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Effect of crop residue and fertilizer on soil properties and yield of rice in Alfisol

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Abstract
An experiment was conducted during *Kharif*, 2019-20 at the Research Farm of Department of Agronomy, Dr. BSKKV., Dapoli, Maharashtra, to study the "Effect of crop residues and fertilizer on soil properties and yield of rice in Alfisol". The study was taken on *ex-situ* incorporation of crop residue along with fertilizers in soil for development of soil fertility and crop productivity. The results emerged out indicated that the application of rice straw @ 2.5 t ha^{-1} + ain leaf residue @ 2.5 t ha^{-1} along with 100% NPK was found to be significantly beneficial for improving soil properties and yield of rice in Alfisol. Lower soil properties and yield were noticed by 50%, 75% and 100% NPK than conjoint use of organic residue and fertilizer in soil. Significantly higher yield and yield attributes were also observed by the application of rice straw @ 2.5 t ha^{-1} + ain leaf residue @ 2.5 t ha^{-1} along with 100% NPK over 50%, 75% and 100% NPK alone. Use of crop residue in conjunction with chemical fertilizers can improve yield and yield attributes. Thus, integrated use of rice straw @ 2.5 t ha^{-1} + ain leaf residue @ 2.5 t ha^{-1} and 100% NPK was found to be feasible and proved overall superior impact on rice crop in Alfisols.

Keywords: Bulk density, MWHC, NPK, Rice, Alfisol

Introduction
Crop residues, fertilizers and its mixtures play an important role in the function of Agro-ecosystems because it sustains overall soil quality and crop productivity. The incorporation of crop residue either partially or completely in the field depends upon cultivation method. Crop residue incorporation can improve soil organic carbon and soil nutrients content. It is beneficial for recycling of nutrients and the better C: N ratio needs to be corrected by applying extra amount of fertilizer at the time of residue incorporation (Singh *et al*., 2017) [15]. Since last two decades, people are taking interest to improve soil quality throughout the world. They recognized the fragility of natural resource for development of soil health. Among of them, residue management is the technology which is beneficial for soil and crop yield (Kumari *et al*., 2018) [8]. Residue management might be the right proposition for improvement of soil quality and providing favourable environment for crop growth. The influence of organic matter on soil physical, chemical and soil fertility is well known. The incorporation of organic matter either in the form of crop residue, organic manure or amendment along with fertilizers has significant effect on bulk density (BD) of soil, soil aggregation, soil structure, soil moisture retention capacity, etc. Incorporation of plant residue in combination with fertilizers can increase SOC, humus content or if used as mulch, the residue can modify the soil temperature (Saha and Ghosh, 2013) [14]. Residue decomposition is a major pathway for providing organic and inorganic elements for the nutrient cycling processes and controls nutrient return to the Agro-ecosystem. Impact of decomposing farm *in-situ* and *ex-situ* various crop residues in soil reflected on residual effect of nutrients in soil and productivity of crop. By addition of nutritious residues in soil which helps to developed soil fertility and subsequently soil carbon, humus and also with the helps to improved productivity of any crops/plants (Adams and Angradi, 1996) [1]. The recycling of crop residues has the advantage of converting the surplus farm waste into useful product for meeting nutrient requirement of crops. Continuous cultivation of rice without adding any residues in same field is heavily depleting the soil nutrient status. In Konkan region of Maharashtra, peoples are doing "rabbing" practices and it enriched the heavey metals in the soil which is realy harmful for balance ecosystem. Inplace of rabbing, residue incorporation in soil with integration of fertilizers improves soil fertility and crop productivity.

