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Influence of crop residues and bio- decomposer on soil physico-chemical parameters and yield of maize (*Zea mays* L.)

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Abstract
A field trial was conducted on maize during *Kharif* season 2021 to evaluate the Influence of crop residues and bio- decomposer on soil Physico-chemical properties, growth and yield of Maize (*Zea mays* L.) var. K-25(Kanchan) in sandy loam soil. The experiment was laid down in randomized block design with different treatments crop residues (Wheat and Mustard) treated with and without Bio-Decomposer replicating thrice. Various treatments doses RDF (N 120 kg ha^{-1}, P_2O_5 60 kg ha^{-1}, K_2O 40 kg ha^{-1}), Wheat and Mustard crop residue 5 t ha^{-1} and bio-decomposer 49.42 g ha^{-1}. T_9 (Wheat residue and mustard residue treated with bio-decomposer + RDF @ 100%) that showed the highest yield and gave the best results with respect to highest grain yield 37.78 q ha^{-1}. In post-harvest soil properties, the important parameter on Physico-Chemical properties on maize crop water holding capacity (%) 55.59 in 0-15 cm and 54.60 in 15-30 cm depth, Organic Carbon (%) 0.579 in 0-15 cm and 0.518 in 15-30 cm depth, Available Nitrogen (kg ha^{-1}) 243.99 in 0-15 cm and 241.89 in 15-30 cm depth, Phosphorus (kg ha^{-1}) 30.52 in 0-15 cm and 28.90 in 15-30 cm depth, Potassium (kg ha^{-1}) 128.62 in 0-15 cm and 125.78 in 15-30 cm depth was found Significant.

Keywords: Crop residue, bio-decomposer, maize, soil health

Introduction
Maize (*Zea mays* L.) is a cereal crop and it is called as “Queen of cereals” and “non-tillering plant”. Maize is one of the three major World food crops, is recognized as the “golden food” because of its high grain yield and nutrition value, and plays a very important role in the daily calorie intake of humans. Maize is the third most important crop in India after Rice and Wheat. In the World, India’s ranks 5th in acreage and 8th in production of Maize. Globally, total area of maize was 186.86 m ha, production 1078.56 M mt and in India area under maize cultivation is about 9.63 m ha, production 25.90 M mt in 2016-17. (Zhong *et al.*, 2014) [24]

Potassium is a major nutrient present which has a good significance because an average human diet is deficient in it (Kumar and Jhariya, 2013) [8]. Maize germ contains about 45-50% of oil that is used in cooking, salads and is obtained from wet milling process (Orthoefer *et al.*, 2003). The oil contains 14% saturated fatty acids, 30% monounsaturated fatty acids, and 56% polyunsaturated fatty acids. The refined maize oil contains linoleic acid 54-60%, oleic acid 25-31%, palmitic acid 11-13%, stearic acid 2-3% and linolenic acid 1% (CRA. 2006). Maize silk contains various constituents essential for our diet such as maizenic acid, fixed oils, resin, sugar, mucilage, salt, and fibers (Kumar and Jhariya, 2013) [8].

Nitrogen is a vital plant nutrient and a major determining factor required for maize production. It is very essential for plant growth and makes up 1-4% of dry matter of the plants. Nitrogen is essential constituent of protein and is present in many other compounds of great physiological importance in plant metabolism. Nitrogen deficiency or excess can result in reducing maize yield (Singh *et al.*, 2010) [18].

Phosphorus (P) is the second most important nutrient after nitrogen, which allows high yields, especially corn, because plant products are often lacking and plants need them in relatively large quantities. In plants, Phosphorus is essential for photosynthesis, respiration, cell function, gene transfer and reproduction. Without phosphorus, there are no cells, plants and grains, and without enough phosphorus, hunger is great (Ademba *et al.*, 2015) [1]

Potassium play important role information of protein and chlorophyll and it provide much of osmotic "pull" that draw water into plant roots. Potassium produces strong stiff straw in maize

and reduce lodging in maize. Potassium imparts increase vigour and disease resistance to plant. The resulting lower K concentrations can further depress the plant resistance to drought stress, as well as K absorption (Shamim *et al.,* 2015) [17].

