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Influence of cropping systems and organic integrated nutrient management on cotton equivalent yield, *Insitu*-biomass conservation and soil properties

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Abstract
Organic agriculture is a production system that sustains the health of soil, surrounding ecosystem and people. It relies on ecological processes, biodiversity and cycles adapted to local condition rather than the use of inputs with adverse effect. Organic agriculture combines tradition, innovation and science to benefit the shared environment with fair relationship and good quality of life for all involved. Unlike chemical farming, organic farming aims to "feed the soil" rather than "feed the plant". It means giving back to the nature what has been taken from it. Since organic farming aims to maintain soil health and to obtain highest yield in a sustainable and ecofriendly manner on the long term basis. Crop rotation is one of the important practices known to reduce infestation of insect pests, disease and weeds. This system not only provides organic matter to the soil but also proved to be profitable cropping system. But continuous growing of any crop or cropping system may leads to increase the intensity of pest, disease and weeds. To break their life cycle, crop rotation is must. Crop rotation affects, the insect population by altering the microclimate or by encouraging the natural enemies of the insect pest in the system. Inclusion of legumes in the cropping system is very effective not only from the point of nitrogen fixation but judicious utilization of soil nitrogen also.

Keywords: Influence, systems, organic, management, cotton, conservation

Introduction
Legumes are dual purpose crops as they not only produce protein rich grains but also fix considerable amounts of nitrogen in the soil. Moreover, after harvest of crops their residue is incorporated in to the soil in situ these help greatly in improving Physico – chemical properties of the soil. In Vidarbha region, main rainfed cropping systems are based on cotton, soybean or pigeonpea in kharif season followed by chickpea or wheat or rabi sorghum in rabi season. Cotton (*Gossypium hirsutum* L.) is one of the important cash as well as fibre crop and play vital role in history and civilization of mankind, with enormous potential in textile industries and is mean of livelihood for millions of farmers and those concern with its trade, processing, manufacturing and other allied industries. Being an industrial commodity, it has an assured world demand and thus holds unique position in the international commerce.
Generally, in organic farming most of the sustainable practices are used, like crop residue retention on the soil surface, intercropping, green manuring mulching and integration of crops and livestock are not alien to agriculture systems including the traditional agriculture practices (Awasthe *et al*. 2017) [1] which prohibit the use of synthetic inputs and the central theme of this method is the health of soil and preventing degradation of natural resources. Demand of organic food and fibre is increasing globally and there is need for innovative farming practices to improve soil health so that food and fibre production resilience may be ensured. Accordingly, experiment was framed to assess the effect of various cropping system rotation on productivity, their *in- situ* biomass addition to next crop and organic carbon and SMBC status under rainfed condition of Vidarbha region of Maharashtra.

Methodology
The experiment was conducted on organically certified field at Centre for Organic Agriculture Research & Training (COART), Department of Agronomy, Dr. PDKV, Akola, Maharashtra during *kharif/rabi* season of 2018-19 and 2019-20 with the objective to assess the impact of various cropping system rotation and nutrient modules on productivity and *in-situ* biomass addition and soil fertility.

The experiment was laid out in strip plot design with main plot consist of six cropping systems *viz*. cotton (sole), pigeonpea + soybean (1:4), blackgram – *rabi* sorghum, pigeonpea + foxtail millet (1:4) and blackgram – chickpea, rotated with pigeonpea + soybean (1:3), cotton + blackgram (2:1), cotton + sunhemp (GM), cotton sole and cotton + pigeonpea (3:1) and rotated every year for the maintenance of soil health and pest distraction. Sub plot consist of organic integrated nutrient management *viz*. organic package for each crops 100% RDN through equivalent organic sources i.e. FYM and vermicompost (top dressing), integrated nutrient management (IONM) 75% through FYM and vermicompost (top dressing) + 25% through neem cake and control (No manure). Phosphorus amount in the experiment as per RDF was adjusted through phosphorus rich organic manure (PROM). Sowing was done on broad bed furrow system for conservation of moisture. Sowing was done in last week of June in both years. Application of *Trichoderma, Rhizobium and PSB* was done in all crops as seed treatment. Plant protection schedule was followed organically (IPM practice). The *in-situ* biomass conservation was done though tractor drawn shredder after main produce taken out on same plot for maintenance of soil health. The cotton equivalent yield and biomass addition through various cropping system were worked out. The initial organic carbon content was 4.40 g/kg of soil and NPK was 193.68, 14.61 and 323.99 kg/ha. Rainfall of season was 834 and 929 mm respectively with 42 and 57 rainy days during experimentations.

