21 Field inspections by Associate Dean, HOD, Chairperson and other members of the advisory committee