Crop residues of agricultural crops are vital sources, not only as nutrients for succeeding, but also for improved soil, air and water quality. The development of effective CRM systems depends on a systematic understanding of factors that manage residue decomposition and their careful application within a specific crop production system. Management of crop residues in agriculture can be economically beneficial to many producers and more importantly to society.

Materials and Methods

The experiment was conducted at CRF NAI, SHUATS' Prayagraj, which is located at 25° 24′46.14″N latitude, 81° 50′49.95″ E longitude, and 98 meters above sea level (MSL). Argo climatically, Prayagraj represents the subtropical belt of the south East of Uttar Pradesh, and is endowed with extremely hot summer and fairly cold winter. The Maximum temperature of the location reaches up to 46ºc-48ºc and seldom falls as low as 4ºc-5ºc. The soil of experimental area falls in order of Inceptisol and in experimental plots is alluvial soil in nature. The soil samples randomly collect from five different sites in the experiment plot prior to tillage operation from a depth of 0-15 cm and 15-30 cm. The experiment was laid out in a Randomized Block Design with Crop residues (Wheat and mustard) treated with and without bio-decomposer nine treatments, each consisting of three replicates. The total number of plots was 27. Maize (*Zea mays* L.) Var. K-25(Kanchan)' were sown *in kharif* season plots of size 2 x 2 m with row to row spacing 60 cm and plant to plant distance 45 cm. The Soil of experimental area falls in order of Inceptisol and is alluvial in nature, both the mechanical and chemical analysis of soil was done before starting of the experiment to ascertain the initial fertility status. The soil samples were randomly collected from 0-15cm and 15-30cm depths prior to tillage operations. The treatment consisted of nine combinations of T_1 [CR @ 0 % + RDF @ 0%] T_2 [WR @100% + RDF @ 0%] T_3 [MR @ 100% + RDF @ 0%] T_4 [WR treated with bio- decomposer + RDF @ 50%] T_5 [MR treated with bio- decomposer + RDF @ 50%] T_6 [WR treated with bio-decomposer + RDF @ 100%] T_7 [MR treated with bio- decomposer + RDF @ 100%] T_8 [WR and MR treated with bio-decomposer + RDF @ 50%] T_9 [WR and MR treated with bio-decomposer + RDF @ 100%]. The dose of RDF @ 0% (N 0 kg ha^{-1}: P_2O_5 0 kg ha^{-1}: K_2O 0 kg ha^{-1}), RDF @ 50 % (N 60 kg ha^{-1}: P_2O_5 30 kg ha^{-1}: K_2O 20 kg ha^{-1}), RDF @ 100 % (N 120 kg ha^{-1}: P_2O_5 60 kg ha^{-1}: K_2O 40 kg ha^{-1}) Wheat crop residue and Mustard residue 5 t ha^{-1}. The samples were analyzed for different Physico-chemical properties which is mention below in table 1.

Table 1: Protocols followed to analysis for Physico-chemical parameters of soil

Analysis	Particulars	Result	Protocol
Physical	Sand (%)	61.68	Bouyoucos, (1927)
	Silt (%)	23.08	
	Clay (%)	15.24	
	Texture	Sandy loam	
	Soil Color	Pale Brown	Munsell, (1971)
	Bulk Density (Mg m^{-3})	1.343	Muthuaval *et al.* (1992)
	Particle Density (Mg m^{-3})	2.610	Muthuaval *et al.* (1992)
	Pore Space (%)	46.78	Muthuaval *et al.* (1992)
	Water Retaining Capacity (%)	50.57	Muthuaval *et al.* (1992)
Chemical	Soil PH	7.39	Jackson, (1958)
	Electrical Conductivity (dS m^{-1})	0.228	Wilcox, (1950)
	Organic Carbon (%)	0.431	Walkley and Black (1947)
	Available Nitrogen (kg ha^{-1})	229.26	Subbiah and Asija (1956)
	Available Phosphorus (kg ha^{-1})	21.05	Olsen *et al.* (1954)
	Available Potassium (kg ha^{-1})	115.89	Toth and Prince, (1949)

Note: CR- Crop residue, WR- Wheat residue, MR- Mustard residue, RDF- Recommended Dose of Fertilizer.