Methods and Materials

The experiment was conducted at Research Farm, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Maharashtra. The experimental soil is characterized by reddish colour, Lateritic type of Alfisols, particularly Kaolinitic, hyperthermic family of *TypicHaplustalf*. The present experiment was framed in Strip Plot Design (SPD) with twelve treatments and three. The treatments comprises T_1– Rice straw @ 5 t ha^{-1}(C_1) +100% NPK (F_1), T_2– Rice straw @ 5 t ha^{-1} (C_1) + 75% NPK (F_2), T_3– Rice straw @ 5 t ha^{-1} (C_1) + 50%NPK(F_3), T_4– Ain leaf residues@ 5t ha^{-1}(C_2) +100% NPK (F_1), T_5– Ain leaf residues@ 5 t ha^{-1}(C_2) +75%NPK(F_2), T_6 Ain leaf residues@ 5t ha^{-1}(C_2) +50%NPK(F_3), T_7–[Rice straw @2.5 t ha^{-1} + Ain leaf residues@2.5 t ha^{-1}](C_3) + 100% NPK (F_1), T_8–[Rice straw @2.5 t ha^{-1} + Ain leaf residues@2.5 t ha^{-1}](C_3) +75%NPK(F_2)[1], T_9–[Rice straw @2.5 t ha^{-1} + Ain leaf residues@2.5 t ha^{-1}] (C_3) + 50%NPK(F_3), T_{10}– Without residue (C_4) + 100% NPK (F_1), T_{11}– Without residue (C_4) + 75% NPK (F_2), T_{12} Without residue (C_4) + 50% NPK (F_3). The layout of field was done as per the strip plot design. The ridges were opened by tractor-operated ridger for preparing raised beds. Then levelled of raised and flat beds was done manually. Small bunds of 15-20 cm height were raised around each plot along with keeping a distance of 2 m between two replications. There were twelve plots in each replication and in all there were three replications. Hence, there were 36 plots of 4.50 m X 3.00 m after that crop residue added in this plot. We have collected residues of selected forest trees species which is dominant in Konkan region of Maharashtra and rice as a main crop of Konkan and naturally sun dried. We incorporated chapped crop residues in rice field before one $1\frac{1}{2}$ month transplanting of rice. The crops rice (Ratnagiri-1) and were raised during *kharif* (rainy) seasons respectively using recommended practices. Rice crops were transplanted with 20 x 15 cm spacing between rows and plants respectively. The 100% NPK recommended dose applied to the crops was 100:50:50 kg ha^{-1} for rice. The fertilizers used were urea, single super phosphate (SSP) and muriate of potash were applied as per treatments. Plot wise soil samples were analyzed for initial, tillering, flowering and at harvest stage of rice for physico-chemical properties of soil. Bulk density was determined dry clod coating technique as described by Blake and Hartge (1986) [3]. Maximum water holding capacity was determined by using Keen-Rocrko-Waske-box at wet and dry basis of water content as described by Michael (1987) [12]. Soil properties *viz.* pH, EC, OC, Avai. NPK were determined by standard procedure as given by Jackson, (1973) [6].

Results and Discussion

A perusal data showed that the bulk density of soil varied from 1.45 to 1.37 (Mg m^{-3}) under crop residues and fertilizer management practices and had statistically significant. The higher (1.38, 1.36 and 1.31 Mg m^{-3}) improvement in bulk density of soil was recorded by the application of rice straw @ 2.5 t ha^{-1} + ain leaf residue @ 2.5 t ha^{-1}than other treatments at tillering, flowering and at harvest stage rice crop. The treatment level C_3 (Rice straw @ 2.5 t ha^{-1} + Ain leaf residue @ 2.5 t ha^{-1}), it was found to be at par with C_1-rice straw @ 5 t ha^{-1} at flowering stage and C_2-ain leaf residue @ 5 t ha^{-1} at harvest of rice. In case of fertilizer levels, 100% NPK was recorded significant only at harvest sage of rice. While, the highest values (1.45, 1.43 and 1.40 Mg m^{-3}) were recorded in control (no residues) during tillering, flowering and at harvest stage of rice. Regarding the interaction effects, application of 100% NPK along with crop residues (rice straw @ 2.5 t ha^{-1} + Ain leaf residue @ 2.5 t ha^{-1}) were significantly improved in the bulk density of soil at tillering, flowering and at harvest stage of rice over control and its initial status of soil.

Table 1: Effect of crop residues and fertilizer on bulk density of soil (Mg m^{-3})

Treatment	Tillering	Flowering	At harvest
Crop residues levels			
C_1 - Rice straw @ 5 t ha^{-1}	1.40	1.39	1.33
C_2–Ain leaf residue @ 5 t ha^{-1}	1.38	1.37	1.31
C_3 - Rice straw @ 2.5 t ha^{-1} + Ain leaf residue @ 2.5 t ha^{-1}	1.38	1.36	1.31
C_4 – Control (No residue)	1.45	1.43	1.40
SE (m) ±	0.02	0.01	0.006
CD at 5%	-	0.03	0.019
F test	NS	Sig	Sig
Fertilizer levels			
F_1- 100% NPK	1.38	1.36	1.31
F_2- 75% NPK	1.40	1.38	1.34
F_3- 50% NPK	1.43	1.41	1.36
SE (m) ±	0.01	0.02	0.005
CD at 5%	-	-	0.016
F test	NS	NS	Sig
Interaction C × F			
SE (m) ±	0.04	0.03	0.013
CD at 5%	-	-	0.040
F test	NS	NS	Sig
Initial value	1.45		

