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Research Article

IMPACT OF CROPPING SEQUENCES ON SOIL FERTILITY IN THE WESTERN ZONE OF TAMIL NADU

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Abstract: To study the influences of different cropping sequences on soil quality parameters, soil samples were collected and analysed for its chemical and biological properties. The cropping consists of seven different cropping sequences grown in three seasons namely *kharif*, *rabi* and *summer* seasons. The soil pH and electrical conductivity did not influence by cropping. The higher organic carbon content of 0.60 percent, available N of 238 kg/ha and available P (23.8kg/ha) was recorded in the Beet root - Maize + Fodder cowpea - Green gram which was comparable with Maize + Fodder cowpea - Grain Cowpea - Prosomillet. The higher available potassium of 584 kg/ha was recorded in Chilies - Cotton + Onion-Sunnhemp. Non-significant results in Mn and Cu was obtained. Higher available B content was recorded in the Onion-Cotton-Maize (0.75 ppm). Maize + Fodder Cowpea-Grain Cowpea-Prosomillet recorded higher value of 116.43 µg/g. Higher soil dehydrogenase activity was recorded (176.3 TPF ug/g/day) in the Sorghum (dual) - Grain Cowpea - Fodder maize + Fodder cowpea.

Keywords: *Cropping sequences, Soil fertility, Soil enzymes*

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Introduction

Sustaining soil fertility is a crucial one due to various soil degradation processes and inappropriate management practices such as imbalanced fertilizers usage, tillage management, nutrient mining and many other anthropogenic activities. So, reducing soil degradation and maintaining soil quality are more important concern for sustaining the soil productivity. Among different factors contributing for the soil degradation, land use changes also one which will influence the soil heath within the short term. The management of soil quality depends on how soil behave to agricultural use and practices [1]. Three components of soil quality viz., physical, chemical and biological are determined by inherent soil characteristics, which can be altered by management practices followed under various cropping sequences, crop and farming systems.

Cropping sequences which affects soil quality based on the management practices and crop species used in the rotation [2]. Over the period of time, these practices result in soil quality changes [3]. However, these parameters are generally interdependent and more importantly, affect each parameter differently related to the assessment of overall quality. Variation in pH among soils under different cropping systems may be attributed to variation in rain fall within the zone, topographic position and management practices [4]. Bandyopadhyay *et al*. (2010) [5] reported decreased EC in soil over initial due to rainfall received during growing season .Greater percolation of water high infiltration rate with residue mulch (green manure) are responsible for the higher removal of bases in sandy loam soil Chemical characteristics of soil such as organic carbon, available nutrients are highly sensitive indicators. Chemical properties are chosen either inhibited root growth or affected the nutrient supply. Reganold and Palmer (1995) [6] used chemical parameters for assessing the soil quality including CEC, total N and P and extractable P, S, Mg and Ca. Nahas *et al*. (1999) [7] had observed that high solubilization of phosphorous in the soils which was influenced by the legume crops also enrichment of soil nitrogen.

Lehria, (1997) [8] reported the appreciable increase in soil organic carbon, available nitrogen and available phosphorus due to green leaf manuring of subabul. Application of organic manure had a positive impact on the soil organic carbon, available nitrogen and phosphorus [9]. Adoption of legumes in the crop rotation showed significant effect on nitrogen fixation and availability [10]. High nutrient balance was observed under the application of 100% organic practices practiced in to the soil under sunnhemp-chillies-sunflower cropping sequence [11]. Accumulation of organic matter to soil increased the physical, chemical and biological properties of the soil. Decomposition rate of organic matter was affected by the type of carbon input added into the soil and tillage practices [12]. Lal (2004) [13] reported that the fertilization and crop rotation played a significant role in impacting soil C.

Soil microbial biomass is a very small part of total carbon in the soil 0.1-5%, it is characterized by its turnover rate. Soil microbial biomass is a labile reservoir of nutrient elements such as C, N, P and S [14]. Lal (2004) explained that the excessive tillage, the low turnover of crop residues and imbalance fertilizer usage were attributed for low level of carbon under the agriculture land use system. Irrespective of the crop rotation incorporation of crop residue or retention will increase the OM in the soil [15].

