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Investigation On Improvement In Fertility Of Soil By Practicing Organic Farming Through Cultivation Of Green Manures As Intercrop In Davangere District

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Abstract

Organic farming is a traditional practice that aids in the conservation of our natural ecosystem and the maintenance of soil fertility. The transition from inorganic to organic farming requires time. Consequently, the Department of Horticulture and ICAR-Taralabalu Krishi Vigyan Kendra in Davanagere District have initiated the Paramparagat Krishi Vikas Yojana (PKVY) program to advance organic farming practices. The concept was exemplified in Rameshwara Village, Nyamathi Taluk. Fifty families were selected from the hamlet to engage in three distinct types of demonstrations: intercropping in an Arecanut plot, maize fallow field and onion fallow field. Each family receives five kilogrammes of seed. The chemical parameters have been subjected to pre- and post-soil testing and analysis. The soil had a pH range of 7.21 to 7.48. The three separate demonstrations under examination. The pH of the soil remained constant, irrespective of whether Velvet Beans were inter planted or cultivated sequentially. The organic carbon levels of the three demonstration plots ranged from 0.53% to 0.61%. The inclusion of velvet beans in all demonstrations will result in an increase in organic carbon levels. Before the planting of velvet beans, the average nitrogen availability was 192.1 kg ha-1; however, in three demonstration plots, this figure ranged from 216.4 kg ha-1 to 239.1 kg ha-1. Before planting, the mean quantity of available phosphorus was 11.85 kg ha-1. Conversely, the onion fallow field exhibited the lowest percentage accumulation at 14.8, and the velvet bean intercropped Arecanut plot demonstrated the highest at 16.8. The soil's capacity to absorb potassium has markedly enhanced in each of the three demonstrated plots. In all three demonstrations, the soil microbial population exhibited a significant rise. The physicochemical properties of the soil are enhanced by the incorporation of green manure velvet beans. Modifying the quantity of microorganisms in the soil also facilitates changes in the soil's biological activity.

Key words: Velvet Beans, Fallow field, Demonstration, Microbial, Biological

Introduction

The fundamental idea of organic farming is to coexist peacefully with nature. Creating a food production system that can withstand the test of time in terms of society, the economy, and the environment is the overarching objective of this integrated strategy. It is a kind of agricultural art that avoids the use of synthetic fertilisers, pesticides, additives, or genetically modified organisms in the management of the agricultural environment.

A natural strength and advantage of India is the country's organic farming system. From a worldwide viewpoint, the agricultural production system is shifting from chemical farming to organic farming in response to the increasing demand for organic products around the world. Organic farming, a practice influenced by nature, is based on repurposing our non-synthetic agricultural expertise from the past. The overuse of chemical farming has detrimental effects, but this technique can help mitigate those effects. In addition, it will boost agricultural output and productivity in a sustainable way, which is essential for a growing population, without upsetting the delicate ecological balance.

Switching from chemical to organic farming all of a sudden is a huge challenge. We must progressively apply the particular principles of organic farming while considering the whole production level. In this light, the Paramparagat Krishi Vikas Yojana (PKVY) initiative in the Davanagere District has helped spread awareness of organic farming methods. The initiative is a collaboration between the Department of Horticulture and the ICAR-Taralabalu Krishi Vigyan Kendra in Davanagere.

Material and Methods

The project was shown in Rameshwara Village, situated in Nyamathi Taluk. One hundred fifty families from the neighbourhood were selected to get guidance and instruction on using organic farming techniques. The fundamental objective of the ongoing study is to assess the current nutritional condition of the soil and then monitor the physicochemical changes occurring in the same field. Simultaneously, the attributes of productivity were evaluated with the economic benefits.

Velvet Beans, scientifically referred to as Mucuna pruriens, are a green manure crop appropriate for intercropping inside Arecanut gardens of the perennial creeper form. It exhibits a climbing habit and possesses a trifoliate structure, with larger pods that carry seeds. It can flourish in diverse soil conditions, with a pH range of 5.0 to 8.0. It has the ability to fix atmospheric nitrogen at a rate of 150 to 270 pounds per acre.

Florence Boniface et al. (2024) examined the promotion of legume pulses, specifically Mucuna pruriens, as a meat alternative and component of a nutritious diet for various cultures. A multitude of individuals remain uninformed about the nutritional value and importance of M. pruriens L throughout various nations, as geographical location significantly affects the chemical composition of food plants. The seeds of M. pruriens possess anti-nutritional characteristics; yet, with appropriate processing, they can transform into a significant food source akin to legumes. The efficient processing of Mucuna seeds is essential for preserving phytochemical concentrations, nutritional quality, and protein integrity.