Mandal *et al*., (2004) [10] reported that incorporation of rice residue along with organic manure was significantly improved in the bulk density (1.18 Mg m^{-3}) over control. The data showed that the maximum water holding capacity of soil varied from 55.08 to 41.38 (%) under the crop residues and fertilizer management practices and had statistically significant. The maximum water holding capacity of soil (49.9, 53.40and 55.08%) was received by rice straw @ 2.5 t ha^{-1} + ain leaf residue @ 2.5 t ha^{-1}at tillering, flowering and harvest stage of rice crop than other. It was found to be at par with C_1-rice straw @ 5 t ha^{-1} and C_2-ain leaf residue @ 5 t ha^{-1}at flowering and harvest stage of rice. The lowest values (41.38, 46.30, 42.53%) were recorded in control (no residue) during tillering, flowering and at harvest stage of rice. In-case of fertilizer levels, application of 100% NPK was noticed significantly higher (41.59, 52.43 and 53.83%) influence of maximum water holding capacity of soil, whereas the lowest values (44.04, 50.41 and 48.59%) were noted in 50% NPK during at tillering, flowering and at harvest stage tillering, flowering and at harvest stage of rice. The interaction effect of crop residue and fertilizer was found non-significant at tillering and at flowering stage of rice.

Table 2: Effect of crop residues and fertilizer on maximum water holding capacity of soil (%)

Treatment	Tillering	Flowering	At harvest
Crop residues levels			
C_1 - Rice straw @ 5 t ha^{-1}	48.64	52.48	53.83
C_2– Ain leaf residue @ 5 t ha^{-1}	49.75	53.19	54.95
C_3 - Rice straw @ 2.5 t ha^{-1} +Ain leaf residue @ 2.5 t ha^{-1}	49.92	53.40	55.08
C_4 – Control (No residue)	41.38	46.30	42.53
SE (m) ±	2.01	1.32	0.45
CD at 5%	-	4.56	1.56
F test	NS	Sig	Sig
Fertilizer levels			
F_1- 100% NPK	49.59	52.43	53.83
F_2- 75% NPK	47.63	51.19	51.97
F_3- 50% NPK	45.04	50.41	48.99
SE (m) ±	1.507	1.05	0.31
CD at 5%	-	-	1.18
F test	NS	NS	Sig
Interaction C × F			
SE (m) ±	5.41	3.13	1.01
CD at 5%	-	-	3.13
F test	NS	NS	Sig
Initial value	42.80		

It might be due to the addition of in the form of residue like organic matter in the soil helps to maintain high pores spaces (increases micro-capillary and macro-capillary pores in soil) resulted; it filled the high amount of water and also the improvement in water holding capacity of soil might be due to build-up of soil organic matter and better soil structure (Sharma *et al.*, 2000 [16] and Mandal *et al.*, 2004) [10]. However, Nagargoje, (2017) [13] and Jadhav, (2018) [7] studied that application of 5 t ha^{-1} ain residue in soil significantly improved water holding capacity of soil. The data pertaining to soil pH influenced significantly by crop residues and fertilizers management practices. Soil pH values varied from 5.89 to 5.62 during the experimentation. The maximum improvement in soil pH (5.82, 5.85 and 5.89) was observed by the C_2–ain leaf residue @ 5 t ha^{-1} and C_3- rice straw @ 2.5 t ha^{-1} + ain leaf residue @ 2.5 t ha^{-1} in crop residue levels over control and other treatments at tillering, flowering and at harvest stage of rice. Significantly highest value (5.90) of pH was recorded in treatment receiving ain leaf residue @ 5 t ha^{-1}followed by (5.89) the treatment rice straw @ 2.5 t ha^{-1} + ain leaf residue @ 2.5 t ha^{-1} which were found to be at par with each other. While the lowest value (5.63, 5.62 and 5.62) was noticed in control (no residue) during tillering, flowering and at harvest stage of rice. Regarding the inorganic one, application of 100% NPK was observed maximum (5.80, 5.84 and 5.88) improvement in soil pH at tillering, flowering and at harvest stage of rice over control and its initial status of soil. Whereas, lowest showed (5.73, 5.71 and 5.75) in 50% NPK only. While the interaction effect, application crop residues (C_3- rice straw @ 2.5 t ha^{-1} + ain leaf residue @ 2.5 t ha^{-1}) and 100% NPK showed significant effect at flowering stage.

