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EFFECT OF ORGANIC FARMING ON YIELD, QUALITY AND SOIL HEALTH IN FINGER MILLET

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ABSTRACT:

Low soil fertility is one of the bottlenecks to sustain production and productivity. Anthropogenic factors such as inappropriate land use systems, monocropping, nutrient mining and inadequate supply of nutrients have aggravated the situation.Keeping in view of the sustained crop yields as well as soil health, an experiment was conducted at Agricultural Research Station, Vizianagaram, for three years during *kharif* 2014, 2015 and 2016 to evaluate the effect of different organic sources of nutrients on yield parameters and soil health of finger millet and a comparison between the organic and conventional method of farming. The organic inputs were supplied in the form of farmyard manure, neem cake and biofertilizers (*Azospirillum* and Phosphorus Solubilising Bacteria). The results revealed that grain and straw yields of conventional plot (29.1 q/ha and 82.3 q/ha) are significantly higher than organic plot (24.4 q/ha and 73.5 q/ha). The yield contributing characters were also found highest in conventional plot compared to organic plot. The soil available nitrogen, potassium and zinc were found significantly high in organic plot(234 kg/ha,320 kg/ha and 2.15ppm) compared to conventional plot(214.2kg/ha, 290.4 kg/ha and 1.07ppm). Whereas the uptake of plant nitrogen and potassium uptake was significantly high in conventional plot (63.1 kg/ah and 41.7 kg/ha) compared to organic plot (57.4 kg/ha and 35.9 kg/ha).

Key words: Finger millet, Organic, Conventional, yield, soil fertility and nutrient uptake.

INTRODUCTION:

Finger millet (locally called as *Ragi or chodi*), is the third most important millet in India next to sorghum and pearl millet, covering an area of 2 million hectares with annual production of 2.15 million tonnes. The most striking feature, which made finger millet an important dry land crop, is its resilience and ability to withstand adverse weather conditions when grown in soils having poor water holding capacity. It is highly valued by traditional farmers as it is nutritious, drought tolerant, short duration and requires low inputs. Finger millet grown on marginal land provides a valuable resource in times of famine. Its grain tastes good and is nutritionally rich (compared to cassava, plantain, polished rice and maize meal) as it contains high levels of calcium, iron and manganese. The millet straw is also an important livestock feed, building material and fuel. Finger millet contains methionine, an essential amino acid lacking in the diets of hundred millions of the poor who rely mostly on starchy staples. The finger millet contains a low glycemic index and has no gluten, which makes it suitable for diabetics and people with digestive problems (Treen Hein, 2005). Moreover finger millet seeds can be stored for a long time due its low vulnerability to insect damage (Rurind *et al*., 2014). In recent years, much emphasis has been given for use of organics to produce adequate amount of high quality food.

The high input agriculture has led to self sufficiency in food grains but it has posed several new challenges. The conversion of inefficient plant protection measures in modern chemical intensive agriculture has resulted into degradation of lands owing to low crop yields with poor quality of produce(Pradhan and Mondal, 1997). Continuous use of chemical fertilizers is leading to reduction in the crop yield and resulted in imbalance of nutrients in the soil, which has adverse effects on soil health. However, it is now realized that in fields under intensive monoculture which receive heavy applications of chemical fertilizers alone, there is a slow decline in productivity. Applications of nitrogen fertilizers are responsible for emissions of green house gases like nitrous oxide (N_2O) and ammonia (NH_3). Besides supplying nitrogen, ammonia can also increase soil acidity. Excessive nitrogen fertilizer applications lead to pest problems by increasing the birth rate, longevity and overall fitness of certain pests (Jhan 2004, Jhan *et al*. 2005).

