E-ISSN: 2618-0618
P-ISSN: 2618-060X

NAAS Rating (2025): 5.20
www.agronomyjournals.com
2025; 8(9): 80-83
Received: 05-06-2025
Accepted: 07-07-2025

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Effect of green manures on soil properties and crop production

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DOI: https://www.doi.org/10.33545/2618060X.2025.v8.i9b.3728

Abstract
High yielding varieties of crops introduction with high dose of chemical fertilizers resulted in the depletion of soil organic matter status and decline in soil fertility. The use of organic manures may pave the way for the development of organic farming in areas suitable for adoption. The concept of organic farming has assumed greater importance with the self-sufficiency in food production in the recent years. Therefore, effective management of organic biomass may help in buildup of soil health. Green manuring is growing in the field plants usually belonging to leguminous family and incorporating into the soil after sufficient growth. The most important green manure crops are sunnhemp, dhaincha and *Sesbania rostrata.* Application organics through green manuing favorably influence the soil physical, chemical and biological environment such as bulk density, water holding capacity, organic carbon, available nitrogen, beneficial microbial population. Organic farming favourably influenced the soil physical, chemical and biological fertility and for better crop yield and quality.

Keywords: Green manures, organic matter, soil properties, yield, economics

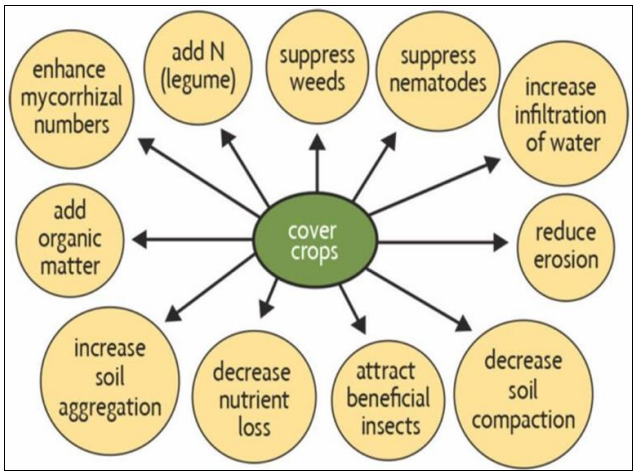
Introduction
Nelson *et al*., 2010 [15] narrated the green manuring and Greenleaf manuring provide multiple benefits to improve the soil fertility and crop productivity. These will improve the soil properties and thereby increasing the soil nutrients availability. No nutrient deficiency has shown in the field, it also helpful for increasing nitrogen uptake by plants and improving crop yield. Li *et al*., 2021 [12] reported that green manure crops, such as *Sesbania aculeata* has been found to increase soil organic matter content, nutrient availability. Through biological nitrogen fixation, increase the nitrogen supply for subsequent crops (Irin and Biswas 2021) [8]. Chandrasoorian *et al*., 2020 [5] reported that the use of green manure crops increased the sustainable soil health. It is one of the slow releasing soil nutrients and enhance the nitrogen content organically. Ansa and Wiro 2020 [2] reported that in addition, green manure crops also contribute to sustainable soil water conservation by reducing erosion. Biological nitrogen fixation improved by green manure application as reported by Kaur *et al*., 2019 [10]. Productivity and profitability have been attained through greenmanure application as narrated by Lorraine *et al*., 2015 [13]. Soil biodiversity can be improved by the application of green manuring.

Effect on chemical properties of soil pH
Continuous application of green manuring has been reduced the pH considerable over the period of time as given by Acharya *et al*., 1988 [1]. The pH of the soil remained almost unchanged by the action of the fertilizers and green manures as noticed by Bhriguvanshi (1988) [4]. The effect of organic matter on soil properties and found that pH of soil did not vary much with incorporation of crop residues and green manures over fertilizer application also reported a decrease in pH (0.2 units) with the addition of sesbania green manuring as reported by Badanur *et al*. (1990) [3]. The post incorporation of in-situ green manures the soil pH and EC and in sampling area has been changed as follows. 1 pH from 7.27 to 7.40, EC from 0.22 to 0.129, 2 OC from 0.58% to 0.68%, 3 OC from 0.39% to 0.61%.

Effect on organic carbon, N, P and K availability

An increase in organic carbon content in the soil due to addition of Sesbania, sunhemp and subabul green leaves as given by Badanur *et al*. (1990) [3] and Swarup (1991). An increase of 44.5% in the available N content due to addition of subabul loppings was noticed by Narkhede and Ghugare (1987). The increase of 21-24 per cent in available nitrogen content of rice soils as reported by Patil and Kulkarni (1992) [16]. Thangaraju and Kannaiyan (1990) while studying the efficiency of green manure on soil fertility, it was observed that accumulation of inorganic N fractions (NH_4^+-N + NO_3-N) were more during the decomposition of *S. rostrata* and increase of NH_4^+-N was significant during 3rd and 4th week of decomposition and a gradual increase in the NO_3-N accumulation was also observed during the decomposition of *S. aculeate* and *S. rostrata*. A significant increase in the available N with the addition of green manures and also observed that the incorporation of daincha to the rice crop could replace or save the N addition of 40-120 kg ha^{-1} as reported by Murthy *et al*. (1990) [14], Prasad (1994) [17] and Budhar *et al*. (1991). The post incorporation of in-situ green manures organic carbon (OC) in sampling area has been changed as follows. 1 OC from 0.33% to 0.58%. 2 OC from 0.58% to 0.68%. OC from 0.39% to 0.61% (Kumar *et al*. 2024)