Table 3: Effect of crop residues and fertilizer on pH of soil

Treatment	Tillering	Flowering	At harvest
Crop residues levels			
C_1 - Rice straw @ 5 t ha^{-1}	5.80	5.80	5.87
C_2–Ain leaf residue @ 5 t ha^{-1}	5.82	5.84	5.90
C_3 - Rice straw @ 2.5 t ha^{-1} + Ain leaf residue @ 2.5 t ha^{-1}	5.81	5.85	5.89
C_4 – Control (No residue)	5.63	5.62	5.62
SE (m) ±	0.049	0.016	0.007
CD at 5%	-	0.054	0.023
F test	NS	Sig	Sig
Fertilizer levels			
F_1- 100% NPK	5.80	5.84	5.88
F_2- 75% NPK	5.76	5.78	5.82
F_3- 50% NPK	5.73	5.71	5.75
SE (m) ±	0.056	0.041	0.002
CD at 5%	-	-	0.006

F test	NS	NS	Sig
Interaction C × F			
SE (m) ±	0.15	0.09	0.013
CD at 5%	-		0.040
F test	NS	NS	Sig
Initial value	5.70		

Lal *et al*., (2000) [9] and Mandal *et al*., (2004) [10] reported that incorporation organic residues like *Lantana camera*, water hyacinth, *Subabhul* leaves, lentil straw, maize stover and rice straw significantly increased in the pH over control in acid clay loam and they suggested that sustained efforts are needed to improve and maintain this, most important natural resource base, the soil through judicious integration of mineral fertilizers, organic and crop residues. The electrical conductivity of soil was found to be low in most of the treatments under the study and found below the safe limit. The EC of soil varied from 0.25 to 0.14 $dSm^{-1}$and was significantly influenced by the application of crop residue and fertilizer management practices. The highest value (0.19 dSm^{-1}) was recorded in treatment receiving ain leaf residue @ 5 t ha^{-1} during tillering stage, whereas at flowering and at harvest of rice was found maximum (0.22 and 0.25 dSm^{-1}) in treatment receiving rice straw @ 2.5 t ha^{-1} + ain leaf residue @ 2.5 t ha^{-1} followed by ain leaf residue @ 5 t ha^{-1} (0.22 and 0.25 dSm^{-1}) over control and its initial status of soil. The lowest value (0.15, 0.14 and 0.14 dSm^{-1}) was recorded in control (no residue) during tillering, flowering and at harvest stage of rice. Regarding the fertilizer levels, application of 100% NPK was found maximum (0.19, 0.22 and 0.24 dSm^{-1}) improvement in EC of soil during tillering, flowering and at harvest stage of rice. Lowest value of EC (0.16, 0.19 and 0.19 dSm^{-1}) was noted in 50% NPK only during tillering, flowering and at harvest stage of rice. The interaction effect of crop residue and fertilizer had significant on EC of soil during at harvest stage only may be due to integration of organic residue and inorganic fertilizers can accumulation of soluble salts at the surface and helps to increases the neutralizing pH levels and releasing cations due to phytoremediaton in acid soils (Bellakki *et al*., (1998) [17]. observed that the application of 100% NPK along with crop residues was significantly improved in EC of soil over control in rice-wheat system.

Table 4: Effect of crop residues and fertilizer on EC of soil (dSm^{-1})

Treatment	Tillering	Flowering	At harvest
Crop residues levels			
C_1 - Rice straw @ 5 t ha^{-1}	0.18	0.22	0.23
C_2– Ain leaf residue @ 5 t ha^{-1}	0.19	0.21	0.25
C_3 - Rice straw @ 2.5 t ha^{-1} + Ain leaf residue @ 2.5 t ha^{-1}	0.18	0.22	0.25
C_4 – Control (No residue)	0.15	0.14	0.14
SE (m) ±	0.006	0.015	0.003
CD at 5%	-	0.048	0.010
F test	NS	Sig	Sig
Fertilizer levels			
F_1- 100% NPK	0.19	0.22	0.24
F_2- 75% NPK	0.18	0.19	0.21
F_3- 50% NPK	0.16	0.19	0.19
SE (m) ±	0.005	0.012	0.003
CD at 5%	-	-	0.009
F test	NS	NS	Sig
Interaction C × F			
SE (m) ±	0.01	0.04	0.007
CD at 5%	-	-	0.021
F test	NS	NS	Sig
Initial value	0.14		

