DOI : 10.5958/2349-4433.2024.00081.0

J Krishi Vigyan 2024, 12(2) : 285-291

Green Manuring – A Cost Effective And Farmer Friendly Alternative For Farm Yard Manure

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ABSTRACT

Long-term fertilizer experiments are an integral tool for comprehending how intensive cropping and continuous fertilizer application affect soil characteristics and crop performance. It paves the way for the evaluation of sustainable agriculture practices. The aim of the current study was to monitor how fertilizers and manures consistently affected the productivity of a rice-rice cropping system in a lateritic soil. *In situ* green manuring was identified as a practical and affordable technology. Integrated nutrient management with FYM and *in situ* green manuring with daincha (*Sesbania*) recorded higher grain and straw yields across years. In comparison to the plot receiving solely inorganic nutrients, the soil's organic carbon content and biological properties were higher in the 100% NPK+ FYM plot and the 100% NPK+ *In situ* green manured (daincha) plot. The economic analysis of the demonstrations in farmers' field during 2019-22 indicates the cost effectiveness of the technology.

Key Words: Farm yard manure,Fertilizer, Green manuring, Nutrient, Management.

INTRODUCTION

Long-term fertilizer studies are crucial for determining how continuous cropping and fertilizer or manure application affect crop output sustainability (Manna et al., 2007). Since the rice-rice cropping system predominates in Kerala's lateritic belts, yield, nutrient absorption, and nutrient dynamics in soil brought on by ongoing fertilizer or manure application assume significant importance for the sustainability of this cropping system. As part of the LongTerm Fertilizer Experiment (LTFE), which has been running at the Pattambi centre of the All India Co-ordinated Research Project (AICRP) since 1997, an analysis of the long-term effects of *in situ* green manuring as an integrated nutrient management technology on productivity in the rice-rice cropping system was attempted in this study.

MATERIALS AND METHODS

At the Regional Agricultural Research Station, Pattambi, Kerala Agricultural University, the current study was conducted to track the long-term impacts of fertilizer and organic manures on production after completion of 25 cycles of rice-rice system in the lateritic soil. The usual lateritic soil in the area has a pH in the acid range. One of the 18 LTFE centers throughout the nation, the Long Term Fertilizer Experiment (LTFE) Pattambi Centre was established in Kerala in 1997. It followed a rice- rice cropping system with rice variety Aiswarya in RBD with 12 treatments such as T1-50% NPK of 90:45:45 (kg N: P_2O_5:K_2O per

Plate 1 *In situ* green manuring using daincha

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Table 1. The effect of long term application of nutrient management practices on grain and straw yields of rice.

Treatment	Yield (kg/ha)	
	Grain yield	Straw yield
T1 (50% NPK)	2811	3341
T2 (100% NPK	3472	4041
T3 (150% NPK)	4104	4707
T4 (100% NPK+Lime)	3770	4263
T5 (100% NPK)	3515	3993
T6 (100% NP)	2974	4015
T7 (100% N)	2175	3135
T8 (100% NPK+FYM)	4650	5562
T9 (50% NPK+FYM)	3713	4678
T10 (100% NPK+ Daincha)	4256	5228
T11 (50% NPK+ Daincha)	3453	4198
T12 (Absolute control)	2141	2384
CD (0.05)	493.6	484.2

ha) (KAU recommendation), T2-100%NPK, T3-150% NPK, T4-100%NPK +600 kg lime, T5-100%NPK, T6-100%NP, T7-100%N, T8-100%NPK +FYM@5 t/ha in *Kharif* season, T9-50%NPK + FYM@5 t/ha in *Kharif* season, T10-100%NPK+ in situ green manuring in *Kharif* , T11-50%NPK + *in situ* green manuring in *Kharif* and T12-Control with 4 replications. On December 2, 2020, the LTFE plot's Kharif crop for the 2020–21 growing season was manually harvested, and grain yield and straw yield were noted. Field-collected soil samples were examined for urease activity (Bremner and Douglas, 1971) and soil organic carbon (Walkley and Black technique). The approach outlined by Eivazi and Tabatabai (1977) and Tabatabai and Bremner (1970) was used to determine the phosphatase activity. By using the chloroform fumigation and extraction procedure, the amount of microbial biomass carbon in the soil was calculated (Jenkinson and Powlson, 1976). According to the method published by Casida and coworkers (1964), dehydrogenase activity was evaluated colorimetrically using a spectrophotometer with triphenyl tetrazolium chloride extraction and triphenyl formazan estimation.

To popularise the technology of *In situ* green manuring using daincha, demonstrations on the ground were held in the fields of farmers in padasekharams (long stretch of paddy fields), and an economic analysis was done.

