



Correlation of Organic Carbon Content of Soil on Paddy Productivity: A Case Study

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Abstract

Soil fertility is one of the important factors controlling yield of the crops. Macronutrients (N, P, K and S) are important soil elements which control its fertility. Soil characterization in relation to evaluation of fertility status of the soils of an area or region is an important aspect in context of sustainable agriculture production. A high SOM (Soil Organic Matter) content provides nutrients to plants and improves water availability, both of which enhances soil fertility and ultimately improve food productivity. Since 2017 ARF with support of NABARD has been conducting trials on 300 acres of agriculture land of villages of district Sonapat, Haryana using hydroponically grown Paddy nursery. A study was carried out on randomly selected 50 acres of land to see the effect of SOC (Soil Organic Carbon) and N (Nitrogen) content on the yield in hydroponically grown paddy.

Keywords: Soil Organic Carbon, hydroponic, paddy, rice, transplantation

1. Introduction

Rice is the staple food crop for more than 60 percent of the world population and dominant crop cultivated in large parts of Asian agriculture regions, where about 90% of the world's rice is produced and consumed. Haryana is the second largest producer of rice in India after Punjab. Soil fertility is one of the important factors controlling yield of the crops. Macronutrients (N, P, K and S) are important soil elements which control its fertility. The knowledge of physico-chemical properties is crucial for characterizing and/or improving soil health to attain optimal productivity for each soil/climatic condition. Soil characterization in relation to evaluation of fertility status of the soils of an area or region is an important aspect in context of sustainable agriculture production. Because of adoption of highly intensive rice wheat cropping system along with imbalanced and inadequate fertilizer use, tillage practices coupled with low use of other inputs such as organic manures and crop residues, the production efficiency of chemical fertilizer nutrients has declined tremendously under intensive agriculture in recent years in rice growing soils of Haryana (Chetan. G et al, 2016).

Plants need an adequate supply of nutrients to grow and complete their reproductive phases. There are 17 nutrient elements that most land plants need for productive growth and development. Elements of concern for soil fertility management are classified into three categories. The first category is called primary nutrients: nitrogen, phosphorus, and potassium. The second category is called secondary nutrients: calcium, magnesium, and sulphur. The third category is called micronutrients: zinc, manganese, boron, copper, chlorine, iron, nickel, and molybdenum. All these nutrient elements are essential for plants, and the absence of any of them will cause plant disorders and affect plant growth and yield (Kanaujia, A et al, 2021).

Healthy soils are important to grow healthy crops, raising healthy animals, and supporting a healthy human population through nutritionally balanced diets. Most agricultural soils are depleted of their soil organic matter (SOM) reserves. SOC is the main component of soil organic matter (SOM). As an indicator for soil health, SOC is important for its contributions to food production, mitigation and adaptation to climate change, and the achievement of the Sustainable Development Goals (SDGs). A high SOM content provides nutrients to plants



and improves water availability, both of which enhances soil fertility and ultimately improve food productivity. Moreover, SOC improves soil structural stability by promoting aggregate formation which, together with porosity, ensures sufficient aeration and water infiltration to support plant growth. It is one of the factors that help in increasing water holding capacity. It improves cation exchange capacity to hold huge quantities of positively charged nutrients such as calcium, magnesium and potassium until the plant needs them.



Fig 1: Hydroponic machine (Abha et al., 2019)



Fig 2: Mechanized Paddy transplantation

Ayurved Research Foundation (ARF) a public charitable trust, undertakes various initiatives for the sustainable integration of livestock and agriculture for the benefit of farmers and society at large. In the year 2020, Govt. of Haryana sanctioned Soil Health Card project to ARF to carry out fertility status study of 3000 acres of land of village Baroda Mor, block Mundlana, tehsil Gohana, Sonipat, Haryana and distribute the cards well before the harvesting of Rabi crop in year 2021. Team ARF systematically carried out the registration of farmers, collection of 3000 soil samples, analysis for 12 parameters namely N, P, K (Macronutrients); S (Secondary-nutrient); Zn, Fe, Cu, Mn, B (Micro - nutrients); and pH, EC, OC (Physical parameters), fertilizer recommendation and distribution of cards. Soil of village was found to be moderately alkaline, majorly deficient in Organic Carbon, Nitrogen and Phosphorus. Potassium and Sulphur were in high quantity whereas secondary nutrients Zinc, Copper, Boron, Iron were found to be in range of medium to high where as Manganese was low as per the Govt. specifications. It was recommended to replenish the soil with vermicompost (@ 2.0 ton/ acre/dose)/ year to increase the organic carbon content may be one of the best options for enhanced available nutrients absorption, better crops growth and high productivity (Kanaujia, A, et al., 2021).

2. Results and Discussion

Since 2017 ARF with support of NABARD has been conducting trials on 300 acres of agriculture land of villages of district Sonipat, Haryana using hydroponically grown Paddy nursery in seven days and transplanting it with the help of automatic mechanized transplanter (Fig 1& 2) on 8th day. One of the major benefits of Hydroponically grown paddy nursery is that it uses about 95% less water as compared to conventional paddy nursery, which accounts for saving of around 1.5 lakh liters of water. Transplantation by conventional method is labour intensive process, while mechanized transplantation reduces reliance on manpower in a substantial manner. Keeping the variety same, various growth parameters like effective no. of tillers, average plant height at maturity, average no. of grain per spike, seed weight and average yield were taken into account to compare the two methodologies.