Ex-situ incorporation of crop residue along with fertilizers showed significant effect on soil organic carbon and it was varied from 14.68 to 10.65 g kg^{-1}. Organic carbon of soil was recorded statistically non-significant at tillering stage rice in both the levels. The highest value (12.89 g kg^{-1}) was recorded by applying rice straw @ 2.5 t ha^{-1} + ain leaf residue @ 2.5 t ha^{-1} (14.68 g kg^{-1}) followed by ain leaf residue @ 5 t ha^{-1} (14.61 g kg^{-1}) which were found to be at par with each other. Whereas, the maximum organic carbon (14.14 g kg^{-1}) was noticed by ain leaf residue @ 5 t ha^{-1} and 100% NPK (13.97 g kg^{-1}) during both the levels of flowering stage of rice over control. The lowest values of organic carbon (11.11, 11.42 and 10.65 g kg^{-1}) and (11.98, 12.68 and 12.67 g kg^{-1}) showed in control during both the levels at tillering, flowering and harvest stage of rice. The interaction effect of crop residue and fertilizer was found to be significant at flowering and at harvest stage of rice. Application integrated use of organic residues along with 100% NPK showed higher build-up of organic carbon in soil may be attributed to reduction-oxidation of process organic matter in soil by the action of higher microbial community, humus synthesis and soil enzyme assay owing to a prevailing optimum amount of moisture percentage and temperature in Coastal areas. It might be due to that the direct incorporation of more residues along with balanced fertilization in the soil (Chavan *et al*., 1995 [5] and Bellakki *et al*., 1998) [17].

Table 5: Effect of crop residues and fertilizer on organic carbon of soil (g kg^{-1})

Treatment	Tillering	Flowering	At harvest
Crop residues levels			
C_1 - Rice straw @ 5 t ha^{-1}	12.53	13.83	14.28
C_2–Ain leaf residue @ 5 t ha^{-1}	12.89	14.01	14.61
C_3 - Rice straw @ 2.5 t ha^{-1} + Ain leaf residue @ 2.5 t ha^{-1}	12.77	14.14	14.68
C_4 – Control (No residue)	11.11	11.42	10.65
SE (m) ±	0.39	0.04	0.03
CD at 5%	-	0.12	0.09
F test	NS	Sig	Sig
Fertilizer levels			
F_1- 100% NPK	12.74	13.97	14.51
F_2- 75% NPK	12.25	13.40	13.48
F_3- 50% NPK	11.98	12.68	12.67
SE (m) ±	0.19	0.04	0.004
CD at 5%	-	0.13	0.014
F test	NS	Sig	Sig
Interaction C × F			
SE (m) ±	0.87	0.08	0.07
CD at 5%	-	0.25	0.21
F test	NS	Sig	Sig
Initial value	10.91		

The data observed that available nitrogen of soil ranged from 283.54 to 339.76 (kg ha^{-1}) indicating that application of crop residues and fertilizers had a significant influence on the available nitrogen content of the soil. Available nitrogen in soil at tillering, flowering and at harvest stage rice crop was recorded highest (339.76, 332.90 and 318.90 kg ha^{-1}) in treatment receiving rice straw @ 2.5 t ha^{-1} + ain leaf residue @ 2.5 t ha^{-1} over control and its initial status of soil. The lowest nitrogen in soil (306.92, 299.19 and 283.54 kg ha^{-1}) was noticed in control during tillering, flowering and harvest stage of rice. Regarding the application of 100% NPK was recorded maximum availability nitrogen (338.94, 331.87 and 317.97 kg ha^{-1}) in soil at tillering, flowering and at harvest stage of rice than 50% NPK alone. The interaction effect of crop residues and fertilizers were statistically significant at flowering and at harvest stage of rice.