RESULTS AND DISCUSSION

During the *kharif* and *rabi* seasons, there was a noticeable impact of treatments on grain output.

The data (Table 1) showed the impact of continuous use of various nutrient management techniques on the grain yield and straw yields of rice harvested during the virippu crop of 2020. The results showed that the treatments' differences in grain yield ranged between 2141 and 4650 kg/ha. The treatment T8 (100% NPK+FYM) greatly outperformed all other treatments, and its mean yield was comparable to that of the treatment T10 (100% NPK + in situ growth of *Sesbania aculeata*). It was noted that the continuous application of organic manures and inorganic fertilizers greatly enhanced rice grain production compared to the control. The treatments in LTFE that used Integrated Nutrient Management techniques had greater grain yields. The physical,

Table 2. The effect of long term application of nutrient management practices on biometric parameters of rice.

Treatment	Plant height (cm)	No. of tillers/ hill	No. of panicles/ hill	No. of seeds/ hill	Weight of the panicle (g)	Test weight (1000 seed weight in g)
T1 (50% NPK)	96.8	10.56	10.50	830	2.02	25.53
T2 (100% NPK	96.9	10.53	10.07	950	2.55	26.57
T3 (150% NPK)	104.6	11.50	11.07	1075	2.6	26.17
T4 (100% NPK+Lime)	103.9	10.83	10.40	1019	2.53	25.57
T5 (100% NPK)	106.4	10.53	9.77	941.3	2.47	25.63
T6 (100% NP)	105.6	9.8	9.20	706.7	1.81	22.87
T7 (100% N)	94.4	8.16	6.97	699.7	2.29	22.77
T8 (100% NPK+FYM)	111.9	11.73	10.77	1149	2.98	26.60
T9 (50% NPK+FYM)	104.3	10.86	10.00	856.7	2.20	25.40
T10 (100% NPK+ Daincha)	102.8	12.36	11.37	1054	2.41	25.80
T11 (50% NPK+ Daincha)	97.2	10.83	10.37	896	2.21	25.23
T12 (Absolute control)	93.2	7.96	7.60	548.7	1.61	21.5
CD (0.05)	7.61	0.941	0.73	128.8	0.278	0.916

chemical, and biological qualities of the soil are improved by organic manures, ensuring a balanced supply of nutrients and a healthier environment for plant growth. According to the statistics, rice had a grain yield that varied from 2141 to 4650 kg/ha. The T8 treatment, which administered 100% NPK+FYM, had the highest yield. Under treatments for integrated nutrient management that included in situ green manuring and FYM, crop yields were discovered to be comparable. The soil gained an extra 21.25 kg/ha of N, 7.4 kg/ha of P, and 22.05 kg/ha of K from the integration of 5 t FYM, whereas the soil gained 136.9 kg/ha of N, 22.61 kg/ha of P, and 47.83 kg/ha of K from the seeding of daincha seeds at 12.5 kg/ha and their subsequent biomass incorporation. In a study by Vinodkumar et al. (2017) on the impact of integrated nutrient management on rice yield and its lasting effects on wheat in lowland rice-wheat systems, the highest grain and straw yields (45.04 and 72.0 q/ha) were significantly recorded. These yields were followed by 75% RDF as inorganic fertilizers as well as green manuring of sunhemp *in situ* incorporated in alternate years and 100% RDF. A similar positive effect of INM was also reported in the LTFE maintained at Pattambi (Thulasi *et al*, 2020). Straw yields of the LTFE experiments followed the same trend as the grain yields with respect to the treatment effects. The highest straw yield was recorded by the treatment involving 100 per cent NPK and FYM @ 5 t/ha. This treatment was shown to be comparable to treatment T10, which involved cultivating *Sesbania aculeata in situ* and using 100% NPK. Combining the use of organic manures with inorganic fertilizers has been shown to increase straw yields while decreasing nitrogen losses through the formation of organic mineral complexes that assure continuous supply of N to rice plants.

According to the results (Table 2), there was a substantial difference between various treatments in terms of biometric characteristics. It was found that treatments using combined application of inorganic fertilizers and organic manures had high values for all plant growth metrics. In comparison to the treatments using only inorganic fertilizers, the treatments T8 and T10 were generally better.

