

EFFECTS OF RESIDUE MANAGEMENT PRACTICES OF WHEAT-RICE CROPPING SYSTEM ON SOIL PHYSICOCHEMICAL PROPERTIES & MICRO AND MACRO NUTRIENT AVAILABILITY TO CROP

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Abstract-A long term experiment was established on resource conservation technologies a sustainable approach for careful management and preservation of resources and environment. This study includes the resource conservation strategies through tillage and residue management for addressing crop productivity, energy saving and soil quality under rice & wheat cropping system. Conventional practices with and without crop residue were improved by adopted resource conservation technologies viz. reduce tillage with and without crop residue and zero tillage with and without crop residue with different irrigations practices. By using these practices it is observed that Percentage organic carbon increased from 0.62 % to 1.07 %, Available Nitrogen (N) increased from 285 to 487 kg/ha, Available Potassium (K) increased from 179 to 280 kg/ha, Available Phosphorus (P) increased from 23.4 to 36.8 kg/ha Availability of micronutrients Mn, Cu, Zn, and Fe also increased from 11.13 to 21.46 mg/kg, 0.45 to 0.99 mg/kg, 0.44 to 1.11 mg/kg, and from 7.26 to 21.43 mg/kg respectively. From the study it is observed that residue left in the soil increases the availability of macro and micro nutrients to the crops hence improve the soil health and yield of crops as compared to the conventional practices.

I. INTRODUCTION

For the good yield production from the agricultural field production, there should be an improvement in the quality of soil by organic mean because the sustainability of the environment for the new generation is must [1], [2], [3]. Due to the application of imbalanced fertilizers and without management of crop residue soil health get degraded [4], [5]. Crop residue contained secondary nutrients and micronutrients and this crop residue when mulching in the soil it improves soil physical, chemical, and biological properties and also increases the primary nutrients in the soil [6], [7], [8]. In our country, the major problem is to achieve high production from low fertile soil [9]. Deficiencies of micro and macro nutrients appeared in soil because they are uptake by crop and plants. Symptoms of deficiency are observed in major crops like rice and wheat are intensive and critical. Assessment of the fertility status of the soil of any region is necessary conditions for the sustainable agriculture [10]. A large quantity of the residue of wheat and rice is produced per year in our country. Use of conservation management practices give the positive results in reduced tillage, zero tillage and crop residue retention in the field of rice-wheat cropping system and increase in the production of food in South Asian countries [11], [12], [13]. Soil moisture is maintained by crop residue retention in the field which increase organic carbon in soil, control of weeds also improve the soil physical properties [14] and all this will result in improving the yield of crops in the rice-wheat cropping system. The technique of conservation reduces disturbance in soil and it retained crop residue on soil surface hence will increase the availability of the nutrients in plants and improve soil properties [15]. After crop harvesting

residue burning is the easiest way for farmers to reduce the residue of the crop from their field. After harvesting of crops, 80% of the rice residue and 50 % of wheat residue is burnt [16]. The residue of crops contains primary nutrients like Nitrogen 5–8 kg, Phosphorus 0.7–1.2 kg and Potassium 12–17 kg [17]. So by residue management technique decomposition of crop residue releases these nutrients to the soil and improves the organic carbon and nutrients availability. The main aim of the study is to the evaluation of crop residue management techniques and its effects on the soil physicochemical properties under rice-wheat cropping system.