Table 6: Effect of crop residues and fertilizer on available nitrogen of soil (kg ha^{-1})

Treatment	Tillering	Flowering	At harvest
Crop residues levels			
C_1 - Rice straw @ 5 t ha^{-1}	335.73	329.59	314.83
C_2 - Ain leaf residue @ 5 t ha^{-1}	339.56	333.52	318.68
C_3 - Rice straw @ 2.5 t ha^{-1} + Ain leaf residue @ 2.5 t ha^{-1}	339.76	332.90	318.90
C_4 – Control (No residue)	306.92	299.19	283.54
SE (m) ±	7.33	1.08	0.59
CD at 5%	-	3.72	2.01
F test	NS	Sig	Sig
Fertilizer levels			
F_1- 100% NPK	338.94	331.87	317.97
F_2- 75% NPK	331.64	325.14	309.75
F_3- 50% NPK	320.90	314.39	299.25
SE (m) ±	3.500	1.20	0.799
CD at 5%	-	3.92	3.10
F test	NS	Sig	Sig
Interaction C × F			
SE (m) ±	16.50	2.90	1.88
CD at 5%	-	8.94	5.79
F test	NS	Sig	Sig
Initial value	298.25		

Meshram *et al.,* (2016) [18] also reported that availability of nitrogen in soil under forest biodiversity conditions due to the naturally addition of leaf litters in the soil helps to building up soil carbon synthesis and more humus formation in soil. A perusal data showed that the available phosphorus (kg ha^{-1}) of soil varied from 9.91 to 17.64 kg ha^{-1} under the crop residues and fertilizer management practices and had statistically significant in both the levels in some regards. The highest available phosphorus of soil (17.64, and 14.57 kg ha^{-1}) was received by the application of rice straw @ 2.5 t ha^{-1} + ain leaf residue @ 2.5 t ha^{-1} during tillering, and harvest stage but at flowering stage (16.20 kg ha^{-1}) was found highest by receiving treatment ain leaf residue @ 5 t ha^{-1} of rice crop than other applications. It was found to be at par with C_1-rice straw @ 5 t ha^{-1} and C_2-ain leaf residue @ 5 t ha^{-1} at flowering and harvest stage of rice. The lowest values (13.21, 11.27 and 9.91 kg ha^{-1}) were recorded in control (no residue) during tillering, flowering and at harvest stage of rice. In-case of fertilizer levels, application of 100% NPK was noticed significantly higher available phosphorus (17.43, 15.96 and 14.27 kg ha^{-1}) in soil than 50% NPK and 75% NPK. The interaction effect of crop residue along with fertilizer was found significant only at harvest stage of rice.

Table 7: Effect of crop residues and fertilizer on available P_2O_5 of soil (kg ha^{-1})

Treatment	Tillering	Flowering	At harvest
Crop residues levels			
C_1 - Rice straw @ 5 t ha^{-1}	16.69	15.58	13.94
C_2 - Ain leaf residue @ 5 t ha^{-1}	17.50	16.20	14.53
C_3 - Rice straw @ 2.5 t ha^{-1} + Ain leaf residue @ 2.5 t ha^{-1}	17.64	16.03	14.57
C_4 – Control (No residue)	13.21	11.27	9.91
SE (m) ±	1.04	0.86	0.03
CD at 5%	-	2.92	0.11
F test	NS	Sig	Sig
Fertilizer levels			
F_1- 100% NPK	17.43	15.96	14.27
F_2- 75% NPK	16.25	14.50	13.39
F_3- 50% NPK	15.11	13.85	12.06
SE (m) ±	0.50	0.649	0.022
CD at 5%	-	-	0.085
F test	NS	NS	Sig
Interaction C × F			
SE (m) ±	1.82	1.89	0.08
CD at 5%	-	-	0.25
F test	NS	NS	Sig
Initial value	10.30		