While studying the effect of herbicides and green manuring on nutrition of wet land rice, Swarup (1987) observed that the incorporation of green manure increased the available K status of soil. The available K content increased trend was noticed by Prasad (1994) [17] due to addition of Subabul, Sesbania and Pongamia green manures. observed that when daincha was incorporated to low land rice, the available K status of a soil was found either equal to or higher than the initial values at the end of 2 seasons showing sustained availability of potassium in soil. Green manure crops, as well as the organic matter they add to the soil, promote the activity of soil microorganisms. Organic acids from decomposed green manures enhance the solubility of important nutrients such as lime, phosphate, and various trace elements. As a result, these nutrients become more available to plants, supporting their growth and overall health (Kumar *et al*. 2024)



(Geo Pard Agriculture, 2025)

Effect on Yield

Response of rice to Sesbania was reported by Maskina *et al*. (1984),

Meelu and Morris (1987), Mahapatra *et al*. (1987) and Mahapatra and Sharma (1989). Maskina *et al*. (1989) concluded that the green manures were equally efficient in increasing the grain yield of rice and the increase in yield was equivalent to 120 kg N ha^{-1} as urea. Halepyati and Sheelavantar (1990) concluded that incorporation of high-density *S. rostrata* resulted in the highest grain yield. Balasubramaniyan and Planiappan (1990) found an increase of about 7% in grain yield for green manured plots. The capable of producing and sustaining more than 6 t ha^{-1} rice yield equal to more than 120 kg inorganic N through sesbania alone application. Raju and Reddy (1991) observed that the incorporation of daincha @ 5 t ha^{-1} increased the grain yield by 42.8% compared with N, but *S. rostrata* did not improved the yield markedly. This may be due to differences in N and lignin contents of plant tissues.

Rakhi and Bajwa (1994) found that green manure amended wetland rice soils undergo lower volatilization losses. Matiwade and Sheelavantar (1994 b) observed that grain yield produced with the application of *Sesbania rostrata* alone was equal to or more than that observed with the application of the recommended dose of N to rice crop. Grain and straw yields of rice were significantly increased and higher number of grains per panicle, number of panicles per hill, grain weight $hill^{-1}$, 1000-grain weight and panicle length was observed in sesbania green manure application was reported by Matiwade and Sheelavantar, 1994. a). Hiremath and Patel (1996) reported that the yielding ability of rice with green manuring of *S. aculeata* or *C. juncea* alone was comparable with that under recommended dose of N and it was attributed to improvement in yield components. Mathews and Stewart (1994) reported 12.3% higher yield due to application of gliricidia foliage @ 5 t ha^{-1} over the control.

Increase in rice grain yield owing to green manuring over cowpea fodder, wheat straw incorporation and the control was 7.4, 7.0 and 20% in 1996 and 13.2, 12.8 and 27.8% in 1997 respectively. Solaiappan *et al*. (1996) found that green manure crops like *S. rostrata*, *S. cannabina* and *S. speciosa* can be raised before single crop rice in wetlands of Periyar Vagai command area utilizing the pre-season rainfed for increased production in the succeeding rice. Hiremath and Patel (1996) observed that Prickly sesban (*S. cannabina*) green manuring significantly increased the grain yield of rice and also reported that incorporation of *C. juncea*, *S. rostrata* increased the panicle number and weight considerably in rice. The net returns ha^{-1} obtained through green manuring was higher than the control. Integrated use of purely organic sources namely *S. rostrata* green manure with FYM was superior to the recommended practice of applying N (120 kg N ha^{-1} as prilled urea), which produced the highest yield of rice 18 and 11 per cent higher than 120 kg N as in the two years. Recent studies have shown that green manure N was generally as effective as fertilizer N (Singh *et al*., 1999). Dubey and Verma (1999) concluded that the effect of organic manures alone (gliricidia leaf) on plant height, panicles m^{-2} and filled grains $panicle^{-1}$ was similar among themselves and better than the control. Chaphale and Badole (1999) noticed that significantly higher yield of grain and straw was recorded by incorporation of gliricidia foliage @ 5 t ha^{-1} over the control. Singh *et al*. (2000) [18] noted that the highest yield was obtained in the treatments with poultry manure and *S. rostrata*, by imparting better improvement of soil structure, bulk density, CEC and WHC of the soil with greater availability of nutrients as compared to other treatments. Similar findings have also been reported.