II. MATERIAL AND METHOD

Sample Collection and Measurements

This study was performed in area of ICAR CSSRI located at 29° 42' 29" N, 76° 57' 11" E Karnal Haryana India. Some adopted resource conservation technologies viz. reduce tillage with and without crop residue, zero tillage with and without crop residue with different irrigations practices , Conventional practices with and without crop residue were also imposed. To observe the effect of different treatment on physicochemical properties of soil and availability of different micronutrients to crop total 9 numbers of agricultural plots were selected to give different types of treatment (detail present in Table-1). Soil samples from each treatment plot were collected surface to 15 cm depth, by random zigzag fashion with the help of auger. For a reliable soil test the collection of the soil sample should be good and representative, collected soil samples from each unit/block are homogenized by thoroughly mixed with hand to get the sample which truly represents the sample of each treatment. Samples from all plot was collected by using similar technique. Collected samples were then air dried ground and sieve through 2 mm sieve and finally packed in polythene with proper labeling. Collected soil samples were then brought to the laboratory of ICAR-CSSRI Karnal, Haryana for analysis. Analysis of physicochemical parameters like pH was measure by pH meter, Electrical Conductivity (E.C) measured by E.C meter, Total organic carbon was determined by the $K_2Cr_2O_7-H_2SO_4$ digestion method, Available Nitrogen (N) was determined through alkaline permanganate method, Available Phosphorus (P) in soil was determined through the Olsen method extraction used for this method is $NaHCO_3$ at pH 8.5. Available Potassium (K) was extracted with ammonium acetate method neutral with pH 7.3. Available soil micronutrients like Zn, Cu, Fe, Mn were extracted at pH 7.3 by Di-ethylene Triamine Penta Acetic Acid (DTPA) extraction method. Then extracted samples were analyzed on atomic absorption spectrophotometer (AAS).

III. RESULTS AND DISCUSSION

Results of physico-chemical properties of study of different soil treatments practices are presented in Table – 2. Graphical presentation of variation of physicochemical parameters value with different treatment plot are presented from Fig. 1 to 6.

Soil pH : pH in soil samples of different treatments plot were ranged from 5.5 to 7.5. Details are present in Table 2. Soil pH of plot T-5 (zero tillage) is 5.5 indicates that soil is acidic. Soil pH of T-1 plot (conventional tillage) is 6.5 indicating soil was acidic to alkaline and soil pH of T-3 plot (residue management in reduced tillage) is 7.56, which is good in residue management practices. Soil pH is very important parameter as availability of macro and micronutrients depends upon the soil pH. As pH decrease the availability of iron, manganese and copper increase. If the pH of soil increase then the micronutrient in soil will decrease and less available to plants hence decrease. Graphically presentations of variation of pH with different treatment plots are depicted in Fig-1.

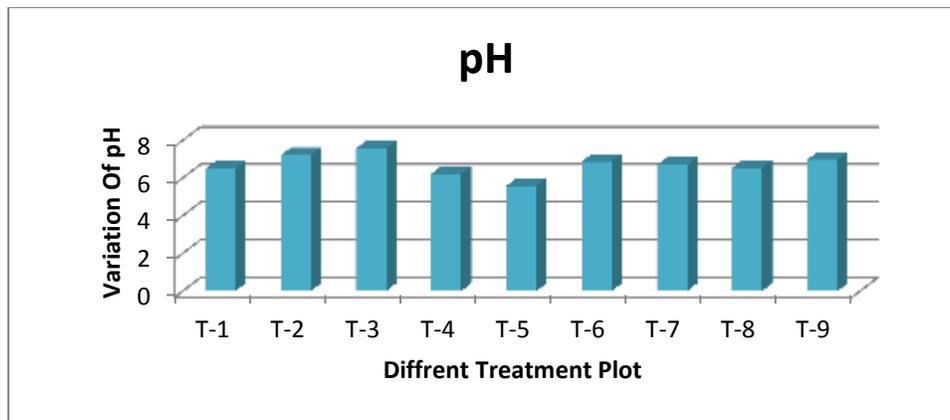


Figure 1 Variation of pH in different Treatments Plot

Soil Electrical Conductivity (EC): Salt concentration in the soil is determined through electrical conductivity. E.C of soil samples ranged from 0.2 to 0.33 ds/m. Minimum value of E.C is noticed in residue management practices. Maximum E.C is noticed in conventional practices. low Electrical conductivity is injurious to soil health and it also affects the soil physical properties like infiltration rate and water holding capacity. Electrical conductivity (EC) 4.0 ds/m at 25°C cause the soil infertile. Graphically presentations of variation of E.C with different treatment plots are depicted in Fig-2.