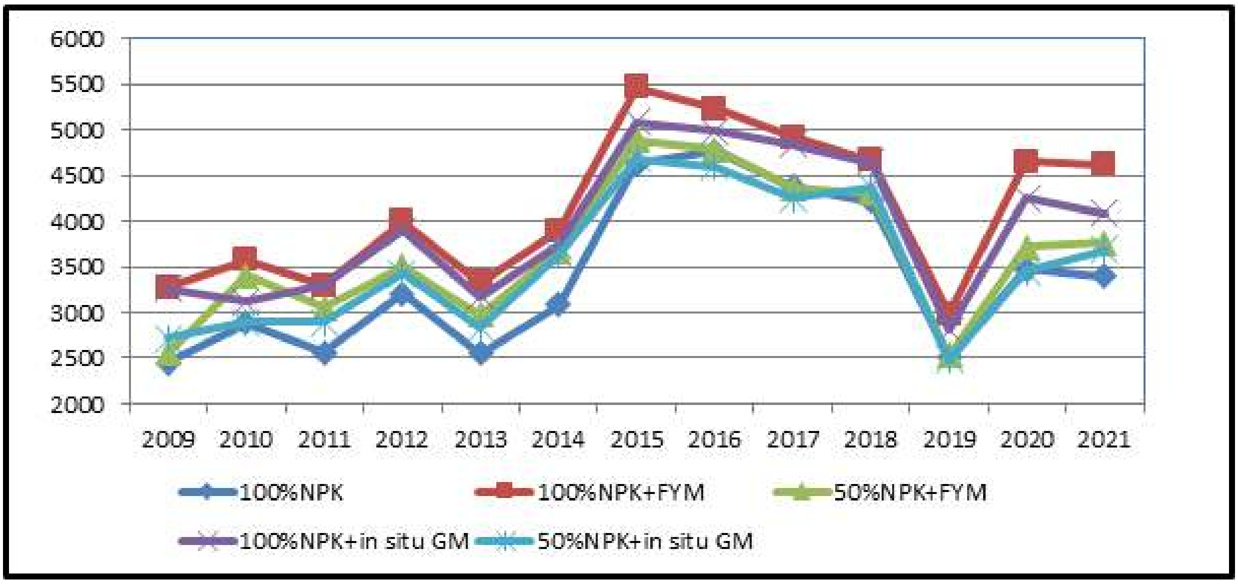

Fig 1 Grain yield (kg/ha) under LTFE at Pattambi over years

Between treatments, there was a considerable variation in the number of panicles per hill. In treatment T7, 100% N alone was administered, the least amount of panicles were seen on each hill. The absolute control (T12), in which no fertilizers or manures were applied, came next. The development and quantity of productive tillers were facilitated by the quick release of nitrogen from fertilizers and the increased soil physical, chemical, and biological qualities brought about by the application of organic manures (Thulasi *et al,* 2022; Dhillon and Singh , 2019)

From the graph with the yield data over years presented below (Fig 1), it was evident that *in situ* green manuring (Daincha) is recognized and popularised as a practical and farmer-friendly method. The graph displays the average Paddy grain yield throughout the course of years (averaged for *kharif* and *rabi*).

The crop yields under in situ green manuring and integrated nutrient management were found to be comparable. Green manure seeds were sown and integrated *in situ* to minimise cultivation costs relative to the field application of FYM, making the crop more economically viable (Beena *et al*, 2002). A frequently used method for managing soil health in terms of the addition of organic matter, *in situ* green manuring using Dhaincha yields an average of 35 mt of green matter per hectare.

Effect of *in situ* green manuring on soil organic carbon and biological properties

The percentage of organic carbon in soil that was determined after 25 years of continuous cropping using the Walkley and Black technique, as reported by Jackson in 1973, varied from 1.19 to 1.96 between the treatments.

Soil organic carbon

The analysis of the enzyme activity and soil organic carbon demonstrated the superiority of the INM treatments. The 100% NPK+ FYM plot and the 100% NPK+ *In situ* green manure (daincha) plot had greater soil organic carbon contents (%) than a plot that only received inorganic nutrients. It was in accordance with the finding of Brar *et al.* (2000) and Beena *et al*. (2002). Thus, it was evident that the enrichment of soil organic carbon by organic manures led to an improvement in soil quality. However, the 100% NPK+ FYM plot saw more of the beneficial effects of organic manuring than the 100% NPK + *In situ* green manured plot. Moreover, the 50% NPK+FYM plot's soil had less organic carbon than the 100% NPK+FYM plot. This showed unequivocally that the use of inorganic fertilizers also helped to increase soil organic carbon, one of the key indicators of soil quality.

Enzyme activities

The dehydrogenase enzyme, which is

Table 3. The effect of long term application of nutrient management practices on soil biological properties.

