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Effect of Organic Nutrient Management on Enhancement of Grain Yield, Quality of Kodo Millet and Soil Organic Carbon Content

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Abstract

The field experiment was carried out at Farmer's Field, Vallampadugai Village, Chidambaram Taluk in Cuddalore District during August – November, 2022 to investigate soil application of bio-compost, consortia bio-fertilizer and foliar spray of Panchagavya and fish amino acid on yield, quality and soil organic matter content with kodo millet grown in sandy loam soil. The field trial was laid out in randomized block design (RBD) with nine treatments and three replications. The study included nine treatments were T_1- Absolute control, T_2- 100% RDF (44:22:0 kg N: P_2O_5: K_2O ha^{-1}), T_3- Bio-compost @ 10 t ha^{-1}, T_4- T_3 + CBF@ 2 kg ha^{-1}, T_5- T_3 + PK@3%, T_6- T_3 + FAA@0.5%, T_7- T_3 + CBF@ 2 kg ha^{-1} + PK@3%, T_8- T_3 + CBF@ 2 kg ha^{-1} + FAA @ 0.5%, T_9- T_3 + PK@3% + FAA @ 0.5%. Kodo millet was grown as test crop with proper cultural practices. The results of the study revealed that significantly highest grain yield of 2110.74 kg ha^{-1} was found to be with bio-compost@10 t ha^{-1} + CBF@ 2 kg ha^{-1} + PK@3% (T_7) than control (T_1) (982.56 $kgha^{-1}$). The same treatment registered highest harvest index (34.36) crude protein (7.68%), crude fiber (5.43%), ash content (3.15%) and soil organic carbon content of 4.3 g kg^{-1} compared to other treatments.

***Key words*:** Organic nutrient sources, Kodo millet, Yield, Quality, Post harvest SOC content

Kodo millet (*Paspalum scrobiculatum*) is repository of nutrients, a great substitute for rice and wheat. It is an impressive source of powerful antioxidants. The phenolic extracts in this tiny millet reduce LDL or bad cholesterol, keep heart healthy, brings down blood pressure levels and prevent various other chronic conditions. These antioxidants also act against free radicals causing damage to the cells, tissues thus preventing various types of cancers [1]. Bio-compost is considered as a key ingredient in organic farming. It is very rich in nutrients. Bio-fertilizers are typically microbial formulations in organic carrier materials that improve soil health and crop growth and development [2]. Many soil microorganisms possess diverse capabilities, including the production of growth-enhancing substances such as phytohormones, vitamins, and enzymes. These microorganisms improve plant resilience to drought by enhancing water retention and producing osmoprotectants, counter salinity by secreting organic acids and inducing antioxidant production, and regulate soil pH to increase nutrient availability. They help plants withstand heat stress through the induction of heat-shock proteins and antioxidants, degrade or transform pollutants, sequester heavy metals, and address nutrient deficiencies by fixing nitrogen, solubilizing phosphate, and mobilizing potassium [3]. Panchagavya is an organic product having the potential to play the role of promoting growth and providing immunity in plant system [4]. Fish amino acid enhances plant growth by providing essential nutrients like nitrogen, phosphorus and potassium. These nutrients are crucial for photosynthesis and overall plant development. Plants absorb amino acids quickly, promoting faster growth rates and healthier foliage.

MATERIALS AND METHODS

The field experiment was carried out at Farmer's Field, Vallampadugai Village, Chidambaram Taluk in Cuddalore District during August– November, 2022 to investigate the effect of soil application of bio-compost, consortia bio-fertilizer and foliar application of Panchagavya and fish amino acid on yield, quality and soil organic carbon content with kodo millet. The soil of the experimental field was sandy loam in texture, Vertisols in order with the taxonomic classification of *Typic Ustifluvent*. The pH, EC were 7.38 and 0.32, respectively. The soil available nitrogen, phosphorus and potassium status were 219, 10.1 and 248 kg ha^{-1}, respectively. The field experiment was carried out with nine treatments and three replications in randomized block design (RBD). The nine treatments were T_1- Absolute control, T_2- 100% RDF (44:22:0 kg N: P_2O_5: K_2O ha^{-1}), T_3- Bio-compost @ 10 t ha^{-1}, T_4- T_3 + CBF@ 2 kg ha^{-1}, T_5 - T_3 + PK@3%, T_6- T_3 + FAA@0.5%, T_7- T_3 + CBF@ 2 kg ha^{-1} + PK@3%, T_8- T_3 + CBF@ 2 kg ha^{-1} + FAA @ 0.5%, T_9- T_3 + PK@3% + FAA @ 0.5%.