Results

After every year and pooled mean of two years study indicated that highest cotton equivalent yield (CEY) was significantly recorded in pigeonpea + soybean (1:4) (1841 kg ha-1) in first year but statistically found at par with blackgram – chickpea cropping sequence. In second year cotton followed by pigeonpea + soybean (1:3) intercropping system recoded significantly highest cotton equivalent yield (1925 kg ha^{-1}) followed by cotton + pigeonpea (3:1) intercropping system. This trend of returns confirmed the dominance of this intercropping systems in the region over continuous sole cotton (1051 kg ha^{-1}) in pooled of both years, the yield of crops was increased due to moisture conservation followed by sowing on Broad bed furrows. Among the organic nutrient treatments significantly highest individual year and pooled cotton equivalent yield was under treatment with 75% FYM + Vermicompost (top dressing) + 25% Neem cake (1660 kg ha^{-1}) followed by 100% FYM + Vermicompost (top dressing) (1586 kg ha^{-1}) and least was obtained under control treatment (867 kg ha^{-1}). Due to the integrated management of nutrients the soil nutrient status gets better with improved source of primary, secondary and micro nutrients. Besides, nutrient management through integration of different kinds of organic sources improves the physical, chemical and biological properties of the soil, which provide better conditions to the base crop as well as the intercrops yield. The highest in-situ biomass addition through pigeonpea + soybean and cotton + blackgram system (5085 kg ha^{-1}) and average shredded and shaded biomass through OINM was (4353 kg ha^{-1}) and organic carbon was increased from 4.40 g kg^{-1} of soil to 5.20 g kg^{-1} of soil in two years due to addition of biomass and integrated nutrients practices adopted in various cropping system. Least improvements of organic carbon in sole cotton for both years and highest with pulses cropping system. Similarly bulk density was also reduced in different pulse based cropping system (1.41 Mg m-3) with OINM practices over initial (1.44 Mg m-3). Gopinath *et al*. (2016) [2] reported that enhancement of soil health was under organic nutrient management. The results were in harmony with results recorded by Tiwari *et al.* (2012) [5], More *et al*. (2008) [4] and Jat *et al.* (2018) [3].

Table: Pooled Cotton Equivalent Yield (kg/ha) of three years and biomass (kg/ha) and soil quality as influenced by various cropping systems and organic integrated nutrient management (OINM) under rainfed

A) Cropping systems 2018-19	**CEY kg ha^{-1}**	**Cropping systems 2019-20**	**CEY kg ha^{-1}**	**Pooled CEY kg ha^{-1}**	**Biomass added (kg ha^{-1})**	**Organic carbon (g $kg^{-1}$of soil)**	**Bulk density (Mg m^{-3})**
T1 - Cotton	1005	Pigeonpea + Soybean (1:3)	1925	1465	4995	5.10	1.41
T2 - Pigeonpea + Soybean (1:4)	1851	Cotton + Blackgram (2:1)	1434	1643	5085	5.20	1.41
T3 – Blackgram - Sorghum	1396	Cotton + Sunhemp (GM) (2:1)	1209	1303	3795	5.00	1.41
T4 - Pigeonpea + Fingermillet (1:4)	1053	Cotton	1094	1073	3925	4.90	1.43
T5 – Blackgran - Chickpea	1848	Cotton + Pigeonpea (3:1)	1701	1775	4470	5.20	1.40
T6 – Sole Cotton	983	Cotton	1119	1051	3846	4.80	1.44
SE(m)+	35		23	22	37		
CD at 5%	110	CD at 5%	73	70	116	-	
B) Oraganic Integrated Nutrient Management (OINM)							
N1- FYM+VC	1549	FYM+VC	1622	1586	4235	5.10	1.41
N2 – FYM+VC+NC	1617	FYM+VC+NC	1704	1660	4362	5.30	1.42
N3 – Absolute Control	813	Absolute Control	921	867	4108	4.30	1.42
SE(m)+	18		16	16	28	-	-
CD at 5%	69		64	62	NS	-	-
Interaction T X N							
SE(m)+	46		23	21	58		
CD at 5%	136		69	62	NS	-	
GM	1356		1414	1385	4353		
Initial value	-	-	-	-	-	4.40	1.44

Conclusion

The Pigeonpea based intercropping system was found to be better option for rainfed ecosystem of Vidarbha with integrated organic nutrient management practices over only cotton cropping and *in-situ* biomass addition improved the soil health under organic farming.

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