Table 1 presents the agronomic data relevant to velvet beans. Each farmer receives ten kilogrammes of velvet beans for cultivation as an intercrop in the current arecanut garden (fifty farmers), maize fallow field (fifty farmers) and onion fallow field (fifty farmers). Soil testing was conducted on each farmer's field to ascertain the parameters including pH, EC, and NPKS before the cultivation of the velvet bean crop. The crop was planted during the Kharif season to maximise its establishment potential. Following a period of 120 to 130 days post-planting, the soil is then tilled using a disc harrow to establish a mulch layer. Following the reintroduction of the same crops for two months, soil testing was conducted to assess any enhancements in soil fertility quality.

Soil samples were obtained using normal techniques, and the dried samples were analysed following the methods described by Piper (1966) and Jackson (1973).

Soil electrical conductivity was assessed in the supernatant of a 1:2 soil-water suspension using an electrical conductivity meter (Piper, 1950). The Walkley and Black (1934) method was employed to ascertain soil organic carbon content. The accessible soil nitrogen was evaluated employing the Alkaline Permanganate method (Subbiah and Asija, 1956). The measurement of available phosphorus was performed using Olsen's reagent (0.5 N sodium bicarbonate solution at pH 8.5), in which stannous chloride is transformed into blue shades, corresponding to the phosphate concentration. The measurement was performed using the spectrophotometer (Olsen et al., 1954).

The soil potassium content was evaluated with a 1N natural ammonium acetate solution and a flame photometer (Jacklon, 1973). A sample was agitated with a 0.15% CaCl2 solution to ascertain the available soil sulphur. The filtrate was examined for sulphur, with turbidity arising from the precipitation of sulphate as barium sulphate, measured using a spectrophotometer at a wavelength of 420 nm (Bradley and Lancaster, 1960). The soil microbial population was examined using several dilution methods. Soil samples were examined for diverse soil microorganisms, including total bacteria, total fungi, and total actinomycetes, utilising the standard dilution plate count method and inoculation on designated nutrient media. The medium formulas utilised for the analysis of several microorganisms are detailed in Table 2.

The gathered data were systematically arranged into tables and examined for variance following the methods established by Panse and Sukhatme (1967). The experimental data underwent statistical analysis via a Randomised Block Design. The critical difference values were computed at a 5% significance level.

Results and discussion

Soil and pH

The pH of the soil varied from 7.21 to 7.48 throughout three independent samples under examination. The soil pH was unchanged by intercropping with Velvet Beans or by follow farming. The electrical conductivity of the soil diminished in all three demonstrations, however it was not significantly impacted. The electrical conductivity (EC) ranged from 0.16 to 0.36 dS m-1 across three separate demonstrations (Table 3 and Fig. 1). Altering soil pH and electrical conductivity values in a short timeframe is typically unfeasible, as they are dictated by the parent material. Nonetheless, Kumar and Singh (2010) and Balakrishna et al. (2024) attained similar results.

Soil Organic Carbon

The organic carbon concentration in the three demonstration plots varied between 0.53% and 0.61% (Table 3). The incorporation of Velvet Beans in all demonstrations will yield an increase in organic carbon levels. The greatest notable growth was recorded in the Arecanut intercropped plot (0.61%), succeeded by the fallow onion plot (0.59%). The increase in organic carbon during demonstrations may be ascribed to the accumulation of carbon in the soil due to the incorporation of green manure crops. The integration of green manure, root biomass, and residual stubbles has resulted in an enhancement in soil organic carbon (Aher et al. 2015).

Divya Bhagas et al. (2018) discovered that the integration of sunhemp green manure and intercropping with other field crops resulted in a substantial enhancement in soil organic carbon generated by green manure. The results of Selvi and Kalpana (2008), Bhanuvalli and NH (2024), and Chand et al. (2011) were analogous to those of earlier researchers.

Soil Available Nutrients (N, P, K & S)

In the three trial plots, the available nitrogen varied between 216.4 and 239.1 kg ha-1, but in the mean plot it was 192.1 kg ha-1 prior to velvet bean seeding. Intercropping velvet beans has a significant impact on soil nitrogen levels. The breakdown of dry materials and leftover agricultural detritus in the soil causes the increased build-up.

Prior to planting, the average amount of accessible phosphorus was 11.85 kg ha-1. Onion fallow field had the lowest percentage accumulation (14.8), whereas velvet bean intercropped Arecanut plot had the most (16.8). The soil microflora may have mobilised phosphorus-solubilizing bacteria, which could explain the dramatic rise.