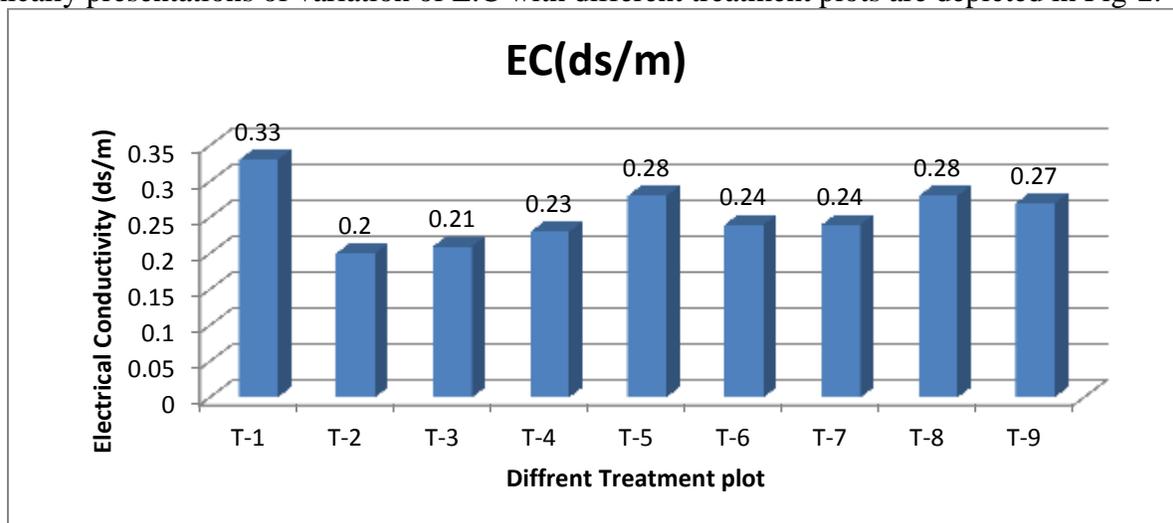


Figure 2 Variation of E.C in different treatment Plots

Total organic carbon in soil: Organic carbon plays a major role in maintaining soil health. Percentage organic carbon ranges from 0.62% to 1.07 % in soil samples. The range of the organic carbon in the soil must be from 0.5 to 0.75 %. From the study it observed that percentage organic carbon is maximum 1.07% in T-6 (Zero tillage + 30 % residue incorporated soil with normal Irrigation practices) followed by 1.05% in T-9 (Zero tillage + 100% residue incorporated soil with Sprinkler irrigation practices) . Hence percentage Organic carbon in residue incorporated soil is increased because decomposition of residue increases the organic matter in the soil. As percentage of organic matter increased there will be an improvement in soil physical, chemical, and biological properties. Hence high value of organic carbon is good for soil fertility and also for crop yield. Organic carbon also improves the texture, water holding capacity, Cation exchange capacity (CEC) and infiltration rate of the soil. Graphically presentations of variation of Organic carbon (%) with different treatment plots are depicted in Fig-3.

