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Comparative Analysis of Long-Term Fertilization affect on Stability of Vertisol Soil Aggregates under Soybean-Safflower and Sorghum-Wheat Cropping Systems

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ABSTRACT: It is well acknowledged that integrated nutrient management, or INM, is a useful strategy for maintaining soil fertility and ensuring sustained crop yield. It has been demonstrated that adding organic manures to the soil improves its properties and increases the availability of nutrients. Soil samples from long-term fertilizer trials at the research farms of Dr. PDKV, Akola, Maharashtra, and VNMKV, Parbhani, Maharashtra, were gathered during the 2020–21 crop year. Samples represent six familiar treatments combinations comprising farmyard manure and chemical fertilizers. The randomized block design (RBD) was accompanied. The study intended to examine the footprint of INM on mean weight diameter (MWD) of vertisols under the Soybean-Safflower and Sorghum-Wheat cropping systems. The long-term practice of manure and fertilizers in Akola and Parbhani significantly impacted the mean weight diameter of soils under different cropping systems. The mean water depth (MWD) values in Akola and Parbhani ranged from 0.47 to 0.89 mm and 0.49 to 0.76 mm respectively, while in the subsurface layer, they varied from 0.42 to 0.79 mm and 0.44 to 0.68 mm respectively. The study found that the 100% NPK+FYM treatment in both cropping systems resulted in the highest MWD values, indicating enhanced soil aggregate stability.

Keywords: Mean weight diameter, inorganics, FYM, Sorghum-Wheat and Soybean-Safflower, Integrated nutrient management.

INTRODUCTION

In India, long-term fertilizer experiments have been essential in expanding our knowledge of nutrient management and sustainable farming methods. Sorghum, also called to be as jowar, is a hardy cereal crop well-acclimated to various agro-climatic situations, comprising regions with low in value *i.e*, marginal lands. One of the key attributes of sorghum is, its capacity to withstand drought, make it suitable for cultivation in areas with irregular or limited water availability. Wheat is a staple food crop known for its high yield potential and nutritional value. It is a major source of carbohydrates in many diets worldwide. Wheat cultivation typically requires relatively higher nutrient inputs compared to sorghum, making it well-suited for the nutrient-rich residual soil conditions left after the sorghum harvest. Organic manure and fertilizer integration has showed promise in sustaining improved productivity and yield stability (Nambiar and Abrol 1989). Soybeans are leguminous crops capable of forming a symbiotic relationship with nitrogen-fixing bacteria, enriching the soil with nitrogen. Soybeans are valued for their protein-rich seeds and oil content, making them significant for both human and animal nutrition as well as industrial uses. Safflower is an oilseed crop, and its seeds contain oil that is commonly used for cooking and industrial applications. Safflower, renowned for its drought tolerance, is ideal for cultivation in regions with water scarcity or irregular rainfall. By cultivating two different crops in sequence, farmers diversify their crop production, mitigating risks associated with mono-cropping and enhancing overall agricultural sustainability.

MATERIAL AND METHODS

The study conducted extensive experiments on longterm fertilizer applications in two locations, Akola (Sorghum-Wheat) and Parbhani (Soybean-Safflower), aimed at comprehending the impacts of prolonged fertilizer use in vertisol and agricultural scenarios. The selection of these locations was based on their specific soil taxonomic class and cropping system. To explore the effects of LTFE on six different cropping systems, a RBD design was implemented. The study utilized six common treatments: Control treatment, 100 percent N

RDF, 100 percent NPRDF, 100 percent RDF, 150 percent RDF, and 100 percent NPK RDF combined with 5 t ha^{-1} of FYM. Soil samples were gathered from predetermined plots at two depths, 0-20 and 20-40 cm. The MWD of the soil was determined using Yoder's apparatus method, as proposed by Kemper and Rosenau in 1986. The collected data underwent ANOVA, and the statistical significance of the difference between treatment means was assessed following Gomez and Gomez's methodology in 1984.