The treatments were imposed randomly on the plots in each replication. The recommended dose of fertilizers (44:22:0

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kg N: P_2O_5: K_2O ha^{-1}) were applied to the field through Urea, SSP and MOP, respectively. The full dose of nitrogen and phosphorus were given as basal. Based on treatments, bio-compost @ 10 t ha^{-1}, consortia bio-fertilizer@ 2 kg ha^{-1} were applied one week before sowing. As per the treatment schedule, Panchagavya @ 3% and fish amino acid @ 0.5% sprayed twice (30 DAS and 60 DAS) during vegetative and reproductive stages of kodo millet crop. The kodo millet cv. CO-3 seeds were treated with consortia bio- fertilizer @600 gha^{-1} and sown with the spacing of 45x10 cm. The plant protection measures were taken with neem seed kernel extract. The need-based irrigation was given. Kodo millet was grown with proper care and harvested. The effect of treatments on grain yield was registered. The quality parameters viz., crude protein, crude fiber, ash contents and soil organic carbon contents were also analyzed with standard procedure and recorded.

RESULTS AND DISCUSSION

Grain yield

The data on grain yield (kg ha^{-1}) of kodo millet cv. CO3 due to different treatments are presented in (Table 1). Among the different treatments tried, highest grain yield of 2110.74 kg ha^{-1} was found to be with bio - compost@10 t ha^{-1} + CBF@ 2 kg ha^{-1} + PK@3% (T_7). The second-best value (1962.27 kg ha^{-1}) found to be with T_8 which received bio compost @10 t ha^{-1} + CBF@ 2 kg ha^{-1} + FAA @ 0.5% which was statistically on par with T_9- Bio-compost @10 t ha^{-1} + PK@3% + FAA @ 0.5% (1949.27 kg ha^{-1}). Application of 100% RDF (44:22:0 kg N: P_2O_5: K_2O ha^{-1}) (T_2) registered grain yield of 1785.31 kg ha^{-1}. The lowest grain yield (982.56 kgha^{-1}) was observed in control (T_1).

The grain yield ranged from 982.56 to 2110.74 kg ha^{-1} due to different treatments. The soil application of bio-compost@10 t ha^{-1} + CBF@ 2 kg ha^{-1} and foliar spray of Panchagavya @3% (T_7) recorded maximum grain yield of 2110.74 kg ha^{-1}. This might be due to application of bio-compost enhanced continuous nutrient supply, improved soil conditions and increased root proliferation. This might be also due to application of consortia bio-fertilizer and followed by Panchagavya spray contributed to increase yield [5]. Application of consortia bio-fertilizers enhanced growth by increasing nutrients leading to improved growth and higher yields.

Table 1 Effect of organic nutrient management on grain yield (kg ha^{-1}), harvest index of kodo millet cv - CO 3 and post-harvest soil organic carbon content

T. No.	Treatment details	Grain yield (kg ha^{-1})	Harvest Index	Post- harvest soil organic carbon content (g kg^{-1})
T_1	Absolute control	982.56	32.83	3.1
T_2	100% RDF	1785.31	33.90	3.3
T_3	Bio-compost @ 10 t ha^{-1}	1301.87	34.12	3.6
T_4	T_3 + CBF@ 2 kg ha^{-1}	1471.12	34.36	3.0
T_5	T_3 + PK@3%	1641.44	33.97	3.5
T_6	T_3 + FAA@0.5%	1625.38	34.35	3.4
T_7	T_3 + CBF@ 2 kg ha^{-1} + PK@3%	2110.74	34.36	4.3
T_8	T_3 + CBF@ 2 kg ha^{-1} + FAA @ 0.5%	1962.27	33.45	4.1
T_9	T_3 + PK@3% +FAA @ 0.5%	1949.27	33.96	4.0
	S. Ed	65.18	-	0.071
	CD (P = 0.05)	143.41	-	0.157

Harvest index

The harvest index was significantly higher in T_7- Bio-compost@10 t ha^{-1} + CBF@ 2 kg ha^{-1} + PK@3% (34.36). This was followed by T_8- Bio-compost @10 t ha^{-1} + CBF@ 2 kg ha^{-1} + FAA @ 0.5 % and T_9- Bio-compost @10 t ha^{-1} + PK@3% + FAA @ 0.5% recorded harvest index of 33.45 and 33.96, respectively. However, lowest harvest index (32. 83) was recorded in control treatment (T_1).

Quality characteristics

Crude protein (%)

The crude protein significantly increased due to different treatments. Application of bio-compost@10 t ha^{-1} + CBF@ 2 kg ha^{-1} + PK@3% (T_7) recorded highest crude protein (7.68%). Application of bio-compost @10 t ha^{-1} + CBF@ 2 kgha^{-1} + FAA @ 0.5% (T_8) recorded crude protein of 7.65%. This was on par with bio- compost @10 t ha^{-1} + PK@3% + FAA @ 0.5% (T_9) (7.64%). However, lowest crude protein of 7.51% was recorded under control treatment (T_1).

