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Evaluation of Chemical Properties of Post-Harvest Soil of Maize as Affected by Application of Organic Manure of Diverse Sources Along with Urea

Mussaddiq Khan Khalil[1]*, Muhammad Owais Khan[2], Waqar Ali[3], Mukhtiar Ali[4], Shuja Ur Rehman Qureshi[5], Farooq Ishaq[1]

[1.] *Soil and Environmental Science, University of Agriculture Peshawar, Pakistan.*

[2.] *Center for Agricultural Resources Research, Institute of Genetics and Developmental Biology, University of Chinese Academy of Sciences, Yanqihu Campus, Beijing*

[3.] *College of Resource and Environment, Huazhong Agriculture University.*

[4.] *Institute of Soil Science, University of Chinese Academy of Sciences, Nanjing, China*

Plant Breeding and Genetics, University of Agriculture Peshawar, Pakistan

Corresponding Author:** ***Mussaddiq Khan Khalil, *Soil and Environmental Science, University of Agriculture Peshawar, Pakistan.*

Abstract: *The present research trail was carried out after harvest of maize crop on calcareous soil (19% lime on w/w basis) of Pakistan, District Nowshera soil series [Piedmont alluvium, silty clay loam, Ustochrept] to study its chemical properties as affected by application of organic manures of different sources integrated with urea. The treatments of the present study were divided into 3 groups based on the combination ratios such as 1:1, 3:1 and 1:0. Total 13 treatments such as:T1=alone Urea (control), T2 [Urea+ SSB (1:1)], T3 [Urea+ SCB (1:1)], T4 [Urea+PL (1:1)], T5 [Urea+FYM (1:1)], T6 [Urea+ SSB(3:1)], T7 [Urea+ SCB (3:1)], T8 [Urea+ PL (3:1)], T9 [Urea+ FYM (3:1)], T10= alone SSB, T11= alone SCB, T12= alone PL, T13= alone FYMwere usedand each treatment was replicated thrice. The combination ratios of the treatments were based on %N (required amount of N is 120 kg/ha) received from Urea and organic manures. Results of the experiment revealed that all the treatments have significantly affected(P>0.05) the soil chemical properties such as pH, E.C, total nitrogen content and organic matter content while bulk density was non-significant. By comparing various treatments groups, treatments having 1:1 combination ratio (T2, T3, T4 and T5) have shown best results in case of pH, E.C and nitrogen content of post-harvest soil. They have mediated the pH and E.C to levels favorable for plant growth and N uptake. While in case of organic matter content maximum results were obtained for treatments having combination ratio of 1:0 i-e (T10, T11, T12 and T13). From the present study it was concluded that all the treatments except control have altered the chemical status of soil to a favorable soil enviro responsive microbial activity and plant growth. Such studies on different soil seriesunder different climatic conditions is advised for wide spread application and authorization of results.*

Keywords: *pH, Electrical conductivity, bulk density, organic matter, nitrogen content*

1. INTRODUCTION

Appropriate fertilizer use leads to increased crop yields and high crop recovery of the applied nutrients. Some elements may be hazardous to soil as well as environment if used in extreme quantities in various forms, i.e. nitrates and phosphates. Efficient fertilization is therefore important in ensuring crops attain maturity within specific growing seasons(Okalebo, 1987).Effectiveness of fertilizers therefore depends on the chemical and physical properties, rate and method of application, soil and climatic conditions and the crop species grown (Mokwunye and Bationo, 2002). In recent years, there has been an increased use of high mineral fertilizers, mainly for economic reasons. Examples of inorganic fertilizers used include50%Urea, diammonium phosphate (DAP) and triple super phosphate (TSP) fertilizers (Smalling et al., 1997).