It might have also solubilized the native phosphorus in the soil through the release of various organic acids which had the chelating effect that reduced phosphorus fixation (Bellakki *et al*., 1998 [17]; Lal *et al.*, 2000 [9] and Mandal *et al*., 2004) [10]. The data pertaining on soil available potassium have been significantly influenced by the application of crop residues and fertilizers management practices. Available potassium values of soil varied from 313.0 to 361.34 kg ha^{-1}. The maximum availability of potassium in soil (361.34 and 343.90 kg ha^{-1}) was observed by the application of rice straw @ 2.5 t ha^{-1} + ain leaf residue @ 2.5 t ha^{-1} during tillering and harvest stage but at flowering stage (350.31 kg ha^{-1}) was found maximum by receiving treatment ain leaf residue @ 5 t ha^{-1}over control and its initial status of soil. It was followed by ain leaf residue @ 5 t $ha^{-1}$and rice straw @ 5 t ha^{-1} which were found to be at par with each other at flowering and at harvest stage of rice. The lowest potassium in soil (334.01, 321.59, 313.00 kg ha^{-1}) was noticed in control during tillering, flowering and harvest stage of rice. Regarding the inorganic applications, 100% NPK was recorded maximum availability of potassium (360.36, 348.61 and 339.98 kg ha^{-1}) in soil at tillering, flowering and at harvest stage of rice than 50% NPK and 75% NPK alone. Crop residue levels during only flowering stage and at harvest stage as well as with the interaction effect of rice was noted statistically significant on available potassium of soil. This could be attributed to the greater capacity of organic colloids to hold K ions on the exchange sites by the application of 100% NPK along with crop residue (Bellakki *et al*., 1998 [17]; Lal *et al.*, 2000 [9] and Mandal *et al*., 2004) [10].

Table 8: Effect of crop residues and fertilizer on available K_2O of soil (kg ha^{-1})

Treatment	Tillering	Flowering	At harvest
Crop residues levels			
C_1 - Rice straw @ 5 t ha^{-1}	355.22	345.43	338.52
C_2– Ain leaf residue @ 5 t ha^{-1}	360.63	350.31	342.62
C_3 - Rice straw @ 2.5 t ha^{-1} + Ain leaf residue @ 2.5 t ha^{-1}	361.34	348.71	343.90
C_4 – Control (No residue)	334.01	321.59	313.00
SE (m) ±	8.18	4.93	2.79
CD at 5%	-	17.05	9.66
F test	NS	Sig	Sig
Fertilizer levels			
F_1- 100% NPK	360.36	348.61	339.98
F_2- 75% NPK	353.57	341.66	335.09
F_3- 50% NPK	344.47	334.27	328.47
SE (m) ±	5.86	4.28	2.03
CD at 5%	-	-	7.97
F test	NS	NS	Sig
Interaction C × F			
SE (m) ±	17.84	11.96	6.65
CD at 5%	-	-	20.48
F test	NS	NS	Sig
Initial value	320.18		

The data related to rice grain and straw yield as influenced significantly by the incorporation of crop residues and fertilizer. The maximum grain and straw yield (47.83 and 55.71 q ha^{-1}) of rice was recorded by the application of rice straw @ 2.5 t ha^{-1} + ain leaf residue @ 2.5 t ha^{-1} over control (no residue). It was found to be at par with C_1-rice straw @ 5 t ha^{-1} and C_2-ain leaf residue @ 5 t ha^{-1}. The lowest rice grain and straw yield (27.74 and 30.99 q ha^{-1}) was recorded in control (no residue). In-case of fertilizer levels, application of 100% NPK was noticed significantly higher grain yield and straw (44.77 q ha^{-1} and 51.77 q ha^{-1}) of rice than 50% NPK and 75% NPK and alone. The interaction effect of crop residue along with fertilizer was found significant in grain and straw of rice may be due to balanced integration of organic matter and fertilizers.

Table 9: Effect of crop residues and fertilizer on grain and straw yield of rice (q ha^{-1})

Treatment	Grain	Straw
Crop residue levels		
C_1 - Rice straw @ 5 t ha^{-1}	46.50	53.49
C_2– Ain leaf residue @ 5 t ha^{-1}	47.37	55.71
C_3 - Rice straw @ 2.5 t ha^{-1} + Ain leaf residue @ 2.5 t ha^{-1}	47.83	55.13
C_4 – Control (No residue)	27.74	30.99
SE (m) ±	1.05	2.02
CD at 5%	3.63	6.98
F-test	Sig	Sig
Fertilizer levels		
F_1- 100% NPK	44.77	51.77
F_2- 75% NPK	42.86	48.78
F_3- 50% NPK	39.45	45.94
SE (m) ±	0.68	0.73
CD at 5%	2.68	2.86
F-test	Sig	Sig
Interaction C × F		
SE (m) ±	3.64	4.41
CD at 5%	11.20	13.60
F-test	Sig	Sig

Singh *et al*., (2017) [15] stated that all the yield attributes were higher with the substitution of crop residue / manure in combination with 50-75% RDF due slow release and continuous supply of balance quantity of nutrients in throughout the various growth stages enables the rice plants to assimilate sufficient photosynthetic products and thus, increased the dry matter and source capacity, resulted in the production of increased grain and straw yield.