Materials and Methods

To study the role different cropping practices on soil quality parameters, post-harvest soil samples were taken from the experiment conducted at Tamil Nadu Agricultural university Coimbatore, Tamil Nadu during summer season of 2016-17 to identify the cropping systems in a view to maintain soil fertility and compare the different cropping systems under garden land condition of Western Zone of Tamil Nadu. The experiment was laid out in Randomized Block Design with three replications. The initial soil samples were collected and analysed for its nutrient content.

Table-1 *Influence of different bio intensive cropping sequences on soil chemical properties*

Treatment	pH	EC (dS/m)	SOC (g/kg)	Av. N (kg/ ha)	Av. P (kg/ ha)	Av. K (kg/ ha)	Av. S (kg/ ha)	Av. Fe (ppm)	Av. Mn (ppm)	Av. Zn (ppm)	Av. Cu (ppm)	Av. B (ppm)
Onion - Cotton - Maize	8.34	0.65	0.57	223	22	525	32.47	5.98	4.49	1.37	2.44	0.75
Beet root - Maize + Fodder cowpea - Green gram	8.41	0.66	0.6	238	23	531	36	6.02	4.73	1.56	2.71	0.44
Sunflower - Cotton + Green gram - *Daincha*	8.45	0.62	0.56	227	19	578	26.07	6.37	4.57	2.26	2.44	0.65
Maize + Fodder cowpea - Grain Cowpea - Prosomillet	8.43	0.66	0.6	230	22	524	35.27	6.05	4.49	1.75	2.7	0.53
Brinjal - Fodder cowpea - Foxtail millet	8.4	0.63	0.58	229	19	537	31.2	6.47	4.63	2.44	2.34	0.43
Chilies - Cotton + Onion - *Sunnhemp*	8.4	0.59	0.57	223	19	584	31.33	6.41	4.62	2.67	2.4	0.42
Sorghum (dual) - Grain Cowpea - Fodder maize + Fodder cowpea	8.42	0.63	0.58	227	23	535	31.87	6.01	4.61	1.74	2.49	0.41
CD(5%)	ns	ns	0.01	7	2	41	2.41	0.12	Ns	0.08	ns	0.15

Table-2 *Influence of different bio intensive cropping sequences on Soil biological properties*

Treatment	MBC (µg/g)	Soil dehydrogenase activity (TPF ug/g/day)	Alkaline phosphatase (PNP ug/g/hr)	Urease (NH_3 µg /g/hr)	Soil bacteria	Soil fungi	Soil actinomycetes
Onion - Cotton - Maize	96.3	132.3	56.25	10.16	40	12	9
Beet root - Maize + Fodder cowpea - Green gram	113.73	147	55.2	11.54	46	15	8
Sunflower - Cotton + Green gram - *Daincha*	98.37	166.2	52.2	12.51	52	19	11
Maize + Fodder cowpea - Grain Cowpea - Prosomillet	116.43	157.5	59.25	13.36	54	16	9
Brinjal - Fodder cowpea - Foxtail millet	96.47	147.4	56.41	12.14	42	14	10
Chilies - Cotton + Onion - *Sunnhemp*	96.87	162.3	54.21	10.22	46	17	11
Sorghum (dual) - Grain Cowpea - Fodder maize + Fodder cowpea	96.5	176.3	56.25	13.16	55	20	13
CD (p=0.05 %)	8.69	12.5	3.24	1.02	4	2	2

The initial soil analysis showed that, soil texture consists of sand (36.6 percent), silt (27.46 percent), clay (35.89 percent) and comes under clay loam. The soil characteristics analysed are, pH (1:2.5) of 8.30, Electrical conductivity of 0.63 dS/m, exchangeable sodium of less than 4 percent, soil organic carbon of 5.8 g/kg, microbial biomass carbon of 108.9 (µg/ g soil),available nitrogen content of 248 kg/ha, available phosphorus content of 24.5 kg/ha , available potassium content of 556 kg/ha, available sulphur content of 12.5 kg/ha and available micronutrient content of 2.32 ppm, 4.56 ppm,6.23 ppm and 2.65 ppm respectively for Zinc, Manganese, iron and copper. Treatments included are seven different cropping systems as follows.