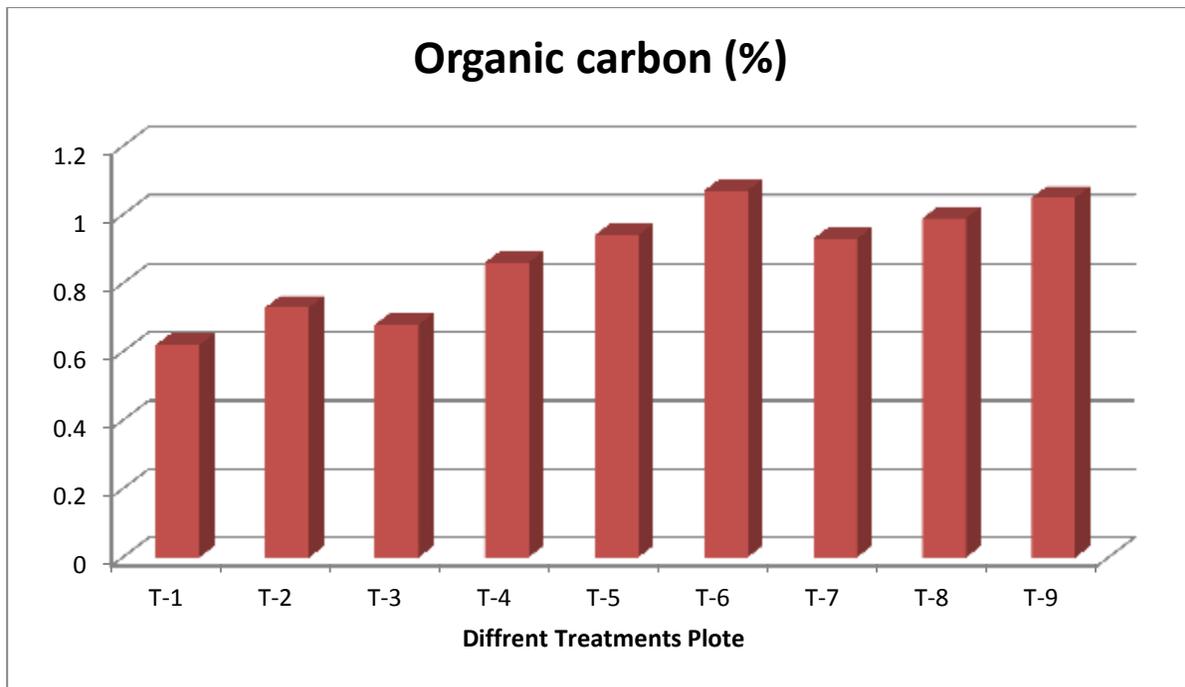


Figure 3 Variation of Organic Carbon (%) in different Treatments Plot

Available Nitrogen, Phosphorus and Potassium (NPK) in soil:

Available Nitrogen (N) in soil samples was ranged from 285 to 487 kg/ha. Maximum available nitrogen content 487 kg/ha was noticed in T-9 plot (Zero tillage + 100% residue incorporated soil with Sprinkler irrigation practices). As the value of organic carbon increase in the soil the nitrogen content also increased. Available nitrogen in soil is affected by wheat & rice straw after crop harvesting. Nitrogen content increased at every growth stage of wheat and rice crop. Hence Residue management practices, zero tillage, and crop rotation increase the availability of nutrients as compare to conventional practices. Sometimes there is an increase in the nitrogen content in soil in conventional practices also due to the continuous application of the fertilizers like urea in the field for improving the yield of crops by farmers.

Available potassium (K) in soil samples ranges from 179 to 280 kg/ha. Maximum concentration of available K was determined in T-7 plot (Zero tillage + 100% residue with drip irrigation practices). Available potassium 218 kg/ha was noticed in conventional practice comparatively low to other residue management practice. Hence it is observed that the value of K is increasing with the treatment of residue management.

Available phosphorus in soil samples ranges from 23.4 to 36.8 kg/ha. Maximum available Phosphorus content was noticed in T-9 plot (Zero tillage + 100% residue incorporated soil with Sprinkler irrigation practices). In P-1 plot (conventional practices with normal irrigation) available phosphorus was 23.45 kg/ha, Low level of phosphate in conventional practices with normal irrigation may be due to phosphate can potentially be lost through soil erosion and to water running over or through the soil. There is considerable concern about P being lost from soils and transported to nearby streams [23]. So by the perusal of result we conclude that sprinkler irrigation practices improve the soil quality by increasing the phosphorus. Graphically presentations of variation of NPK with different treatment plots are depicted in Fig-4. Hence available phosphorus was also comparatively low from all other residue management practices.