Results and Discussion

As depicted in table 2 shows that the maximum bulk density of soil (Mg m^{-3}), was found for T_1 (Control) which was 1.345 in 0-15 cm and 1.1347 in 15-30 cm depth. Minimum was found for T_9 [WR and MR treated with bio-decomposer + RDF @ 100%] which was 1.323 in 0-15 cm and 1.325 in 15-30 cm depth. The interaction effect of Crop residues and NPK on bulk density (Mg m^{-3}) of soil was found non-significant. This is show that the maximum particle density of soil (Mg m^{-3}), was found for T_9 [WR and MR treated with bio-decomposer + RDF @ 100%] which was 2.656 in 0-15 cm and 2.668 in 15-30 cm. Minimum was found for T_1 [CR @ 0 % + RDF @ 0%] which was 2.600 in 0-15 cm and 2.609 in 15-30 cm. The interaction effect of Crop residues and NPK on particle density (Mg m^{-3}) of soil was found non-significant. The results show that the maximum pore space (%) of soil, was found for T_9 [WR and MR treated with bio-decomposer + RDF @ 100%] which was 51.50 in 0-15 cm and 50.35 in 15-30 cm. Minimum was found for T_1 [CR @ 0 % + RDF @ 0%] which was 47.00 in 0-15 cm and 46.82 in 15-30 cm. The interaction effect of Crop residues and NPK on pore space (%) of soil was found significant. The maximum water holding capacity (%) of soil, was found for T_9 [WR and MR treated with bio-decomposer + RDF @ 100%] which was 55.59 in 0-15 cm and 54.60 in 15-30 cm. Minimum was found for T_1 [CR @ 0 % + RDF @ 0%] which was 51.15 in 0-15 cm and 50.00 in 15-30 cm. The interaction effect of Crop residues and NPK on water holding capacity (%) of soil was found significant.

As perusal table 2 shows that the pH and EC of soil in which the maximum pH and EC at 25˚C (dS m^{-1}) was found for T_9 [WR and MR treated with bio-decomposer + RDF @ 100%] which were 7.74 in 0-15 cm, 7.76 in 15-30 cm and 0.263 in 0-15 cm, 0.259 in 15-30 cm and minimum was found for T_1

[CR @ 0 % + RDF @ 0%] respectively which were 7.40 in 0-15 cm, 7.43 in 15-30 cm and 0.230 in 0-15 cm, 0.226 in 15-30 cm respectively. The interaction effect of Crop residue and NPK on pH and EC was found non-significant. The result depicted in table 2 shows that the Maximum Organic carbon (%) in soil were found for T_9 [WR and MR treated with bio-decomposer + RDF @ 100%] which were 0.579 in 0-15 cm and 0.518 in 15-30 cm. Minimum was found for T_1 [CR @ 0 % + RDF @ 0%] which were 0.437 in 0-15 cm and 0.390 in 15-30 cm. Maximum Available Nitrogen, Phosphorus, Potassium (kg ha^{-1}) in soil were found for T_9 [WR and MR treated with bio-decomposer + RDF @ 100%] which were 243.99 in 0-15 cm and 241.89 in 15-30 cm, 30.52 in 0-15 cm and 28.90 in 15-30 cm , 128.62 in 0-15 cm and 125.78 in 15-30 cm kg ha^{-1} respectively. Minimum was found for T_1 [CR @ 0 % + RDF @ 0%] which were 231.68 in 0-15 cm and 228.00 in 15-30 cm, 21.67 in 0-15 cm and 17.10 in 15-30 cm, 117.25 in 0-15 cm and 112.00 in 15-30 cm in depth respectively. The interaction effect of Crop residue and NPK on Organic carbon, available Nitrogen, Phosphorus and Potassium was found significant.