Crude fiber (%)

Crude fiber showed an increasing trend with application of organic nutrient sources viz., bio-compost, consortia bio fertilizer, Panchagavya and fish amino acid. The highest crude fiber (5.43%) was recorded in T_7. This was followed by 5.29 and 5.17% were observed in T_8 and T_9, respectively. There was a non - significant differences between T_8 and T_9. However, control (T_1), recorded least crude fiber of 4.39%.

Ash content (%)

Application of bio- compost, consortia bio - fertilizer, Panchagavya and fish amino acid significantly increased ash content from 1.84 to 3.15%. Among the treatments, application of bio-compost@10 t ha^{-1} + CBF@ 2 kg ha^{-1} + PK@3% (T_7) recorded highest ash content (3.15%). Application of bio-compost @10 t ha^{-1} + CBF@ 2 kg ha^{-1} + FAA @ 0.5% (T_8) recorded ash content of 2.85%. This was on par with bio-compost @10 t ha^{-1} + PK@3% + FAA @ 0.5% (T_9) recorded the ash content (2.73%). Whereas lowest ash content of 1.84% was recorded under control treatment (T_1).

This might be due higher macro nutrients composition and trace elements in bio-compost had a significant effect on growth and chemical constituents of plants [6]. Application of organic sources would have caused accumulation of nutrients in comparison to synthetic fertilization [7] which resulted better quality. The relative increase in protein content might be due to supply of nutrients especially nitrogen and micro nutrients to the growing tissues which led to synthesis of soluble protein [8]. The availability of nutrients particularly nitrogen which is an integral part of protein is ensured by application of bio-compost, Panchagavya and fish amino acid which contributes to higher NPK content, thereby favoring highest protein content in grains [9].

Table 2 Effect of organic nutrient management on crude protein (%), crude fibre (%) and ash content (%) at harvest stage of kodo millet cv. CO 3

T. No.	Treatment details	Quality parameters		
		Crude protein (%)	Crude fibre (%)	Ash content (%)
T_1	Absolute Control	7.51	4.39	1.84
T_2	100% RDF	7.53	4.53	3.08
T_3	Bio-compost @ 10 t ha^{-1}	7.54	4.65	2.04
T_4	T_3+ CBF@ 2 kg ha^{-1}	7.56	4.72	2.22
T_5	T_3+ PK@3%	7.61	5.06	2.46
T_6	T_3+ FAA@0.5%	7.59	4.94	2.36
T_7	T_3+ CBF@ 2 kg ha^{-1} + PK@3%	7.68	5.43	3.15
T_8	T_3+ CBF@ 2 kg ha^{-1} + FAA @ 0.5%	7.65	5.29	2.85
T_9	T_3 + PK@ 3% + FAA @ 0.5%	7.64	5.17	2.73
	S. Ed	0.004	0.206	0.082
	CD (P = 0.05)	NS	NS	0.183

Post-harvest soil organic carbon content (g kg^{-1})

The effect of soil application of bio compost, consortia bio fertilizer and foliar application of Panchagavya and fish amino acid on organic carbon content in the post-harvest soil of kodo millet was statically significant. Among the different treatments tried, control (T_1) registered lowest soil organic carbon content (3.1 g kg^{-1}). The highest soil organic carbon content (4.3 g kg^{-1}) was found to be with bio-compost@10 t ha^{-1} + CBF@ 2 kg ha^{-1} + PK@3% (T_7). This was followed by 4.1 and 4.0 g kg^{-1} were observed in T_8 and T_9, respectively which were received bio-compost @10 t ha^{-1} + CBF@ 2 kg ha^{-1} + FAA @ 0.5% and bio compost @10 t ha^{-1} + PK@3% + FAA @ 0.5%, respectively. The treatment T_7 significantly differed with T_8 whereas T_8 was on par with T_9. However, application of 100% RDF (44:22:0 kg N: P_2O_5: K_2O ha^{-1}) (T_2) registered organic carbon content of 3.3 g kg^{-1}increased from 3.1 g kg^{-1} found to be with control (T_1). Application of bio-compost helps to increase the organic carbon in soil [10]. This might be due to application of bio - compost exhibits beneficial residual effect of carbon content thereby increased soil organic carbon content [11]. This also could be attributed to addition of organic nutrient source cause more plant residues after harvest of the crop [12].

CONCLUSION

Based on the results obtained from the field experiment, it can be inferred that application of bio-compost@10 t ha^{-1} + CBF@ 2 kg ha^{-1} + PK@3% (T_7) registered significantly highest yield, quality of kodo millet and post-harvest soil organic carbon content. Hence, it is concluded that bio-compost@10 t ha^{-1} + CBF@ 2 kg ha^{-1} + PK@3% (T_7) would be beneficial for the farmers for maximizing yield and quality of kodo millet in typic ustifluvent soil. Overall, organic nutrient management fosters a harmonious relationship between agriculture and environment, promoting sustainable land management practices for future generations.

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