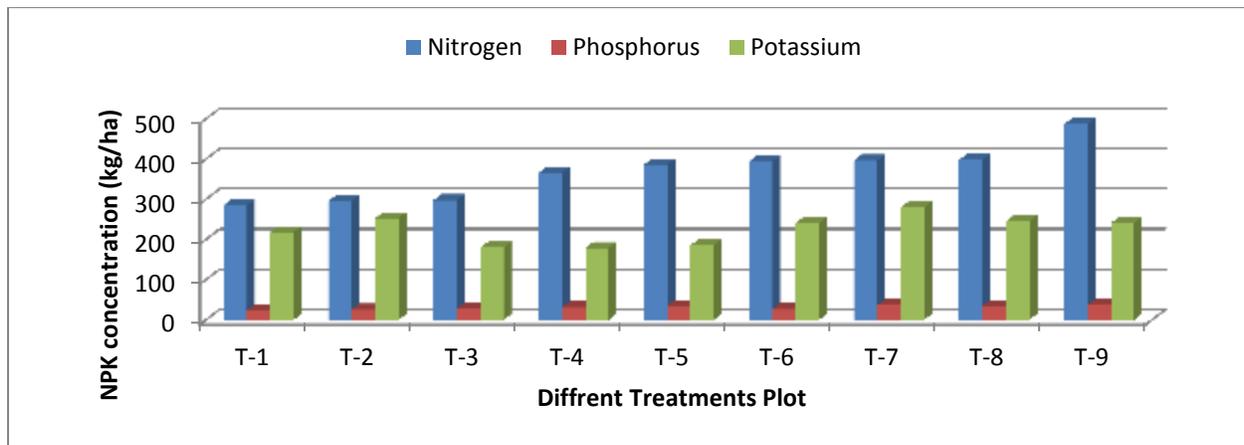


Figure 4 Variation of Available Conc. Of (NPK) in different Treatments Plot

Available micronutrients (Fe, Zn, Cu, Mn) in soil:

Concentration of Mn in soil samples ranges from 11.13 to 21.46 mg/kg. Maximum Mn concentration was observed in T-7 plot (Zero tillage with 100% residue with drip irrigation practices) and minimum concentration was in T-5 plot (Zero tillage with normal irrigation practices). Minimum range of micronutrients in T-5 is may be due the problems of weed growth which compete with the micronutrients present in soil. Maximum concentration of copper determined is 0.99 mg/kg in T-9 plot (zero tillage +100 % residues with sprinkle irrigation practices. On other side in conventional practices minimum concentration of Cu is 0.45 is observed. The availability of the Cu is maximum in T-9 plot is due to the residue management practices. Higher amount of the organic carbon always increase the availability of Cu in soil. Minimum concentration of Cu in conventional practices is due to less amount of organic carbon present in it. Concentration of available Zinc is also maximum in T-9 plot which is 1.11 mg/kg and minimum concentration is in T-1 (conventional with normal irrigation practice) plot which is 0.44 mg/kg. The availability of micronutrient Zn is may be maximum due to the residue management practices in (T-9) and less Zn due to the conventional tillage and residue burning in T-1 plot. Concentration of Fe soil samples ranges from 7.26 to 21.43 mg/kg. Availability of Fe is Maximum in T-8 (Zero tillage + 100% residue with normal irrigation practices). Residue left in the soil increases the availability of macro and micro nutrients to the crops hence improve the soil health and yield of crops as compared to the conventional practices as there may be loss of micronutrients due to residue burning. Graphically presentations of variation of concentration of Mn, Fe and Cu, Zn in different treatment plots are depicted in Fig-5 & 6.