Treatment	Total SOC (%)	Microbial biomass C (µg/g soil)	DHA ((µg TPF hydrolysed g^{-1} soil s 24 hr^{-1})	Urease (g^{-1} soil hr^{-1})	Acid phosphatase (µg p-nitrophenol g^{-1} soil hr^{-1})	Aryl sulfatase (µg p-nitrophenol g^{-1} soil hr^{-1})
T1 (50% NPK)	1.56	211.5	160.7	172.0	19.94	9.048
T2 (100 % NPK)	1.59	233.3	137.8	242.1	18.15	8.885
T3 (150% NPK)	1.68	270.5	132.7	274.2	17.54	8.170
T4 (100% NPK+ lime)	1.49	269.7	209.5	285.4	23.65	10.423
T5 (100% NPK)	1.57	233.8	143.8	252.5	19.56	8.815
T6 (100% NP)	1.51	219.1	182.7	183.5	17.56	9.135
T7 (100% N)	1.41	214.8	146.7	199.0	16.89	8.105
T8 (100% NPK+ FYM)	1.96	319.0	302.6	303.7	33.17	11.22
T9 (50 % NPK+ FYM)	1.71	299.8	286.9	271.7	28.27	10.02
T10 (100% NPK+ in situ GM)	1.82	291.5	286.3	285.4	26.87	10.12
T11 (50% NPK+ in situ GM)	1.73	278.9	227.9	192.0	27.50	10.05
T12 (Control)	1.19	193.6	201.4	155.4	14.86	8.020
CD (0.05)	0.169	16.86	19.55	15.09	2.294	0.735

known to oxidise soil organic materials, is a frequently used indication of biological activity in soil. The soil's dehydrogenase activity ranged from 132.7 g TPF hydrolyzed/g soil/24 hr in the plots that received 150 percent NPK (T3) to a maximum value of 302.6 g soil/24 hr in the plot that received 100 percent NPK+FYM. According to Shikha Verma *et al*. (2022), the introduction of an inorganic nitrogen source promoted the development of bacteria that used the natural pool of organic carbon as a substrate for dehydrogenase. In our study, it was shown that when inorganic fertilizer treatment levels increased from 50% NPK to 150% NPK, the activity of the dehydrogenase enzyme reduced. The soil's dehydrogenase activity was boosted by applying lime with 100% NPK. The dehydrogenase activity was boosted in several treatments when inorganic fertilizers and organic manures were applied together (Sumayya, 2017). In treatments that combined the use of organic manures and chemical fertilizers, there was an increase in urease activity. This could be because the healthy microbial community in soil contributes large quantities of urease. The soil's urease activity was likewise enhanced by the treatments using higher doses of inorganic nitrogen fertilizer. The treatment T12 (absolute control), which used no fertilizers or manures, reported the lowest level of urease. The phosphatase activity of soil varied from 14.86 to 33.17 µg p-nitrophenol /g soil /hr. The treatment T12 (absolute control) showed the lowest degree of phosphatase activity. In the rice-rice cropping system, various nutrient management techniques had a stronger influence on soil quality, notably on biological metrics. These soil enzymes were the important parameters for soil quality assessment.

Microbial biomass carbon

The transformation of nitrogen, phosphorus, sulphur, potassium, calcium, magnesium, manganese, and zinc into forms that plants can utilise depends on the microbial biomass. The MBC of the soil is greatly influenced by the management practices in LTFE soil. The treatment

Table 4. Net profit per hectare per year (B:C ratio) over three years

Year	100% NPK	100%NPK+5t FYM	100% NPK+ *in situ* green manuring
2019-20	88500 (1.59)	118750 (1.67)	129750 (1.89)
2020-21	99840 (1.66)	139040 (1.78)	148450 (2.01)
2021-22	119291 (1.79)	150647 (1.84)	181470 (2.23)

T8 (100% NPK+FYM) had the greatest amount of microbial biomass carbon in the soils, which was 295.2 g/g. This treatment was determined to be comparable to the treatment T10 (100% NPK + *in situ* growth of *Sesbania aculeata* (for Virippu crop). Nikhil (2013) and Sumayya (2017) both reported similar results.

***In situ* green manuring identified as a cost effective technology in farmers' fields**

Technology demonstrations were conducted in farmers' fields also during 2019-2022. *In situ* green manuring with daincha was identified as the most appropriate technology for substituting farm yard manure addition in soils of Kerala.

CONCLUSION

Long term fertilizer experiments provide an opportunity to evaluate the sustainability of agricultural practices. The maintenance or improvement of important soil fertility parameters, such as soil organic carbon, nutrient availability, etc., as well as steady or growing crop yields over time would be proof of sustainability in continuous rice production systems. Since the rice-rice cropping system predominates in Kerala's lateritic belts, changes in the soil's physical, chemical, and biological characteristics as well as its ability to absorb nutrients are crucial to the long-term viability of this cropping system. *In situ* green manuring with daincha produced improved grain and straw yields and was selected as a cost-effective and farmer-friendly method in long-term fertilizer studies and demonstrations in farmers' fields.

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Received on 27/3/2024 Accepted on 20/5/2024