Integrated N management through Sesbania with FYM can be used instead of 120 kg N as prilled urea, the recommended dose in a rice – wheat rotation and it was also equal to >180 kg inorganic N. Green manuring along with FYM application as

purely organic source boosted rice yield to 6.9 t ha^{-1} (Gupta *et al*., 2000) [7]. concluded that at 200 kg N ha^{-1} full substitution of fertilizer N with green manure reduced the grain yield but the partial substitution through green manure recorded almost similar or comparable yield with fertilizer N. Budhar *et al*. (1991) found that *Kharif* rice receiving green manures recorded significantly higher (14 – 38%) grain yield over no green manure mainly due to N supplying effects of green manures. Such beneficial effects of green manures in increasing rice yields were earlier reported by Singh *et al*. (2000) [18] found that the increase in grain yield over control was 2.6 t ha^{-1} (102.7%) with poultry manure and 2.5 t ha^{-1} (98.0%) with *S. rostrata* followed by chemical fertilizer at 2.47 t ha^{-1} (96.9%). concluded that among various organic sources, in-situ incorporation of daincha @ 12 t ha^{-1} remarkably increased the grain (18%) and straw (16%) yield of rice over no organic manure owing to increase in growth and yield attributing characters of rice.

Effect on residual nutrients

Green manure incorporation might lead to better P nutrition by reducing bonding energy and P sorption maxima (Hundal and Dhillon., 1993). Budhar *et al*. (1991) reported that the post harvest soil sample analysis indicated that *S. rostrata*, FYM, biogas slurry and poultry manure applied plots had higher amount of residual N in the soil. Nitrogen accumulated by *S. rostrata* at the time of incorporation (55 days after sowing) was 156 kg ha^{-1}. The application of green manure enables the utilization of the fixed nutrients of soil in available form and regulation of its supply to the crop through mineralization and prevention of leaching and other losses was reported that Organic materials acting as slow release source of N are expected to more closely match N supply with rice N demand, and this could reduce N losses.

found that *S. rostrata* registered significantly higher soil organic carbon which was 10.63% higher than traditional rice-rice cropping system. This might be due to the following a) Green manure was totally returned to soil as carbon inputs. b) Green manure plants add lignin N. c) Green manure contains polyphenols, which might have provided fast route to increased soil organic carbon (Cadisch and Giller, 2001). d) Root released carbon of green manure accounted for 20-40% of photosynthetically fixed carbon from different plants. Daincha incorporation significantly improved the soil fertility status by increasing organic carbon content, available soil N, P and K at post-harvest stage as reported by Singh *et al*. (2000) [18]. reported that the available N of the soil increased from the initial status of 225 kg ha^{-1} to 243.2 kg ha^{-1} with poultry manure, to 238.5 kg ha^{-1} with *S. rostrata*, and to 233.5 kg ha^{-1} with FYM whereas available N decreased from initial status to 198.4 kg ha^{-1} in the control.

Effect on uptake of nutrients

Reported that green manure incorporation significantly increased the major nutrients uptake possibly due to the improved availability of these nutrients. Addition of green manure benefited the rice crop through increased N availability in soil as seen from the higher uptake by rice crop efficient utilization of mineralized N from the incorporated *Sesbania rostrata* as reported by Sripriya (1993). While studying the effect of green manuring in rice monocropping, it was found that incorporation of green manures to rice field significantly increased the N, P and K uptake possibly due to the enhanced availability of these nutrients as reported by Omar (1995) and Jagadeswari (1997). Chitra *et al*. (1999) found that the organics *viz*., green leaf manure and composted sugarcane trash recorded highest apparent N recovery by rice in *Kharif* and *Rabi* season. Singh *et al*. (2001) observed that among the organic matter sources, the total uptake of nutrients through the green manure treatment was found to be maximum. In a two year experiment with rice observed that application of green manure + azospirillum significantly increased the N uptake and it was comparable with FYM + azospirillum during 1995-96, but it was on par with FYM + Azolla during 1996-97. A field experiment conducted to study the iron availability and nutrient content of rice as influenced by green manuring revealed that application of green manures increased Fe, Mn, Zn and S content of rice. Green manuring resulted in significantly larger amount of total nutrient uptake than other organic manure. Application of green manure increased the Zn, Mn uptake.

Conclusion

The green manures are very essential for environmental sustainability by reducing fertilizers and pesticides, improving soil physio chemical properties, controlling soil and water erosion, and preventing the leaching of nitrate and other chemical inputs into surface and groundwater. The application of green manure plants improves the soil physical, chemical, and biological properties by increasing the amount of organic matter and thereby increasing the organic carbon content of the soil. Moreover, it acts as a binding agent resulting soil structure improvement. The microorganisms are rich in green manured soil and thereby increasing the nutrient availability in soil. According to several previous studies and current studies, the incorporation of several green manure crops significantly improved the chemical, physical and biological properties of the soil.

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