RESULT AND DISCUSSION

The MWD of the soil is significantly affected by the application of nutrient treatments, particularly through the long-term incur of manure and fertilizer in two distinct cropping systems in Akola and Parbhani. This influence is notable at both surface and sub-surface depths. In Akola, the MWD ranges from 0.47 to 0.89 mm at the surface and 0.42 to 0.79 mm at the sub-surface, while in Parbhani, it varies from 0.49 to 0.76 mm at the surface and 0.51 to 0.87 mm at the sub-surface. The treatment consisting of 100 percent N-P-K along with FYM demonstrated an improvement in aggregate stability for both cropping systems. In contrast, the control treatment exhibited the lowest MWD values at both 0-20cm and 20-40cm soil depths. The treatments, when ordered based on MWD, were as follows: 100 percent NPK+FYM > 150 percent NPK > 100 percent NPK > 100 percent NP > 100 percent N > control.

The incur of the 100 percent NPK+FYM plot resulted in a noteworthy increase in the MWD of soil aggregates at both depths in two cropping systems, surpassing all other treatments. This signifies enhanced aggregate stability through the implementation of INM. In contrast, the control plot exhibited smaller MWD values, indicating inferior stability of aggregates. The elevated MWD observed in INM plot can be attributed to the binding capacity of OC and carbonates, which fosters improved aggregation of soil. Generally, MWD of soil aggregates declined with increase in depth, highlighting that 0-20cm soil exhibited higher MWD compared to 20-40cm soil across all treatments. This disparity is influenced by the higher content of OC and the secretion of organic acids in surface soil, contributing to improved aggregate stability (Bangre *et al.* (2021; Aulakh *et al.*, 2013).

Unbalanced fertilization plots (100 percent N, 100 percent NP) recorded significant increase in mean weight diameter than unfertilized plot under two cropping systems except in 100 percent N in Soybean-Safflower. At subsurface depth similar trends were reported. Additionally, the incur of 100 percent NPK reported a significant increase in mean weight diameter than unbalanced fertilized plots (100 percent N, 100 percent NP) and unfertilized treatment in two cropping systems at both soil depth. Supplement, of 50% more RDF raise to continued significant increase in mean weight diameter in two cropping systems at both soil depths. The greater percentage increase in MWD at surface soil was reported in 100 percent NPK+FYM treatment than unfertilized treatment in Sorghum-Wheat cropping system compared to Soybean-Safflower cropping system.

Table 1: Impact of long-term fertilization and manuring under Sorghum-Wheat and Soybean-Safflower cropping systems on the mean weight diameter of soils.

MWD 0-20 cm		
Location& cropping system / Treatments	**AKOLA (Sorghum-Wheat)**	**PARBHANI (Soybean-Safflower)**
Control	0.47	0.49
100% N	0.54	0.53
100% NP	0.61	0.56
100% NPK	0.69	0.63
150% NPK	0.75	0.71
100% NPK+FYM	0.89	0.76
SE m ±	0.02	0.01
CD at 5%	0.06	0.05
MWD 20-40 cm		
Location & cropping system / Treatments	**AKOLA (Sorghum-Wheat)**	**PARBHANI (Soybean-Safflower)**
Control	0.42	0.44
100% N	0.48	0.47
100% NP	0.52	0.51
100% NPK	0.57	0.58
150% NPK	0.62	0.61
100% NPK+FYM	0.79	0.68
SE m ±	0.01	0.02
CD at 5%	0.04	0.06

Basal application of FYM is responsible for increase in MWD seen in treatments when integrated nutrition management was followed. The enhancement of soil physical properties and OC content, resulting from farm

yard manure and inorganic fertiliser incur are responsible for the soil aggregates stability and successive increase in mean weight diameter (Hati *et al.*, 2007; Selvi *et al.*, 2005). These findings are similar with results recorded by Bandyopadhyay *et al.* (2010). Organic matter plays a essential role in soil aggregates stability by forming and enhancing the bonds between clay domains and quartz particles (Bhattacharyya *et al.*, 2009; Chakraborthy *et al*., 2010; Bangre *et al.*, 2021).