All these factors results in decline in the productivity of most of the crops. Hence, conversion of modern chemically intensive agriculture to a more suitable form of agriculture like organic farming appears to be an option for maintaining the desirable agricultural production in future(Modgal *et al*., 1995). Use of organic manures alone or in combination with chemical fertilizers will help to improve physico-chemical properties of the soils, efficient utilization of applied fertilizers for improving seed yield and seed quality. Organic manures provide a good substrate for the growth of microorganisms and maintain a favourable nutritional balance and soil physical properties. It is recognized that combined source of organic matter and chemical fertilizers play a key role in increasing the productivity of soil. However, over a longer period of time, applications of organic materials such as livestock manure and crop residues have been found to bring about a gradual improvement in soil productivity and crop performance. A study carried out on five crops in Japan showed that applications of organic matter enhance root growth and nutrient uptake, resulting in higher yields (FFTC, 1998).Another benefit from the increased use of organic materials is that it can help to solve pollution problems caused by agro-industrial wastes. However, the soil must not be seen as a dumping ground for organic wastes. If too much nitrogen fertilizer is applied, whether in the form of organic matter or chemical fertilizer, some of the excess nitrogen is converted to nitrates, which are harmful to human health (Preap *et al*., 2002).

The organic production system aims at supporting and sustaining healthy ecosystems, soil, farmers, food production, the community, and the economy. Reduction and elimination of the adverse effects of synthetic fertilizers and pesticides on human health and the environment is a strong indicator that organic agriculture is gaining worldwide attention (Aksoy, 2001 and Chowdhury, 2004). Organic fertilizers are environmentally friendly, since they are from organic sources [Oyewoli *et al*., 2002]. The current global scenario firmly emphasizes the need to adopt eco-friendly agricultural practices for sustainable food production. The cost of inorganic fertilizers is increasing enormously, to the extent that they are out of reach for small and marginal farmers. The organic fertilizers provide nutritional requirements, suppress plant pest populations, and increase the yield and quality of agricultural crops in ways similar to inorganic fertilizers (liu *et al*., 2007). Solaiman and Rabbani, 2006 reported results and their findings on the application of a combination of cow dung and a half dose of inorganic fertilizer. Bio fertilizers such as Trichoderma enriched with inorganic fertilizers play a significant role in the growth and yield of crops, e.g., mustard and tomato, and have the potential to reduce 50% of the cost of inorganic fertilizers (Haque *et al*., 2012). Microorganisms or plant growth promoting rhizobacteria (*Bacillus* sp) innoculant help to reduce the application of inorganic fertilizers and contribute to improving soil fertility and reducing a negative environmental impact (Adesemoye *et al*., 2009). Organic fertilizers contain macro-nutrients, essential micro-nutrients, vitamins, growth-promoting indole acetic acid (IAA), gibberellic acid (GA) and beneficial microorganisms (Sreenivasa *et al*., 2010).

Therefore use of locally available agro-inputs in agriculture by avoiding or minimizing the use of synthetically compounded agrochemicals appear to be one of the probable options to sustain the agricultural productivity. Moreover, by virtue of using less quantity of chemical fertilizers and pesticides and depending upon naturally available sources of nutrients, organic food could better provide vistas towards high remuneration with premium price in market with inherent lesser cost advantage.

MATERIAL AND METHODS

The field experiment was conducted during *kharif* 2014, 2015 and 2016 at Agricultural Research Station, Vizianagaram, ANGRAU, to study the effect of organic farming using only organic inputs in comparision with conventional method of farming using inorganic fertilizers on growth parmeters, yield, soil fertility status and nutrient uptake at harvest in finger millet. The soil was sandy loam in texture, neutral in reaction with low soluble salts, low in organic carbon and available nitrogen and high in available phosphorus and potassium.The experiment was laid out with two treatments i.e. organic treated plot and inorganic treated plot (conventional plot). The recommended dose of fertilizer(60:40:30 kg NPK ha^{-1}) was applied to inorganic treated plot and green manure, FYM@ 5t ha^{-1} along with 1t ha^{-1} of neem cake as top dressing was applied to organic treated plot. Recommended dose of nitrogen was applied through urea in two equal splits as basal and 30 days after transplanting to the conventional plot. Entire dose of phosphorus and potassium were applied through single super phosphate and muriate of potash as basal dose. Moreover green manure (sunhemp) was grown *insitu*, incorporated and biofertilizers in the form of *Azospirillum* and *PSB* @ 5 kg ha^{-1} were applied in organic plot. The crop was harvested at maturity stage and growth characters like plant height, no. of productive tillers/plant, no. of ear heads/plant, no. of fingers/ear head and yield attributes like grain yield, straw yield were recorded. Plant samples were collected at harvesting stage to determine nutrient content and nutrient uptake. The final soil samples were collected after harvest of the crop and the available macro and micronutrients were determined by adopting standard procedures.