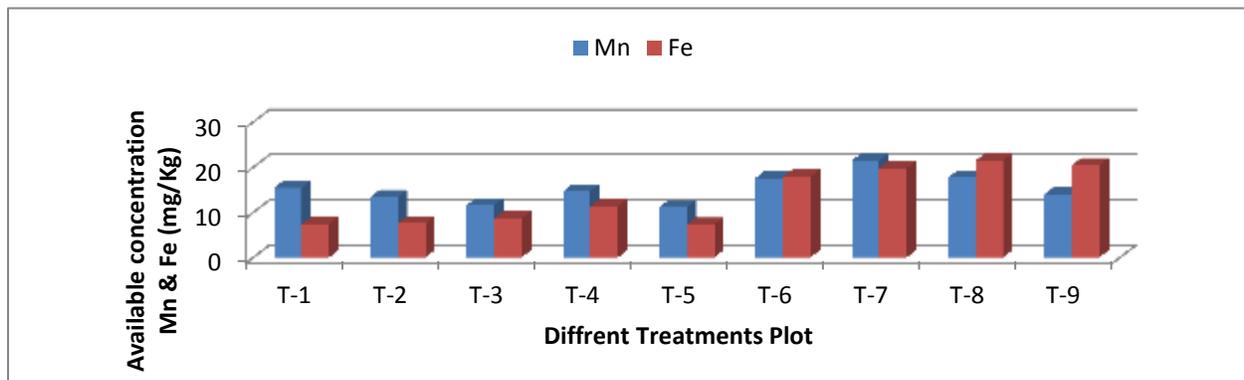


Figure 5 Variation of Conc. Of Available Mn & Fe in different Treatments Plot

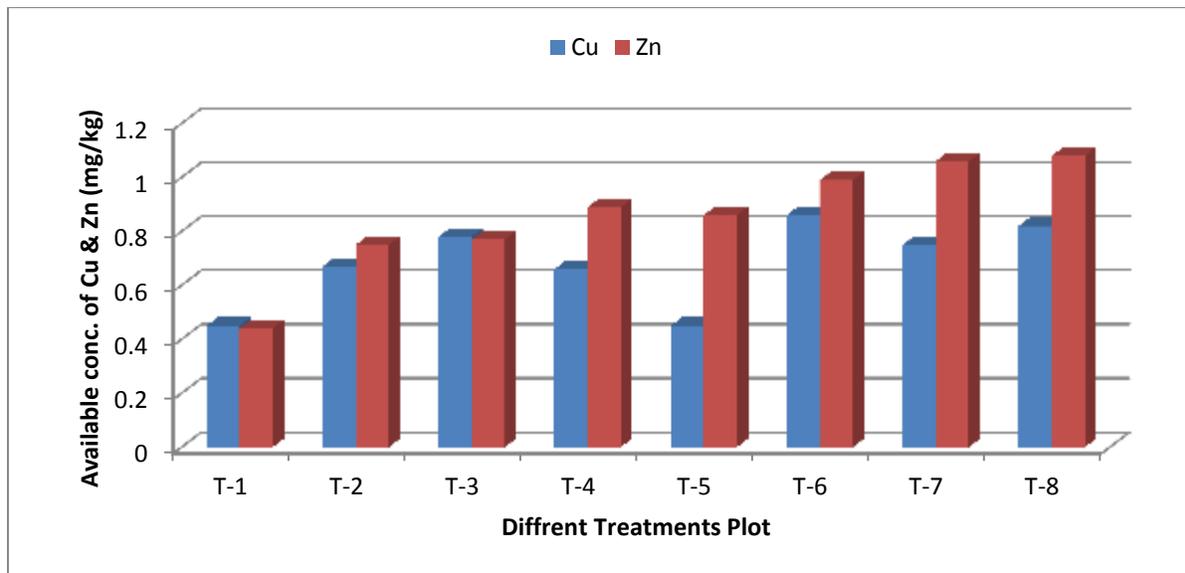


Figure 6 Variation of Available Cu & Zn in different Treatments Plot

Related Study done by other others

Saika et al [18] studied on residue management practices and noted that concentration of SOC was increased under zero tillage with 100% residue retention (ZTW_{R100}) as compared to conventional tillage in wheat crop. Availability of Nitrogen content was highly affected by the residue management and manure practice in zero tillage treatment. Available nitrogen value is 119.7 kg/ha which is higher as compared to conventional practice (77.4 kg/ha). Availability of the Phosphorus (P) was noted maximum in zero tillage wheat with 100% residue as compared to conventional wheat without residue. The value in ZTW_{R100} was 34 kg/ha and in conventional tillage with no residue (CVW_{R0}) was 19.7kg/ha. Available potassium in ZTW_{R100} was noted 129.9 kg/ha and in CVW_{R0} was 77.3 kg/ha.

