Enhancing Soil Fertility through Brown Manuring

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ABSTRACT

Weeds significantly hinder agricultural productivity by reducing crop yield and depleting soil nutrients. While inorganic fertilizers and herbicides are commonly used to enhance yields, their application adversely impacts soil health and the environment due to the release of toxic substances. Brown manuring emerges as an eco-friendly solution to these challenges. It effectively suppresses weeds while providing additional benefits such as biological nitrogen fixation, enrichment of soil with macro and micronutrients, conservation of soil moisture, and enhancement of soil's physical, chemical, and biological properties. This sustainable approach offers a promising alternative to conventional methods, fostering improved agricultural outcomes and environmental health.

INTRODUCTION

Soil fertility is the ability of soil to provide essential nutrients and support plant growth. Over time, soil fertility can decline due to several factors such as overuse of chemical fertilizers, excessive tilling, and continuous monocropping. Depletion of organic matter, loss of soil structure, and erosion further degrade soil quality. Additionally, conventional farming practices can cause nutrient imbalances, reduce microbial activity, and ultimately diminish crop yields. Brown manuring is an

advanced weed management technique that has gained popularity in India. It aims to control weeds without harming the soil characteristics, including physical, chemical, and microbiological aspects. To enhance soil fertility, Brown manuring is an innovative, eco-friendly technique where an additional cover crop is sown along with the main standing crop. These cover crops are later terminated using non-selective herbicides, typically at the flowering stage. Once desiccated, the cover crop residues remain in the field, turning brown in color, so it is called brown manuring (Tanwar *et al.* 2010). Unlike traditional green manuring that involves tilling the soil to incorporate the biomass, brown manuring is a no-till approach, leaving the residues on the soil surface. This helps in maintaining soil cover, conserving moisture, preventing erosion, and improving soil organic matter content. By enhancing soil structure and microbial activity, brown manuring also supports nutrient recycling, contributing to long-term soil fertility and sustainability in cropping systems (Das *et al*., 2020). This method provides the dual benefit of organic matter incorporation and weed suppression, reducing the need for additional tillage or chemical interventions. Brown manuring can be practiced in maize, rice, sugarcane etc.

Difference between Green manuring and Brown manuring

Green Manuring	Brown Manuring
Incorporation of a manure crop into the soil by tillage before seed setting, typically at flowering.	A no-till method where herbicides are used to kill the manure crop and weeds, leaving plants standing.
May increase surface erosion due to soil disturbance during incorporation.	Reduces soil erosion as plants remain standing, protecting lighter soils from wind and water erosion.
Requires adequate soil moisture for incorporation and decomposition.	Helps conserve soil moisture by minimizing soil disturbance and leaving plant cover.
Microbial activity is essential for the decomposition of incorporated manure.	Decomposition happens gradually as standing plants break down over time.
Controlled through tillage, which can disturb weed growth.	Controlled through chemical desiccation using herbicides.

Importance of brown manuring on soil health

Incorporating brown manuring alongside pre-emergence herbicides significantly enhances the soil's physical and chemical properties. This practice boosts soil organic matter content, improves soil aggregation, and promotes the availability of essential nutrients, especially nitrogen, within the root zone. By enriching the organic matter, brown manuring helps create better soil structure, which facilitates water infiltration and root development while reducing bulk density. Additionally, it mitigates nutrient losses, particularly nitrogen, by minimizing leaching and runoff, thus preventing soil erosion. The synergistic effect of combining brown manuring with herbicide application supports overall soil health, fosters nutrient retention, and enhances crop productivity, while simultaneously offering sustainable long-term benefits to the agricultural ecosystem (Iliger *et al*., 2017).

Crops suitable for brown manuring

(i) Leguminous crops: Crops provide nitrogen as well as organic matter to the soils. Legumes can fix atmospheric nitrogen with the help of its nodule bacteria. The legumes are preferably used in green manuring crops

Example: Sun hemp, Dhaincha, Mung, Cowpea, Lentil etc.

(ii) Non leguminous crops: The non-leguminous crops used as a green manuring crop which provide only organic matter to the soil. These are used to a limited extent. Example: Niger, Wild indigo etc. (Chauhan and Rahevar, 2021)

Leguminous crops, such as Dhaincha, Sunn Hemp, and Cowpea, are frequently used in brown manuring due to their ability to biologically fix atmospheric nitrogen into the soil while simultaneously adding organic matter. This dual benefit enhances soil fertility and supports sustainable crop production. In contrast, non-leguminous crops like Niger and Wild Indigo, which contribute only organic matter without nitrogen fixation, are less commonly used for this purpose. The integration of leguminous crops with cereals is considered an ideal practice. Cereals can efficiently utilize a portion of the nitrogen fixed by legumes, creating a synergistic effect that boosts yield and maintains soil fertility. This combination offers a range of benefits, including improved productivity, sustainable soil health, and enhanced ecosystem services, such as better water retention and nutrient cycling. The intercropping system of legumes and cereals not only supports higher yields but also contributes to long-term sustainability by minimizing the need for synthetic fertilizers and promoting natural nutrient replenishment.

Benefits of using brown manuring

Enhanced Soil Organic Carbon and Nitrogen Efficiency: Brown manuring increases soil organic carbon levels, which in turn supplies essential nitrogen to crops. Sarangi et al. (2016) indicates that up to 25% of nitrogenous fertilizer can be substituted by the nitrogen provided through brown manuring, reducing dependency on synthetic fertilizers.

Improved Soil Health and Biodiversity: Brown manuring not only enriches soil organic carbon but also enhances biological parameters, such as earthworm population, which are key indicators of healthy, fertile soil.

Soil Moisture Conservation and Erosion Control: This practice helps in conserving soil moisture while reducing both surface runoff and wind erosion, thereby protecting soil structure and minimizing nutrient loss.

Eco-Friendly Weed Management: Brown manuring serves as an environmentally sustainable method for weed suppression. For example, the use of Sesbania in direct-seeded rice systems has been shown to reduce weed density by 41–56% (Nawaz et al., 2017).

Affordability for Resource-Poor Farmers: Many Indian farmers operate with limited financial resources, brown manuring offers substantial benefits with minimal input costs, making it an economically viable solution for improving soil health and crop productivity.

CONCLUSION

Brown manuring is a sustainable agricultural practice in which plant biomass is returned to the agroecosystem to rejuvenate soil fertility and enhance the availability of essential nutrients. This method plays a key role in improving both the physical and biochemical properties of the soil, thereby contributing to better soil structure, nutrient retention, and microbial activity. In addition to enriching the soil, brown manuring also offers economic benefits to farmers by reducing the need for synthetic fertilizers and pesticides, making it a cost-effective practice. Importantly, the practice plays a significant role in balancing greenhouse gas emissions by increasing soil organic carbon and mitigating harmful emissions. brown manuring is an eco-friendly technique that enhances overall agroecosystem health. It should be actively promoted by extension agencies to maximize its potential

and make its benefits accessible to farming communities across the nation.

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