The soil's ability to absorb potassium has been significantly improved in all three of the displayed plots. The data enhancement is in sync with all the proofs. Between 536.1 and 583.4 kg ha^{-1}, there was an improvement range.

There was 13.5 kg ha-1 of sulphur in the first soil sample. The sulphur concentration, however, showed an increasing trend in all three tests, with an average value of 15.2 kg ha-1.

The mineralisation of phytomass and atmospheric nitrogen fixation by the leguminous crop may explain why the soil's nutrient availability increased after velvet beans were integrated. The phosphorus content of the soil increased in a direct correlation with the change in soil pH. Ziblim et al. (2013) and Biradar and Palled (2008) found similar results regarding the improved soil nutrient status.

After two growing seasons, Ariel Freidenreich et al. (2022) found that treatments with Sunhemp produced 48-71% more dry biomass material than treatments with Velvt beans. Soiling Sunhemp also resulted in significantly higher amounts of Total Nitrogen and Total Carbon in its dry biomass. The treatments that were most effective in terms of soil organic matter, total carbon, and nitrogen building were sunhemp, sunhemp + chicken manure, and fallow + poultry manure.

Soil Microbial population (Bacteria, fungi and Actinomycetes)

The soil microbial population exhibited substantial growth in all three situations (Table 4). The bacterial count was greatest in the maize fallow field (28.6), succeeded by the onion fallow field (23.4). Nevertheless, the fungal population was more prevalent in the maize fallow field, succeeded by the onion fallow field (19.1). The arecanut intercropped with velvet beans had the highest population of Actinobacteria (20.4), succeeded by the maize fallow field (18.4). The increased microbial population in soil enriched with green manure may stem from the augmented accumulation of organic carbon, which acts as an energy source for bacteria, as shown by Rajannan & Oblisami (1979).
Dumkhana et al. (2023) indicated that the effects of velvet bean powder (VBP) on crude oil were evaluated for its NKP values, demonstrating its efficacy in the restoration of soils contaminated with petroleum hydrocarbons. In the bioremediation of hydrocarbon-contaminated soils, the efficacy of VBP-modified soils substantially enhanced total petroleum hydrocarbon (TPH) removal across all treatments, with the most significant reductions observed in options C, D, and E, which comprised ratios of 4:1:1, 8:2:3, and 4:1:2, respectively. VBP applied to oil-contaminated soil exhibited enhanced effectiveness by augmenting microbial communities that reduce petroleum hydrocarbon pollution in hazardous soil.
The increased microbial population after applying different organic matter sources largely aligns with the findings of Aher et al. (2018).

Conclusion

When green manure velvet beans are integrated into the soil, they help enhance the physicochemical properties of the soil, which is one of the reasons why they are helpful to the soil. By producing a change in the number of microbial communities, it also contributes to the transformation of the biological activity of the soil, which is a significant factor in the overall change. Therefore, it is possible to draw the conclusion from this study that green manures are one of the components that contribute to the maintenance of the organic ecosystem and are also involved in the process of restoring the fertility condition of the soil. This conclusion might be attainable because of the fact that this study was conducted.

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Table 1: Initial Soil Properties of Demonstration plots.

Sl.No	Soil property	Arecanut Plot	Maize Fallow Field	Onion Fallow Field	Mean
01	Sand (%)	11.6	9.8	10.4	10.6
02	Clay (%)	28.6	21.6	23.6	24.6
03	Silt (%)	44.9	41.3	49.3	45.16
04	Electrical Conductivity (dSm^{-1})	0.32	0.56	0.68	0.52
05	Soil pH	7.81	7.74	7.96	7.83
06	Organic Carbon (%)	0.41	0.34	0.31	0.35
07	Available Nitrogen ($Kg\ ha^{-1}$)	184.6	198.1	193.6	192.1
08	Available phosphorus ($Kg\ ha^{-1}$)	13.48	11.26	10.81	11.85
09	Available Potassium ($Kg\ ha^{-1}$)	484.1	413.7	456.9	451.5
10	Available Sulphur ($Kg\ ha^{-1}$)	14.1	13.8	12.6	13.5
11	Bacteria ($X\ 10^{6}$)	13.1	12.8	11.6	12.5
12	Fungi ($X\ 10^{3}$)	11.4	11.8	11.1	11.43
13	Actinomycetes ($X\ 10^{4}$)	13.8	12.1	11.9	12.6

Table.2 Chemical composition of standard media for fungi, bacteria and actinomycetes