Table 2: Post harvesting Physico-chemical parameters of soil in maize field

Treatment	BD (Mg m^{-3})		PD (Mg m^{-3})		Pore space (%)		Water holding capacity (%)	
	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm
T_1	1.345	1.347	2.600	2.609	47.00	46.82	51.15	50.00
T_2	1.342	1.343	2.624	2.634	48.01	47.50	51.82	50.04
T_3	1.341	1.342	2.624	2.635	48.05	50.14	52.12	51.00
T_4	1.337	1.339	2.637	2.646	48.15	47.80	52.47	51.97
T_5	1.335	1.336	2.639	2.648	48.30	47.88	53.15	52.89
T_6	1.332	1.335	2.642	2.651	49.50	48.11	53.48	52.80
T_7	1.331	1.333	2.643	2.655	51.00	50.15	54.50	53.00
T_8	1.327	1.329	2.654	2.664	51.10	50.23	54.15	53.90
T_9	1.323	1.325	2.656	2.668	51.50	50.35	55.59	54.60
F- test	NS	NS	NS	NS	S	S	S	S
S.Em.(±)	-	-	-	-	1.352	1.351	0.331	0.330
C.D.	-	-	-	-	0.633	0.632	1.155	1.154

Table 3: Post harvesting Physico-chemical parameters of soil in maize field

Treatment	pH (w/v)		EC (dS m^{-1})		Organic Carbon (%)		Nitrogen (Kg ha^{-1})		Phosphorus (Kgha^{-1})		Potassium (Kg ha^{-1})	
	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm
T_1	7.40	7.43	0.230	0.226	0.437	0.390	231.68	228.00	21.67	17.10	117.25	112.00
T_2	7.41	7.42	0.233	0.228	0.472	0.412	236.75	232.89	25.71	21.45	124.69	121.01
T_3	7.49	7.50	0.235	0.231	0.478	0.423	239.83	233.67	29.62	26.03	126.90	120.56
T_4	7.52	7.52	0.242	0.238	0.523	0.462	238.81	232.90	22.83	19.67	120.75	115.67
T_5	7.55	7.55	0.243	0.239	0.525	0.463	240.87	236.12	28.41	25.56	121.91	118.15
T_6	7.60	7.61	0.249	0.245	0.551	0.491	241.71	236.75	29.91	23.90	123.57	119.92
T_7	7.65	7.67	0.251	0.247	0.558	0.499	240.48	236.90	23.87	20.56	125.60	120.12
T_8	7.72	7.72	0.260	0.256	0.573	0.51	242.64	239.96	29.11	23.04	127.92	123.08
T_9	7.74	7.76	0.263	0.259	0.579	0.518	243.99	241.89	30.52	28.90	128.62	125.78
F- test	NS	NS	NS	NS	S	S	S	S	S	S	S	S
S.Em.(±)	-	-	-	-	1.452	1.45	0.466	0.465	0.164	0.162	0.320	0.319
C.D.	-	-	-	-	0.780	0.750	0.218	0.217	1.130	1.128	0.150	0.149

Conclusion

On the basis of above finding, it is concluded that Recommended dose of fertilizer of Nitrogen @ 120 kg ha^{-1}, Phosphorus @ 60 kg ha^{-1}, Potassium @ 40 kg ha^{-1} and Wheat residue @ 5 t ha^{-1} & Mustard residue @ 5 t ha^{-1} in T_9 was found best. Also, T_9 (N_{120} P_{60} K_{40} Kg ha^{-1} + WR 5 t ha^{-1} & MR 5 t ha^{-1}) gave the best Physico-chemical properties of soil, yield (37.78 q ha^{-1}) As it is result of only one year study, further experimentation is required for its recommendation which will help in enhancing yield per unit area for sustaining productivity and fertility of soil.

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