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Recycling of Cotton Crop Residue for Sustainable Cotton Production in Vertisols of Andhra Pradesh, India

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A B S T R A C T

A field experiment was conducted on clay soils of Regional Agricultural Research Station, Lam, Guntur during *kharif* 2016-17, 2017-18 and 2018-19 to find out the the residual effect of recycling of cotton crop residues on succeeding cotton and impact of recycling of crop residues on yield, yield attributes, soil organic Caron, N, P_2O_5, K_2O and soil microbes invertisols. The three years of the experimental data indicated that the application of RDF @ 150N:60P_2O_5:60K_2Okgha^{-1} recorded highest plant height (166.5cm), number of bollsplant^{-1}(52.9), seed cotton yield(4568.6kgha^{-1}) followed by 75% RDF + cotton crop residue incorporation + decomposed michorhiza (DM) and was significantly superior over other treatments tried and lowest was recorded with application of cotton crop residue only without any combination of fertilizers and decomposed michorhiza but highest soil microbes population was reported with the cotton crop residue incorporation + 75% RDF + decomposed michorhiza (DM)@2kgha^{-1} + FYM@ 5tha^{-1}fallowed by cotton crop residue+ 75% RDF + decomposed michorhiza (DM)@2kgha^{-1}under the study. Further, reported that the major nutrient (N, P_2O_5, K_2O) availability status was significantly influenced by the treatments imposed and that the treatment of cotton crop residue incorporation + 75% RDF + decomposed michorhiza (DM)@2kgha^{-1} was significantly superior on the availability of soil N, P_2O_5 and K_2O respectively in the study.

Introduction

The utilization of cotton crop residues as soil amendment may hold a good promise for improving the soil health, crop productivity and reduce the disposal problem. Cotton, the most important commercial fiber crop has been cultivated in India and Andhra Pradesh over an area of 126.55 and 7.36 L.ha respectively (CCI, 2014-2015). Huge quantity of cotton stalks is left over in the field after harvest, which needs some valuable disposal solution. It is estimated that 50 MT of cotton stalks is available in India, Though, a portion of it is being utilized for fuel/ fodder purpose, major portion of it is being burnt by the farmers in Andhra Pradesh especially in Krishna zone for early clearance of the land for taking succeeding crops. This results in loss of abundant organic matter and plant nutrients besides carrying environmental pollution through global addition of CO_2. Therefore, it is highly essential to explore the influence of direct incorporation of huge

quantities of crop residues into farm soil and its subsequent effect on soil properties and succeeding crop productivity. Tractor drawn shredders and terminator are available now and cotton stalk will be cut into pieces and easily incorporated in to the farm soil. However, the high C:N ratio and presence of polymers such as cellulose and lignin in the crop residues may act as natural barrier for its biological degradation. In such case, microbial interaction of specific microorganisms (cellulolytic and lignolytic) with soil and crop residue may be considered as an appropriate strategy for effective decomposition of added substrate. Hence, research for an alternative method of recycling of crop residues is necessary for their early decomposition and for improving soil health besides sustaining agricultural crop production.

The burning of paddy straw results in losses of N (up to 80 %), P (25 %), K (21 %) and S (4-60 %), air pollution @ $CO_2$13 t ha^{-1}, thereby depriving the soils of its organic matter content (Gaind and Nain, 2008). Increase in rice yield, improvement in soil physico-chemical and biological properties in rice-rice cropping system due to incorporation of paddy straw was observed by Rajkhowa (2012). Research results also indicated that fungi belonging *Pleurotus sajorcaju*, *P. platypus* and *P. citrinopileatus* are known to colonize coir fibre, cotton stalks and sorghum stover (Ragunathan and Swaminathan, 2003).

Residue recycling is a key measure to enhance the soil fertility and productivity in system of crop production. The plant nutrient availability in a soil is a measure of soil fertility, while the soil physical environment is the king pin regulating the retention and movement of soil moisture, air, nutrients and temperature. Keeping in view this investigation was designed and conducted in vertisols of Andhra Pradesh, with an objective to find the impact of incorporated cotton crop residue on succeeding cotton.

Materials and Methods

A field study was carried at Regional Agricultural Research Station, Lam Farm located at Guntur (Latitude: $16^0 18^1$, Longitude: $80^0 29^1$, Altitude:33 MSL). The climate is sub-tropical with mean annual rainfall of 950 mm. The soil of experimental field was clay loam in texture, alkaline in reaction (pH 8.3), non saline. Low in available N (226 kg ha^{-1}), high in P_2O_5 (82.1kg ha^{-1}) and high in K_2O (1220 kg ha^{-1}) and low in organic carbon (0.49%) respectively. The experiment was conducted for three successive *kharif* seasons i.e., 2016-17, 2017-18& 2018-19 in Krishna agro-climatic zone of Andhra Pradesh.

The experiment consisting of eight treatments viz., T_1 - Recommended dose of fertilizers (RDF150 -60 -60), T_2 - Cotton crop residue only, T_3 -Cotton crop residue +75% RDF, T_4 - Cotton crop residue +75% RDF + DM, T_5 - Cotton crop residue +50 % RDF, T_6 - Cotton crop residue +50 % RDF + DM, T_7 - Cotton crop residue + DM and T_8 - Cotton crop residue + DM @2kg/ha + FYM @ 5t /ha were randomly allocated and replicated thrice and adopted randomized block design (RBD) for three years of the experimentation. Recommended dose of N, P and K for cotton was applied as entire P as basal, N and K in three splits (30, 60 and 90 DAS) by pocketing.

