Effect of organic fertilizers and biofertilizers on yield and yield attributing traits of direct sown rainfed finger millet, *Eleusine coracana* (L) Gaertn

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ABSTRACT

Finger millet was grown under three year old *Melia azedarach* in red sandy loam soil with different management options viz T_1 [Control, farmyard manure (FYM) @ 10 tonnes/ha], T_2 [100% recommended dose of fertilizers (RDF)], T_3 (75% N + 25% N FYM), T_4 [75% recommended dose of nitrogen (RDN) + 25% N vermicompost], T_5 (75% RDN + 25% N poultry manure), T_6 (75% RDN + *Azospirillum*), T_7 [75% RDN + phosphate solubilizing bacteria (PSB)], T_8 (75% RDN + *Azospirillum* + PSB), T_9 (Sole crop without trees). The growth attributes viz plant height, dry matter production and number of tillers/m^2 were significantly influenced by the application of T_5 (75% RDN + 25% N poultry manure) and was on par with application of recommended dose of NPK fertilizers. Significant increase in yield components viz number of fingers per ear head, finger length and 1000-grain weight was noticed in T_5. The highest grain (2681 kg/ha) and straw yield (5063 kg/ha) resulted with sole crop on par with T_5 (2405 and 4733 kg/ha respectively) and T_2 (2393 and 4745 kg/ha respectively). The lowest grain (1583 kg/ha) and straw yield (3402 kg/ha) was found in T_1 (control) ie farmers' practice. From the present investigations it can be inferred that among nutrient management practices tested 75 per cent RDN + 25 per cent N poultry manure and 100 per cent RDF in agri-silvi culture system were better for realizing higher grain yield, straw yield and economic returns apart from sustaining better soil nutrient status on sandy loam soils of southern Telangana region.

Keywords: Organic fertilizers; yield; rainfed; finger millet; biofertilizers

INTRODUCTION

Ragi or Mandua commonly known as finger millet, *Eleusine coracana* (L) Gaertn is an important small millet crop grown in India. It is a staple food crop in many hilly regions of the country. The crop is well adapted to very poor and marginal lands where other Kharif crops cannot be grown successfully. Finger millet occupies 12 per cent of global millet area and is cultivated in more than 25 countries in Africa and Asia. On global basis it is cultivated over an area of about 3.0 Mha with a production of 3.8 MT and productivity of 1.3 q/ha. India alone contributes more than 50 per cent to the world's production. Finger millet constitutes an area of 1.27 Mha with average annual production of 1.89 MT and productivity of 1490 kg/ha (Anon 2011).

To get higher yield of finger millet new high yielding fertilizer responsive varieties should be adopted with proper nutrient management practices. The secret of boosting its yield mainly lies in timely transplanting and properly fertilizing the crop. It is advisable to optimize the use of inorganic fertilizers along with the organic manures such as farmyard manure (FYM), poultry manure and vermicompost for getting the higher yields of better quality and keeping the cost of production at sustainable level. Hence the present studies were undertaken to optimize the FYM, poultry manure and

vermicompost requirement of rainfed direct sown finger millet in conjunction with biofertilizers. As the organic farming practices were planned to suit the farmers the studies were done to see the effect of organic sources on growth and yield of direct sown rainfed finger millet.

MATERIAL and METHODS

Experimental site: Field experiment was conducted with finger millet variety PRS-2 at agroforestry research block, Acharya NG Ranga Agricultural University campus, Rajendranagar, Hyderabad during Kharif 2013. The weekly mean maximum temperature during the crop growth period ranged from 27.8 to 33.5°C with an average of 30.5°C while the weekly mean minimum temperature ranged from 17.7 to 25.0°C with an average of 21.6°C. The total rainfall received during the crop growth period was 437.1 mm distributed over 30 rainy days. The experimental soil was alfisol having sandy loam texture with pH 7.57, electrical conductivity 0.195 dS/m and organic carbon 0.75 per cent. It was medium in available nitrogen (259.2 kg/ha) and phosphorus (40.85 kg/ha) and high in available potassium (352.1 kg/ha).

The experiment was laid out in a randomized block design and replicated thrice with 9 treatments comprising T_1 [Control, farmyard manure (FYM) @ 10 tonnes/ha], T_2 [100% recommended dose of fertilizers (RDF)], T_3 (75% N + 25% N FYM), T_4 [75% recommended dose of nitrogen (RDN) + 25% N vermicompost], T_5 (75% RDN + 25% N poultry manure), T_6 (75% RDN + *Azospirillum*), T_7 [75% RDN + phosphate solubilizing bacteria (PSB)], T_8 (75% RDN + *Azospirillum* + PSB), T_9 (Sole crop without trees). The recommended package of practices was used for raising the crop.