Results and discussion

The experiment was initiated during 2016-17. One whole cropping sequence was completed. After completing one whole cropping sequence by cultivating three crops per year, post-harvest, soil samples were collected and analysed for available nutrients. The results reveal that, the physico chemical properties do not influenced by the different crops [Table-1]. The higher organic carbon content (0.60 %) was recorded in the Beet root - Maize + Fodder cowpea - Green gram which is mainly due to the high amount of below ground biomass. This in line with Kaur *et al*. (2008) [16]. In the present study also revealed higher enzyme activity and microbial carbon were found in these cropping sequence [Table-2] could have contributed for the improvement of soil organic carbon.

Available N (238 kg/ha) was recorded higher in the Beet root - Maize + Fodder cowpea - Green gram. It might be due to the inclusion of N fixing legume green gram and fodder cowpea in the cropping sequence. This is supported by Crews and Peoples (2004) that inclusion of legume with crop rotation increase the soil fertility by fixing the atmospheric nitrogen in the root nodules. Availability of nitrogen increased for the succeeding crops by the process of mineralization. Bhuiyan and Zaman (1996) [17] also reported that the increased available nitrogen by inclusion of leguminous green manure.

The higher available P of 23.8 kg/ha was recorded in the same treatment. might be due to the higher organic matter accumulation and further by decomposition could have released the organic acid and it would have released the P from unavailable form to available form. This is line with Anwar *et al*. (2005). Inclusion of leguminous green manure and legume in the cropping sequences might be the reason for higher availability of the phosphorus by the transfer of unavailable P to available P while fixing N.

Higher available K was recorded in the available in the maize + veg. cowpea - sunflower - cowpea cropping systems. The higher available potassium of 584 kg/ha was recorded in Chilies - Cotton + Onion - Sunnhemp which is on par with Sunflower - Cotton + Green gram-Daincha. This may be due to inclusion of green manure in these treatments. It might be due to the inclusion of daincha as green manure sole crop in *kharif* and intercrop in *rabi* which would have increased the K by storing it in biomass and degradation of its biomass.

The higher available sulphur value of 36.00 kg/ha was recorded in Beet root - Maize + Fodder cowpea - Green gram which is on par with Maize + Fodder cowpea - Grain Cowpea-Prosomillet (35.27 kg/ha).The lowest available S content of 26.07 kg/ha was recorded inclusion of oilseed cropping sequence *i.e*. Sunflower - Cotton + Green gram-Daincha.

Higher available Fe was recorded in the-Brinjal - Fodder Cowpea-Foxtail millet (6.47 ppm) followed by Chilies - Cotton + Onion-Sunnhemp (6.41 ppm) and Sunflower - Cotton + Green gram-Daincha (6.37 ppm). Lowest was recorded in Onion -Cotton-Maize (5.98 ppm). Regarding Mn and Cu non-significant results was obtained. Higher available B content was recorded in the Onion - Cotton-Maize of 0.75 ppm which was followed by Sunflower - Cotton + Green gram-Daincha (0.65 ppm).

Microbial biomass carbon is the indication of short-term indicator of soil quality. Among the different cropping sequences, Maize + Fodder cowpea - Grain Cowpea-Prosomillet recorded higher value of 116.43 µg/g which was statistically on par with 113.73 µg/g [Table-2]. High microbial activities contribute to high MBC that might be due to more residue addition and inclusion of legume in this treatment. It was supported by Smyrna (2016) reported that higher amount of MBC was under bhendi - maize+cowpea - sunflower CS due to higher activity of microbial population. Higher soil dehydrogenase activity was recorded (176.3 TPF ug/g/day) in the Sorghum (dual) - Grain Cowpea - Fodder maize + Fodder cowpea which is onpar with Sunflower - Cotton + Green gram-Daincha (166.2 TPF ug/g/day). Lowest value was recorded in the Onion - Cotton-Maize cropping sequence. It activity might be due to increased organic matter addition and root exudation by inclusion legume in the cropping sequence. This is in line with Surucu *et al*. (2014) that inclusion of green manure amended soil had high dehydrogenase activity. Highest alkaline phosphatase and Urease activity was recorded (59.25 PNP ug/g/hr and 13.36 NH_3 µg /g/hr)) in the Maize + Fodder cowpea - Grain Cowpea-Prosomillet might be due to inclusion of legume in the cropping sequences that could have released more phosphatase enzymes than non-legume and also legumes required more phosphorus for the symbiotic N fixation process than cereals. This is agreement with Maseko and Dakora (2013) [19] that urease activity might be due to addition of cowpea as legume crop which could have fix more N. This is in line with Roldan *et al*. (2003).