Chemical Composition	Rose Bengal (Fungi)	Thornton's media (Bacteria)	Caseinate Agar Media (Atinomycetes)
Glucose	10 gm	-	-
Peptone	5gm	-	-
KH_2PO_4	1gm	-	0.5 gm
$MgSO_4$	0.03gm	0.2gm	0.2 gm
Agar-Agar	15-18gm	15-18 gm	15-18 gm
Distilled water	1000ml	1000 ml	1000 ml
$CaCl_2$	-	0.2 gm	-
$FeCl_2$	-	Trace	-
$NaCl_2$	-	0.1 gm	-
KNO_3	-	0.5 gm	-
Asparagin	-	0.5 gm	-
Mannitol	-	1 gm	-
Yeast extract	-	Trace	-
Sodium Caseinate	-	0.2 gm	-
$FeCl_3$	-	0.01 gm	-

Table 3: Soil chemical parameters as influenced by Velvet Beans cultivation in three different cropping systems

Sl.No	Demonstration	pH	EC	OC	N	P	K	S
01	Arecanut + Velvet Beans	7.43	0.16	0.61	216.4	16.8	536.1	16.8
02	Maize Fallow field	7.21	0.31	0.53	241.6	15.1	583.4	14.9
03	Onion fallow field	7.48	0.36	0.59	239.1	14.8	568.7	13.9
04	Mean	7.37	0.27	0.57	232.3	15.56	562.7	15.2
05	SEM (+)	0.04	0.01	0.03	5.1	0.9	6.1	0.3
06	DCP=0.05	NS	NS	0.11	16.8	1.9	21.8	1.4

EC-Electrical Conductivity (ds m^{-1}): OC-Organic Carbon (%): N –Nitrogen, P-Phosphorus, K-Potassium, S-Sulphur (kg ha^{-1})

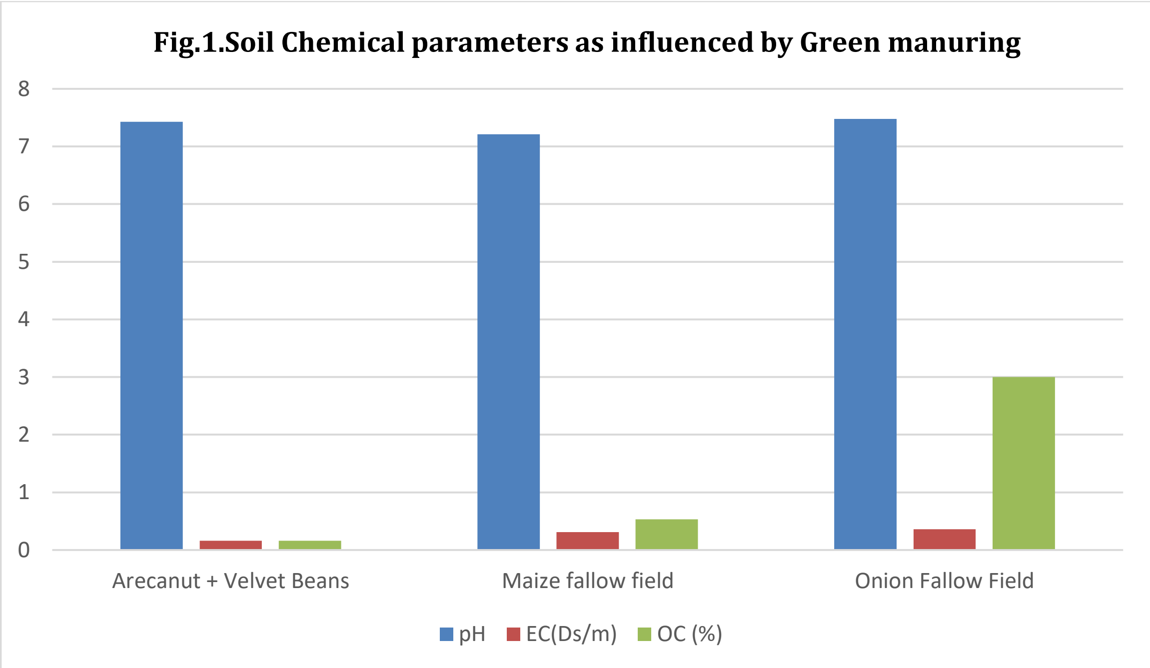

Table 4: Soil Microorganisms status after the Green Manuring of Velvet Beans

Microorganism	Arecanut + Velvet Beans	Maize Fallow field	Onion fallow field
Bacterial (x 10^6)	21.8	28.6	23.4
Fungi (x10^3)	18.6	19.8	19.1
Actinomycetes	20.4	18.4	17.8