RESULTS AND DISCUSSION

The pooled mean data (Table 1) of all the three years recorded significantly higher grain and straw yields in the conventional plot compared to organic plot. Among the two treatments, significantly highest grain and straw yields were recorded in conventional plot (29.1 q ha^{-1} and 82.3 q ha^{-1}) compared to the organic plot (24.4q ha^{-1} and 73.5 q ha^{-1}). Similar results were recorded by Pawar *et al.*, (2013). Among the plant growth characters, plant height and leaf length were found significantly high in conventional plot (110.6cm and 34.8cm) compared to the organic plot (98.7cm and 29.0cm). Among the yield contributing characters the No. of productive tillers/plant, ear head length and No. of fingers/ear were found highest in conventional plot (2.7, 8.2 cm and 7.7 cm) compared to the organic plot (2.3, 8.1cm and 6.9cm),but no significant difference was found between the two treatments. The increase in the growth and yield owing to the application of inorganic fertilizers may be attributed to the fact that this nutrient being important constituents of nucleotides, proteins, chlorophyll and enzymes involved in various metabolic processes which have direct impact on vegetative and reproductive phase of plants. These findings confirm those of Mengel and Kirby, 1996.

The physicochemical properties (Table 2) were not significantly influenced by both the methods. The organic carbon % has increased by 0.2% in organic treated plot (0.44%) compared to the initial value (0.42%).The Organic Carbon % was increased with application of FYM and incorporation of green manures. The buildup of Organic Carbon could be attributed to the manures and subsequently addition of leaf residue and debris of plants (Bhandari *et al*., 2002). The soil available Potassium was found significantly high in organic plot (320 kg ha $^{-1}$) compared to the conventional plot(290.4 kg ha $^{-1}$). The soil available Nitrogen and Phosphorus were found highest in organic plot (79 kg ha $^{-1}$ and234 kg ha $^{-1}$) compared to the conventional method (71.6 kg ha $^{-1}$ and214.2 kg ha $^{-1}$) but there is no significant difference between the two treatments. This is due to the enhancement in the efficiency of nutrient use from all the sources through mineralization of soil organic matter, animal excreta, other manures and biofertilizers. The increase in P availability might be due to the release of appreciable quantities of carbon dioxide during decomposition of organic matter which forms the carbonic acid, leading to increased solubility of phosphorous resulting in higher availability (Sedvi *et al*., 2005).Whereas the higher K status in soil might be due to the organic manures on decomposition released the organic acid which might have mobilized the native or non-exchangeable forms of K and charge the soil solution with K ions, so that it may be readily available (Yaduvanshi *et al*., 2013).The soil available Zn was found significantly high in the treatment of organic plot (2.15 ppm) compared to the conventional plot (1.07 ppm) and no significant difference was found in soil available Fe, Mn and Cu among both the treatments.

The N and K uptake (Table 3) were found significantly highest in conventional plot when compared to the organic plot. The uptake of nitrogen and potassium were found significantly high in conventional plot (63.1 kg ha $^{-1}$ and 43.7 kg ha $^{-1}$) when compared to organic plot (57.4 kg ha $^{-1}$ and 35.9 kg ha $^{-1}$). This could be primarily due to increased availability of the nutrients in the crop root zone resulted in increased absorption of the elements by the plants as well as higher dry matter production. These results are in consonance with the findings of Singh *et al*., 2009 and Datt *et al*., 2003. The uptake of micronutrients was not significantly influenced by both the treatments.