Conclusions

It can be concluded that the application of rice straw @ 2.5 t ha^{-1} + ain leaf residue @ 2.5 t ha^{-1} along with 100% NPK is most useful for improving soil properties, yield attributes and yield of rice in Alfisol. Significantly declining the nutrient status of soil and yield of rice was due to 50%, 75% and 100% NPK alone. Overall, conjoint use of rice straw @ 2.5 t ha^{-1} + ain leaf residue @ 2.5 t ha^{-1} and 100% NPK was found to be overall superior effect on rice in Alfisol.

References

1. Adams MB, Angradi TR. Decomposition and nutrient dynamics of hardwood leaf litter in the femow whole watershed acidification experiment. Forest Ecology and Management. 1996;83:61-69.
2. Bellaki MA, Badanur VP, Setty RA. Effect of long – term integrated nutrient management on some important properties of vertisols. Journal of the Indian Society of Soil Science. 1998;51(2):111-117.
3. Blake GR, Hartge KH. Bulk density. In: Methods of Soil Analysis, Part-I, Klute, A. (Ed.). American Society of Agronomy Inc. and Soil Science Society of America Inc. Madison, Wisconsin, USA; c1986. p. 371-373.
4. Bray RH, Kurtz LT. Determination of total, organic, and available forms of phosphorus in soils. Soil Science. 1945;59:39-45.
5. Chavan KN, Kenjale RY, Chavan AS. Effect of forest tree species on properties of lateritic soil. Journal of the Indian Society Soil Science. 1995;43(1):43-46.
6. Jackson ML. Soil Chemical Analysis, Prentice Hall of India Pvt. Ltd., New Delhi. 1973.
7. Jadhav TD. Impact of recycling agroforest leaf litter/residue on decomposition rate, soil properties and yield of mustard in Alfisol. M.Sc. Thesis submitted to Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, MS. 2018.
8. Kumari K, Prasad J, Solanki IS, Chaudhary R. Long-term effect of crop residues incorporation on yield and soil physical properties under rice - wheat cropping system in calcareous soil. Journal of Soil Science and Plant Nutrition. 2018;18(1):27- 40.
9. Lal JK, Mishra B, Sarkar AK. Effect of plant residues incorporation on specific microbial groups and availability of some plant nutrients in soil. Journal of the Indian Society of Soil Science. 2000;48(1):67-71.
10. Mandal KG, Misra AK, Hati KM, Bandyopadhyay KK, Ghosh PK, Mohanty M. Rice residue- management options and effects on soil properties and crop productivity. Food Agriculture & Environment. 2004;2(1):224-231.
11. Meshram NA, Syed Ismail, Rathod PK. Effect of FYM and Inorganic fertilization on Soil Organic Matter fractions under Long Term Fertilizer Experiment in Vertisol. Journal of Agricultural Research and Technology. 2018;43(3):459-464
12. Michael AM. Irrigation theory and practices of soil. Vikas Publishing House, New Delhi; c1987. p. 464-472.
13. Nagargoje DB. Assessment of decomposition dynamics,

microbial community and soil fertility under different Agro forest trees in Alfisol. M.Sc. Thesis submitted to Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, MS. 2017.
14. Saha R, Ghosh PK. Soil organic carbon stock, moisture availability and crop yield as influenced by residue management and tillage practices in maize – mustard cropping system under hill Agro–ecosystem, National academy science letters. 2013;5:461-468.
15. Singh PP, Pawar R, Meena R. Response of integrated nutrient management on yield and chemical properties of soil under Rice - Wheat Cropping system. International Journal of Chemical Studies. 2017;5(2):366-369.
16. Sharma A. Seasonal to interannual rainfall probabilistic forecasts for improved water supply management: Part 3: A nonparametric probabilistic forecast model. Journal of Hydrology. 2000 Dec 20;239(1-4):249-58.
17. Bellakki MA, Badanur VP, Setty RA. Effect of long-term integrated nutrient management on some important properties of a Vertisol. Journal of the Indian Society of Soil Science. 1998;46(2):176-80.
18. Meshram A, Jaiswal AK, Khivsara SD, Ortega JD, Ho C, Bapat R, Dutta P. Modeling and analysis of a printed circuit heat exchanger for supercritical CO2 power cycle applications. Applied Thermal Engineering. 2016 Oct 25;109:861-70.