Biometric and yield observations: Five plants in each plot were selected at random and tagged. These plants were used for recording biometric observations at different stages of crop growth. The harvested produce from each net plot was threshed, sun-dried, winnowed separately and the finger millet grain yield was recorded at 14 per cent moisture content (Watson 1947). Plant height was measured with a wooden scale from the base of the plant to the tip of growing point at harvest from ten earmarked plants. The data were analyzed statistically as per Panse and Sukhatme (1978).

RESULTS and DISCUSSION

Data given in Table 1 (Fig 1) show that mean plant height was 29.0, 79.6 and 88.7 cm after 30 and 60 days after sowing (DAS) and at harvest respectively. After 30 DAS the maximum plant height (33.9 cm) was recorded in T_9 (sole crop without trees) which was at par with T_2 (100% RDF) and T_5 (75% RD N + 25% N poultry manure) with plant height of 30.7 and 30.4 cm respectively as compared to 24.8 cm in T_1 (FYM @ 10 tonnes/ha) ie control. This trend continued after 60 DAS till harvest. However the plant height increased at faster rate from 30 to 60 DAS but after that there was a fall in rate of increase.

The increased availability of nutrients in the soil through mineralization of organic sources could have triggered cell elongation and multiplication resulting in high growth rate of shoots and in turn plant height of finger millet over control. Combination of organics and inorganics which ensured ready availability of nutrients at initial stages of crop might be due to improved soil properties and long term nutrient availability through organics. Similar results were obtained by Narolia et al (2009) and Giribabu et al (2010).

Mean dry matter production of 1285, 2418, 4235 and 5549 kg/ha was recorded after 30, 45, 60 and 75 DAS respectively (Table 1, Fig 2). After 30 DAS the treatments T_9 (sole crop without trees) and T_4 (75% RD N + 25% N vermicompost) resulted in dry matter content of 1667 kg/ha each as compared to 3740 kg/ha in T_1 (FYM @ 10 tonnes/ha) ie control. After 75 DAS T_9 (Sole crop without trees), T_5 (75% RD N + 25% N poultry manure), T_4 (75% RD N + 25% N vermicompost) and T_8 (75% RD N + *Azospirillum* + PSB) resulted in dry matter content of 6285, 5993, 5736 and 5573 kg/ha respectively as compared to 4747 kg/ha in control (T_1).

The photosynthetic activity of the plants is well reflected in their dry matter production. Significant increase in plant dry matter production at different stages of growth was due to increase in nitrogen levels which may be due to the effect of nitrogen in increasing the amount and efficiency of chlorophyll that influenced the photosynthetic efficiency and formation of the other nitrogen compounds like amino acids, proteins and protoplasm resulting in increase in plant height, number of tillers and number of ears. As the soil was medium in available nitrogen the crop responded well to applied nitrogen leading to more dry matter production. The

Table 1. Plant height and dry matter production of finger millet as influenced by nutrient management in *Melia azedarach*-based agri-silvi system

Treatment	Plant height (cm) at			Dry matter production (kg/ha) at			
	30 DAS	60 DAS	Harvest	30 DAS	45 DAS	60 DAS	75 DAS
T_1 (FYM @ 10 tonnes/ha)	24.8	63.3	78.6	1069	1813	3740	4747
T_2 (100% RDF)	30.7	83.7	91.3	1380	2768	4667	5020
T_3 (75% N + 25% N FYM)	26.9	74.0	84.0	1127	2100	3811	5111
T_4 (75% RDN + 25% N vermicompost)	29.5	82.1	90.4	1667	2425	4220	5736
T_5 (75% RDN + 25% N poultry manure)	30.4	83.3	91.1	1413	2807	4640	5993
T_6 (75% RDN + *Azospirillum*)	28.1	81.9	89.7	1200	2313	3982	5287
T_7 (75% RDN + PSB)	27.5	79.2	87.6	1173	2220	3873	5187
T_8 (75% RDN + *Azospirillum* + PSB)	29.1	82.8	90.8	1247	2387	4189	5573
T_9 (Sole crop without trees)	33.9	86.3	94.8	1667	2933	4993	6285
Mean	29.0	79.6	88.7	1285	2418	4235	5549
SEm±	1.26	1.32	1.24	72	160	260	242
$CD_{0.05}$	3.82	3.98	3.74	218	486	787	731