kumari et al [19] studied on residue management & observed that the organic carbon increased from 0.83 to 0.90%. crop residue increment reduce the pH from 8.26 to 8.01. crop residue with increased Zinc application increased the nitrogen content by 13% and 3%. Available phosphate and potash are increased 66% and 21% due to crop residue incorporation.. Decomposition of the crop residue in the field produce the polysaccharides, organic acid and amino acid hence enhance the availability of micronutrients crop residue increase the Cu by 18%. Available Zinc increased due to residue incorporation is 147%. Increase in the crop residue also increase the Fe content by 19%.

Ghimire et al [20] observed from his study that No-tillage increased soil aggregation, improved other soil properties, and favorably influenced SOC accretion. Effects of crop residue addition are often observed when it was integrated with reduced-tillage systems or with improved nutrient management. Applications of N fertilizers with FYM and crop residues increased stubble and root biomass yield, and improved SOC accumulation, in some cases up to 84%. crop residue, and nitrogen management practices to improve SOC sequestration and enhance agricultural sustainability.

Shahrzad et al [21] reported that residue of the crop decreased the pH by about 0.3 and the pH of the soil is caused the availability of the metal in the soil. Increase and decrease of the pH of soil affects the uptake of nutrients by soils which are essential for the plants growth. Due to decrease the pH of soil the availability of Cu and Mn will increase in soil. Crop residue decomposition increase the ions in soil hence increase the EC of soil. Crop residue also increases dissolved organic carbon in soil.

Mbah et al [22] reported that the residue management techniques had significantly higher CEC and non-significant values of total N compared to the control. Surface mulch (SM), Burn and incorporation (BAI) and Slash and incorporation (SAI) gave relatively higher OM, available P and total N values relative to the control (Table 2). The mean pH, OM, available P and total N values in residue treated plots ranged from 4.6 to 5.1, 0.98 to 1.25%, 2.8 to 3.8 mgkg⁻¹ and 0.41 to 0.071%, respectively, in the first cropping season. Slash and incorporation (SAI) of residue gave the highest OM content (1.35%) in the first cropping season while BAI gave the highest total N (0.070%) value in the second cropping season. Observed values of available P in SM in the second season showed 25, 66 and 84% increase compared to SAI, BAI and control. Similarly, pH was 11, 13 and 7% lower in control plots relative to SM, BAI and SAI plots, respectively in the second cropping season. The observed improvement in soil properties in residue management treated plots could be attributed to the effects of these treatments on soil conditions.

IV. CONCLUSION

Application of the residue of crops increased the availability of micronutrients Zn , Cu and Fe and Mn results of this higher yield of rice and wheat. It is observed that Addition of the crop residue in the field as well as decomposition of the crop residue enhance the population of microorganism which increase the soil organic carbon content which ultimately improve the soil quality. It observed that percentage organic carbon is maximum (1.07%) in T-6 plot (Zero tillage + 30 % residue incorporated soil with normal Irrigation practices) followed by 1.05% in T-9 (Zero tillage + 100% residue incorporated soil with Sprinkler irrigation practices). Available Nitrogen and Phosphorus concentration is also maximum in T-9 plot. Maximum concentration of available K was observed in T-7 plot (Zero tillage + 100% residue with drip irrigation practices). This study shows that residue management practices improve the soil physico-chemical properties. It was concluded that by use of the maximum crop residue improves the quality of the soil and also beneficial for crop and plants growth.

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