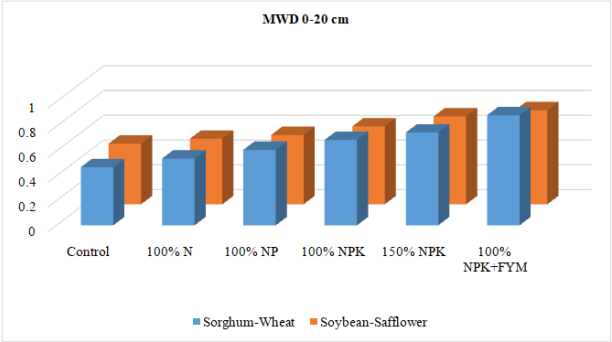

Fig. 1. Impact of long-term fertilization and manuring under sorghum-wheat and soybean-safflower cropping systems on the mean weight diameter of soils (0-20 cm).

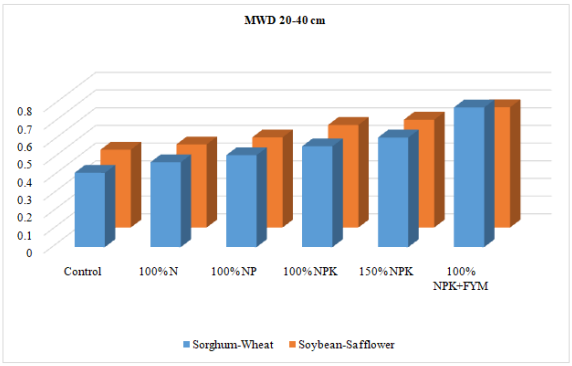

Fig. 2. Impact of long-term fertilization and manuring under sorghum-wheat and soybean-safflower cropping systems on the mean weight diameter of soils (20-40 cm).

CONCLUSIONS

From the above investigation results, it can be concluded that the application of balanced fertilizer and organic fertilizer, especially 100% NPK+FYM treatment, has significantly improved the mean weight diameter (MWD) sof Soil aggregates in sorghum-wheat and soybean-safflower growing systems and also at soil depth. This demonstrates superior aggregate stability and physical soil attributes.

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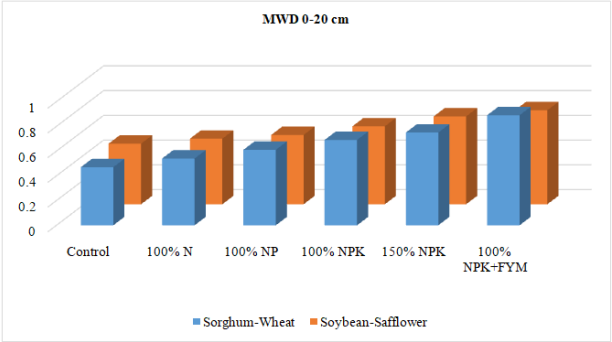
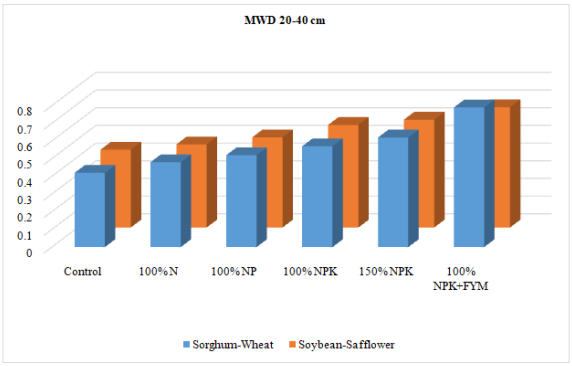


Fig. 1. Impact of long-term fertilization and manuring under sorghum-wheat and soybean-safflower cropping systems on the mean weight diameter of soils (0-20 cm).



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