Three years of the experimentation was conducted in same field, at the end of the season cotton stalks (stubbles) were shredded with the tractor drawn terminator and that shredded particles were incorporated into the soil during the fallow period (after harvest of cotton lint), Decomposing mychorrhiza which consisting of Azospirillum+VAM+ K

solubilizing bacterial strain developed at Agriculture Research Station, Amarvathi, ANGRAU was incorporated into the soil by mixing with FYM @5kg per 2kg of DM after shredding the cotton stakes..

The data pertaining to yield attributes, yield, available NPK and microbial population were collected after harvesting of the cotton crop. Statistical analysis for yield, yield parameter, available soil nutrients, available soil microbial population were done by following the analysis of variance technique for RBD as suggested by Gomez and Gomez (1984).

Results and Discussion

Available OC

Pooled analysis of three years data on available organic carbon content of the experimental soils were not significantly influenced by recycling of cotton crop residue along with the combination of chemical fertilizers, FYM and DM. Numerically higher OC content was reported with the T_3& T_4 treatment during the experimentation (Table.1). This clearly indicated that the built up of OC content in soil through the recycling of cotton residue may require sufficient time to synthesize and added the OC to the soils.

Available soil N, P_2O_5 and K_2O

Soil samples were collected at 75 DAS and at harvest were analyzed for available soil nitrogen, phosphorous and potassium that the pooled analysis found that the availability soil phosphorous and potassium were found significant but nitrogen was found non-significant. Significantly more available P_2O_5 and K_2O were recorded with the treatment T4 i.e., incorporation of cotton crop residue followed by the application of 75% RDF and decomposed michoryza @ 2kgha^{-1} at 75 DAS and harvest. This might be due to the balance in the availability of organic and inorganic nutrients to cotton crop during the experimentation.

Soil microbial population

Soil samples were analyzed at Agricultural Research Station on microbiology at Amaravathi and estimated the microbial population at 75 DAS and at harvest. Among the microbial population, the bacterial population (_x10^{6}CFU/g) was found significant but fungi were non-significant at 75DAS and harvest. Maximum bacterial population (171.5 and 45.6_x10^{6}CFU/g) was significantly reported with the treatment combination of cotton crop residue + DM + FYM @ 5t /ha during the experimentation. This might be due to the availability of organic matter content which will be suitable for feeding the bacterial population for their servility.

Yield attributes and seed cotton yield

The data pertaining to plant height and number of bolls plnat^{-1} and seed cotton yield were statically analyzed and that the experimental results indicated that the significantly more plan height, more number of bolls plant^{-1}and higher seed cotton yield were reported with treatment T_1 i.e., RDF which was on a par with treatment 4 i.e., incorporation of cotton crop residue followed by the application of 75% RDF and decomposed michoryza @ 2kgha^{-1}

From the experimental results it can be concluded that the cotton stalks can easily be recycled with tractor drawn terminator followed by easy decomposition of shredded cotton stalks by using the decomposed michorhiza there by improve soil bacterial population and sustain the cotton production in vertisols of Andhra Pradesh.

Table.1 Effect of in-situ incorporation of cotton crop residue and fertilizers on yield attributes, yield, microbial population and nutrient status of the soil

Treatments	Plant Height (cm)	No. of Bolls Plant^{-1}	Seed cotton yield (Kg ha^{-1})	Bacteria (_x10^{6}CFU/g)		Fungi (_x10^{4}CFU/g)		Organic carbon (%)		Avail. N (kg ha^{-1})		Avail P_2O_5 (kg ha^{-1})		Avail K_2O (kg ha^{-1})	
				75 DAS	At Harvest	75 DAS	Harvest	75 DAS	Harvest	75 DAS	Harvest	75 DAS	Harvest	75 DAS	Harvest
T_1 - Recommended dose of Fertilizers	166.5	52.9	4,568.6	115.7	31.2	36.8	16.3	0.333	0.453	333.0	291.6	81.7	76.3	838.6	1,063.6
T_2 -Cotton crop residue only	141.1	30.9	2,646.3	136.1	35.9	39.2	20.7	0.370	0.273	257.0	223.3	47.1	44.3	748.6	910.6
T_3 -Cotton crop residue +75% RDF	158.7	43.6	4,070.3	148.2	32.5	39.6	18.3	0.453	0.530	326.6	288.6	92.4	82.7	842.3	1,081.6
T_4 -Cotton crop residue +75% RDF + DM	161.4	45.6	4,220.0	157.1	29.9	39.5	21.1	0.487	0.493	340.0	302.3	116.1	96.9	930.6	1,122.0
T_5 -Cotton crop residue +50 %RDF	154.9	39.9	3,783.0	154.6	34.3	45.3	21.3	0.467	0.363	296.6	258.0	73.7	60.0	836.6	1,009.3
T_6 -Cotton crop residue +50 % RDF + DM	153.9	41.0	3,965.0	149.3	34.3	46.0	29.1	0.480	0.387	322.0	268.3	87.5	59.6	876.6	1,099.3
T_7 - Cotton crop residue + DM	148.5	36.6	3,115.3	146.0	35.8	47.3	22.7	0.370	0.373	271.3	242.6	54.7	55.9	805.0	907.6
T_8 - Cotton crop residue + DM + FYM @ 5t /ha	155.1	40.2	3,463.6	171.5	45.6	50.3	26.9	0.453	0.453	293.3	219.00	62.6	66.2	848.6	987.0
Sem±	2.50	1.85	193.63	7.33	1.80	4.18	3.46	0.04	0.06	22.60	26.29	10.35	5.89	29.40	39.44
CD (0.05)	7.66	5.66	593.03	22.45	5.51	NS	NS	NS	NS	NS	NS	31.69	18.03	90.1	120.7
CV (%)	3.24	7.74	8.99	8.62	8.91	16.85	22.20	15.38	20.06	12.84	17.39	21.27	15.04	6.06	6.68

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