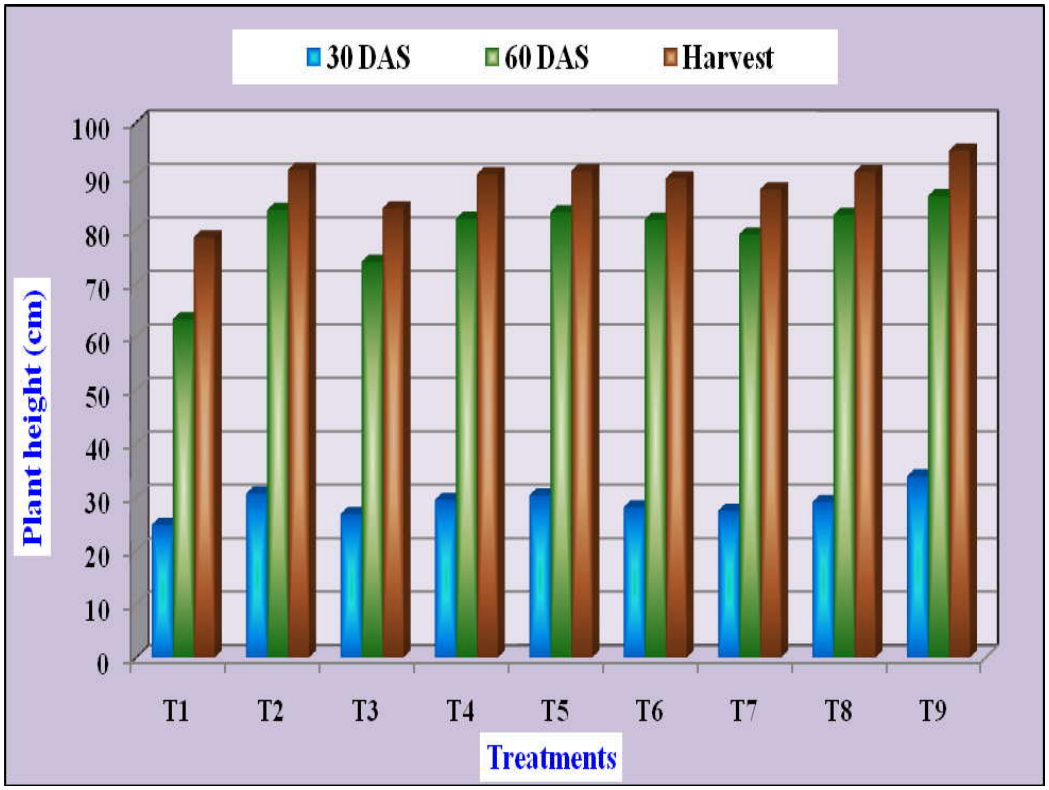

Fig 1. Plant height of finger millet as influenced by nutrient management in *Melia azedarach*-based agri-silvi system

results are in accordance with the findings of Kumar et al (2004). The improved physico-chemical properties and availability of nutrients at slow rate for longer time with the use of organics might be responsible for more number of tillers, maximum leaf area and increased photosynthesis leading to accumulation of significantly higher dry matter. The results are in agreement with the findings of Giribabu (2006) and Prasad et al (2010).

Maximum productive tillers (185.4/ m^2) were recorded in T_9 (sole crop without trees) which was at par with T_5 (75% RDN + 25% N poultry manure), T_2 (100% RDF) and T_4 (75% RDN + 25% N vermicompost) with 175.4, 175.0 and 166.0 tillers/m^2 respectively. Minimum days to 50 per cent flowering (65.0) were recorded in T_1 (FYM @ 10 tons/ha) and maximum (72.0) in T_9 (sole crop without trees) which

Table 2. Yield attributing traits and yield of finger millet as influenced by nutrient management in *Melia azedarach*-based agri-silvi system

Treatment	Productive tillers/m^2	Days to 50% flowering (days)	Number of fingers /ear head	Finger length (cm)	Ear head weight (g)	Test weight (g)	Grain yield (kg/ha)	Straw yield (kg/ha)
T_1 (FYM @ 10 tonnes/ha)	152.9	65.0	5.90	6.33	3.46	2.48	1583	3402
T_2 (100% RDF)	175.0	71.0	6.30	7.17	3.96	3.05	2393	4745
T_3 (75% N + 25% N FYM)	156.7	66.0	5.97	6.63	3.56	2.56	1828	3745
T_4 (75% RDN + 25% N vermicompost)	166.0	68.3	6.17	7.00	3.80	2.64	2216	4377
T_5 (75% RDN + 25% N poultry manure)	175.4	70.7	6.30	7.37	4.01	3.05	2405	4733
T_6 (75% RDN + *Azospirillum*)	159.4	67.0	6.07	6.83	3.67	2.79	1977	4014
T_7 (75% RDN + PSB)	154.7	67.0	6.00	6.70	3.64	2.72	1954	4006
T_8 (75% RDN + *Azospirillum* + PSB)	161.3	69.3	6.10	6.90	3.77	2.89	2126	4241
T_9 (Sole crop without trees)	185.4	72.0	7.73	8.67	4.27	3.26	2681	5063
Mean	165.2	68.5	6.28	7.07	3.79	2.83	2129	4258
SEm±	6.81	0.86	0.35	0.30	0.14	0.14	102	205
$CD_{0.05}$	20.58	2.61	1.05	0.90	0.41	0.41	310	619