Higher soil microbial population of bacteria (55X 10^{-6}), fungi (20 X 10^{-4}) and actinomycetes (13 X 10^{-3}) was recorded in the Sorghum (dual) - Grain Cowpea - Fodder maize + Fodder cowpea. Its activity might be due to increased organic matter addition and root exudation by inclusion legume in the cropping sequence.

Conclusion

The present research clearly indicates that, Beet root - Maize + Fodder cowpea - Green gram which was comparable with Maize + Fodder cowpea - Grain Cowpea-Prosomille cropping sequences recorded favourable soil fertility parameters like organic carbon, available nutrients. The Sorghum (dual) - Grain Cowpea - Fodder maize + Fodder cowpea cropping sequence recorded higher biological characteristics. The conclusion drawn from the research is that, addition of any pulse crop such as cowpea or green gramor green manure is essential to

Application of research: This cropping sequence which includes legumes/ green manure can be recommended to farmers as a soil fertility maintenance cropping for western zone of Tamil Nadu

Research Category: Soil Fertility

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Study area / Sample Collection: Western Zone of Tamil Nadu

Cultivar / Variety / Breed name: Maize, Cowpea

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References

[1] Gregorich E., Monreal C., Carter M., Angers D. and Ellert B. (1994) *Canadian journal of soil science*, 74(4), 367-385.
[2] Masto R. E., Chhonkar P. K., Singh D. and Patra A. K. (2007) *Agriculture, Ecosystems and Environment*, 118(1-4), 130-142.
[3] Jokela W. E., Grabber J. H., Karlen D. L., Balser T. C. and Palmquist D. E. (2009) *Agronomy Journal*, 101(4), 727-737.
[4] Ananthanarayana R. and Ravi M. (1997) *Journal of the Indian Society of Soil Science*, 45(2), 384-385.
[5] Bandyopadhyay P., Saha S., Mani P. and Mandal B. (2010) *Geoderma*, 154(3-4), 379-386.
[6] Reganold J. P. and Palmer A. S. (1995) *Journal of Soil and Water Conservation*, 50(3), 298-305.
[7] Nahas E., Siqueira J., Moreira F., Lopes A. and Guilherme L. (1999) *Solubilizacao microbiana de fosfatos e de outros elementos. SIQUEIRA, JO; MOREIRA, FMS; LOPES, AS; GUILHERME, LRG*, 467-486.
[8] Lehria S.K., Bali S.V. and Singh B. (2006) *Proceedings of the IUFRO-ISTS-UHF international conference on world perspective on short rotation forestry for industrial and rural development. Nauni, Solan, India. Edited by: Verma, K.S., Khurana, D.K. and Christersson, L*. pp.316-319.
[9] Anwar M., Patra D., Chand S., Alpesh K., Naqvi A. A. and Khanuja S. (2005) *Communications in soil science and plant analysis*, 36(13-14), 1737-1746.
[10] Crews T. and Peoples M. (2004) *Agriculture, Ecosystems and Environment*, 102(3), 279-297.
[11] Bama S. and Somasundaram E. (2017) *International Journal of Chemical Studies*, 5(4).
[12] Weil R. R., Islam K. R., Stine M. A., Gruver J. B. and Samson-Liebig S. E. (2003) *American Journal of Alternative Agriculture*, 18(1).
[13] Lal R. (2004) *13th International Soil Conservation Organisation Conference, Brisbane, paper.*
[14] Haider J., Marumoto T. and Azad A. K. (1991) *Soil Science and Plant Nutrition*, 37(4), 591-599.
[15] Singh R. J., Ghosh B., Sharma N., Patra S., Dadhwal K. and Mishra P. (2016) *Ecological indicators*, 61, 753-765.
[16] Kaur T., Brar B. and Dhillon N. (2008) *Nutrient Cycling in Agroecosystems*, 81(1), 59-69.
[17] Bhuiyan N.I. and Zaman S.K. (1996) *In: Rahman M, Podder AK, Van Hove C, Begum ZNT, Heulin T, Hartmann A(Eds.)Biological nitrogen fixation associated with rice production, Book series: Developments in plantand soil sciences*, 70,pp 51-64.
[18] Maseko S. and Dakora F. (2013) *South African journal of botany*, 89, 289-295.