CONCLUSION:

Organic manures are an excellent natural source containing nitrogen, phosphorus, potassium and micronutrients. The quantity of manure needed for a specific application depends upon its nutrient content and the rate at which nutrient becomes available for plant uptake. The use of manures may not increase the grain and straw yields in a very short period but will certainly help to enhance the organic matter content of the soil which improves the physical, chemical and biological properties of the soil along with the quality of the crop yield.

Table 1: Effect of organic and inorganic manures on growth, yield of finger millet

S.no	Particulars	Organic plot				Conventional plot				T value
		2014-15	2015-16	2016-17	Mean	2014-15	2015-16	2016-17	Mean	
1	Plant height(cm)	93.4	86.5	116.2	98.7	96.3	108.9	126.5	110.6	11.40*
2	No. of Productive tillers/ plant	1.6	2.07	3.23	2.30	1.9	2.50	3.77	2.71	2.75
3	Leaf length(cm)	29.5	24.90	32.67	29.02	30.6	35.00	38.90	34.84	9.04*
4	Leaf width (cm)	1.1	0.97	1.65	1.24	1.1	1.09	1.37	1.19	0.97
5	Ear head length(cm)	7.8	8.60	7.73	8.04	6.5	9.18	8.90	8.21	0.98
6	No. of Fingers/ear	6.9	6.80	7.00	6.91	7.3	7.93	7.83	7.69	1.49
7	Straw yield (q ha^{-1})	71.73	71.91	76.76	73.47	78.1	81.47	87.26	82.28	4.72*
8	Grain yield (q ha^{-1})	22.3	26.48	24.29	24.36	25.2	32.84	29.26	29.10	4.37*

*Significant at P=0.05 level

Table 2: Effect of organic and inorganic manures on soil health at harvest

S. no	Particulars	Organic plot				Conventional plot				T value
		2014-15	2015-16	2016-17	Mean	2014-15	2015-16	2016-17	Mean	
1	Organic carbon (%)	0.43	0.44	0.44	0.44	0.42	0.42	0.42	0.42	1.84
2	pH	6.85	6.57	7.23	6.88	6.31	6.27	6.69	6.42	2.59
3	EC	0.19	0.20	0.35	0.25	0.21	0.17	0.32	0.23	1.01
4	Available N (kg ha^{-1})	223.5	249	230	234	213	217	213	214	6.10*
5	Available P_2O_5 (kg ha^{-1})	97.6	77	64	79	87	73	55	72	3.86
6	Available K_2O(kg ha^{-1})	312.0	316	332	320	282	295	294	290	30.49*
7	Available Zn (ppm)	1.2	1.37	1.19	2.15	1.1	1.09	1.07	1.07	4.77*
8	Available Fe (ppm)	9.5	8.44	13.89	10.61	9.8	8.31	10.78	9.62	0.49
9.	Available Mn (ppm)	4.2	5.61	7.14	5.64	4.3	5.67	5.30	5.08	1.02
10.	Available Cu (ppm)	0.70	2.21	2.41	1.79	0.80	1.80	2.24	1.63	1.54

*Significant at P=0.05 level

Table 3: Effect of organic and inorganic manures on Plant nutrient uptake of finger millet

S.no	Particulars	Organic plot				Conventional plot				T value
		2014-15	2015-16	2016-17	Mean	2014-15	2015-16	2016-17	Mean	
1	N Uptake (kg ha^{-1})	75.6	46.78	49.77	57.38	80.9	55.56	52.8	63.1	4.07*
2	P Uptake(kg ha^{-1})	12.2	12.86	14.9	13.35	14.4	15.18	16.5	15.36	2.15
3	K Uptake(kg ha^{-1})	32.8	44.37	30.5	35.9	40.6	45.71	38.8	41.7	9.39*
4	Zn Uptake (gm ha^{-1})	228.6	256.6	228.7	238	300.7	271.46	213.7	261.9	0.75
5	Fe Uptake(gm ha^{-1})	1525.4	1461.5	1064	1350.5	1692.5	1654.1	1645	1664.0	3.67

*Significant at P=0.05 level

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