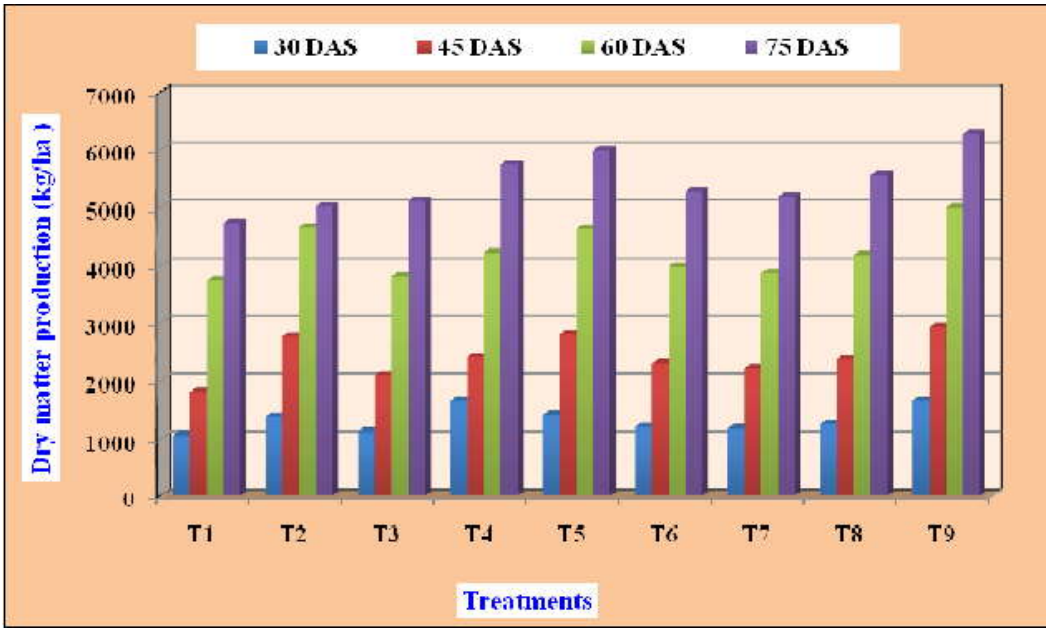

Fig 2. Dry matter production of finger millet as influenced by nutrient management in *Melia azedarach*-based agri silvi system

was at par with T_2 (100% RDF) and T_5 (75% RDN + 25% N poultry manure) with 71.0 and 70.7 days respectively. The abundant supply of nutrients by different sources to the crop might have promoted vegetative growth for long duration thereby delayed flowering compared to treatments with less or without fertilizers. Similar findings were reported by Kumar and Thakur (2004) and Giribabu (2006).

Maximum number of fingers (7.73/ear head) and finger length (8.67 cm) was found in T_9 which were significantly higher than other treatments. Ear head weight was also maximum (4.27 g) in T_9 and at par with T_5 and T_2 with 4.01 and 3.96 g weight respectively. Test weight was maximum in T_9 (3.26 g) being at par with T_2 (3.05 g), T_5 (3.05 g) and T_8 (2.89 g).

NPK are essential nutrients required for the promotion of the meristematic and physiological activities. These activities promote higher photosynthetic activities leading to the production of enough assimilates for subsequent translocation to various sinks thereby leading to production of higher sink components like productive tillers, number of fingers, finger length, weight of grains

and test weight. The results are also in accordance with the findings of Jagathjothi et al (2010) and Giribabu et al (2010).

Grain (2681, 2405 and 2393 kg/ha) and straw (5063, 4733 and 4745 kg/ha) yields were maximum in T_9 and at par with T_5 and T_2 respectively. The conjunctive use of organic and inorganic sources has beneficial effect on physiological process of plant metabolism and growth thereby leading to higher grain yield. The easy availability of nitrogen due to mineralization of organics influences the shoot and root growth favouring absorption of other nutrients. Similar results were obtained by Varalakshmi et al (2005), Yakadri and Reddy (2009) and Umesh et al (2006). Reduced yield in finger millet compared to sole crop may be ascribed to competition for light, moisture and nutrients with suppressing effect on crops and reduced solar radiation on crop canopy. Similar results were reported by Deswal and Nandal (2008), Prasad et al (2011) and Kumar et al (2013).

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