It was observed that hydroponically raised and transplanted paddy nursery accounted for an average yield gain of 1.5 -25 q per acre as compared to conventional.

A study was carried out on randomly selected 50 acres of land to see the effect of SOC (Soil Organic Carbon) and N (Nitrogen) content on the yield in hydroponically grown paddy. It was observed that, a. Fields with %OC between 0.4-0.5 have the highest yield varying from 18.0 qtl/acre - 19.2 qtl/acre, b. Fields with %OC between 0.3-0.4 have the yield varying from 16.5 qtl/acre - 17.4 qtl/acre, c. Fields with %OC between 0.2-0.3 have the yield varying from 15.0 qtl/acre - 16.5 qtl/acre, d. Fields with %OC between 0.1-0.2 have the yield varying from 16.0 qtl/acre - 16.5 qtl/acre. In general, it was observed that SOC has direct bearing on yield of crop, better the OC and N, higher the yield. Every 0.1% increment in OC resulted in 3% - 5% better yield. Other growth parameters like plant height, no. of tillers, average no. of grains/ spike have no direct correlation with %OC.

Inadequate and imbalanced nutrient supply has led to extra mining of all essential nutrients in the soil. It has been observed that in last couple of years, the yields have become almost static. The probable reason for the static yield pattern is decline in the organic matter content, imbalanced use of fertilizers, extra mining of nutrients, low use of organic manures and deficiency of secondary and micronutrients.

Organic soil management has become the pressing need today for reversing the cycle of soil degradation and thereby putting a step forward towards soil and crop sustainability. Vermicompost is a nutritive organic fertiliser rich in N, K, P, OC, micronutrients like calcium (Ca), magnesium (Mg), zinc (Zn) and manganese (Mn), acceptable C:N ratio and beneficial soil microbes. Additionally, vermicompost contain enzymes like amylase, lipase, cellulase and chitinase, which continue to break down organic matter in the soil (to release the nutrients and make it available to the plant roots). The soil treated with vermicompost has significantly more electrical conductivity (EC) and near neutral pH, scientifically proven to be excellent growth promoters and protectors for crop plants, benefits the environment by reducing the need for chemical fertilizers and decreasing the amount of waste going to landfills. Application of vermicompost at the rate of 2 tons per acre twice in a year may help farmers in replenishing the soil organic carbon for better productivity and quality production.

Conclusion

Haryana is the second largest producer of rice in India after Punjab. Soil fertility is one of the important factors controlling yield of the crops. Soil fertility is one of the important factors controlling yield of the crops. Macronutrients (N, P, K and S) are important soil elements which control its fertility. Since 2017 ARF with support of NABARD has been conducting trials on 300 acres of agriculture land of villages of district Sonipat, Haryana using hydroponically grown Paddy nursery in seven days and transplanting it with the help of automatic mechanized transplanter on 8th day. A study was carried out to see the effect of SOC (Soil Organic Carbon) and N (Nitrogen) content on the paddy yield, which revealed it has direct bearing on yield of crop, better the OC and N, higher the yield.

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A Brief Author Biography

Dr. Anil Kanaujia – Skilled Scientist with 26+ years of experience in natural product chemistry and medicinal chemistry based new drug discovery research, process chemistry, research on food safety, isolation & characterization of molecules from medicinal plants using Flash chromatography, ¹H, ¹³C and 2D NMR spectroscopic techniques; commercialization of standardized herbal extracts, standardization of polyherbal formulations, analytical research & method development and validation using HPLC-PDA, HPTLC, AAS, UV VIS spectrophotometer etc. techniques. Currently working with the AYURVET RESEARCH FOUNDATION, Sonapat, Haryana, as Head- R&D, managing and providing the guidance on innovative research projects to the team of professionals. Credited with 14 patents (10 US, 1 Chinese, 3 Indian), published 35 research articles in peer reviewed international and national journals.

Mr. Jainendra Gupta- Skilled and educated professional with more than 10+ years of experience on performing various rural development activities. Having graduation in agriculture from Dindayal Upadhyay Gorakhpur University, Gorakhpur, U.P in the year 2007. Having experience in rural development activities such Vermicomposting production, organic farming, Farmers Training, Self Help Groups (SHGs), Farmer Producer Organization (FPO), Farmer Clubs formation, Biogas, Fish Farming, etc. having experience in CSR activities Sanjeevani project, human health campaigning, toilet construction, solar light installation, stadium hall construction, science lab construction, biogas and Vermicompost unit construction. Currently working as Sr. Rural project in charge with Ayurved research foundation, leading the rural team members

Ms. Samanwita Banerjee – Skilled and educated professional with M.Sc. microbiology from Bangalore University in the year 2010. Having more than 9 years of experience of performing various microbiological and chemical testing, Research and Development in the areas of research on food safety, analytical research, feeds analysis, Milk analysis, quantification of active ingredient in medicinal plant. Having an experience on Instrumentation such as ELISA technique, UV spectroscopy, Flame photometer, IR moisture balance, STFR machine, etc. Published 7 research articles in peer reviewed international and national journals.

Ms. Suruchi Malik- An enthusiastic and fervid professional in microbiology. Completed Post-graduation in Microbiology from CCS University, Meerut in 2020 & PG diploma in food safety & quality management from IGNOU, Delhi. Have 1.5 years of experience of analytical testing in Chemical & microbiological analysis in Food, Feed, Water, Milk & Milk products. Involved in Research & development activities for food safety & sustainable development.