Soils of Pakistan are generally alkaline and calcareous in nature, where maize crop generally suffers from deficiency of essential nutrients like N, P and K. About 80 to 90 % soils from arid and semiarid

regions of the world, including Pakistan, are deficient in available nitrogen (NFDC, 2001).Various other factors which will affect the nitrogen availability is temperature, moisture content, pH of the soil and amount of clay minerals in the soil. Nitrogen is the most essential nutrient required for plant growth and is usually absorbed in nitrate form by plants (Tisdale and Nelson, 1990) and it constitutes about 1.7% to 5.8% of dry weight of many plants. It is the also the important component of many nucleic acids, organic acids and many proteinaceous compounds, apart from this its plays a vital role in synthesis of chlorophyll, photosynthesis process and carbon dioxide (CO_2) assimilation. (Jassochaverria et.al. 2005). Nitrogen also have synergistic relation with other nutrients like phosphorous, potassium and calcium and deficiency of nitrogen in soil will result the plants to suffer from others nutrients deficiency (Brady, 1984).

Nowadays the combine application of organic materials and inorganic fertilizers became the favorable method for farmers to enhance their crop yield and production growth. However, most of the researchers and farmers are unaware of that which is the best fertilizer integration ratio and what type of organic manure should be used for obtaining good fertile soil and economical crop yield. The vigorous application of organic and inorganic fertilizers to soil in greed of economical crop yield leads to demolition of fertility status of soil, therefore the present study was initiated with an objective to study and compare various ratios of organic manures and its effect of chemical properties of post-harvest soil of District Peshawar, KPK, Pakistan.

2. MATERIALS AND METHOD

2.1. Experimental design and treatments

The experimental site is situated at 34.01 ^{O} N latitude 72^{O} E longitudes having an altitude of 298 m above sea. The area has continental climate type. Total 9 treatments were used and each treatment was replicated five times thus making 45 experimental units. Each of the plot size was 12 m^2 (4m x 3m).The experimental units were designed according to Randomize Complete Block design. Different types of organic manures were also applied to specified plots before one week of sowing whereas 50%Urea was added to soil in split doses at time of sowing and fist irrigation. The combination of treatments is shown in table 1.

Table1. *Treatments combination of the experiment.*

Treatments	%N from Organic manure (O.M)	% N from Urea	Urea: O.M (based on %N)	Required amount of N (kg/ha)
T1 (Control)	0	100%	0:1	120
T2	50 % N from SSB	50%	1:1	120
T3	50%N from SCB	50%	1:1	120
T4	50%N from PL	50%	1:1	120
T5	50%N from FYM	50%	1:1	120
T6	25%N from SSB	75%	3:1	120
T7	25%N from SCB	75%	3:1	120
T8	25%N from PL	75%	3:1	120
T9	25%N from FYM	75%	3:1	120
T10	100% N from SSB	0	1:0	120
T11	100% N from SCB	0	1:0	120
T12	100%N from PL	0	1:0	120
T13	100% N from FYM	0	1:0	120

Abbreviations: N= Nitrogen, **SSB**= Soya bean straw biochar, **SCB**= Sugar cane bagasse, **PL**= Poultry Litter, **FYM**= Farm yard Manure

2.2. Soil Sampling and Sample Analysis

The composite soil sample (0-15cm) was taken from experimental site before initiation of the experiment and separate soil samples were collected from depth of 15-30cm after harvest of the maize crop. The samples were air dried and ground to pass through 2-mm sieve. Soil color was recognized according toMunsil Color Chart notation. The prepared soil samples were then analyzed for various physical and chemical properties such as soil texture by method of (Gee and Baudur, 1886), pH of soil by method of (Mclean, 1982), electrical conductivity (EC) by method proposed by (Black, 1965), Organic matter content by method of (Nelson and Sommers, 1982), total nitrogen by method of

(Bremener and Mulveney, 1982). Extractable phosphorous and potassium by method proposed by (Soltanpur, 1985) in the laboratory in order to evaluate the physical and chemical properties of the experimental location and its data is shown in the table 2.

The data of the following soil parameters were recorded afterthecrop harvest:

- pH of the post-harvest soil.
- EC (dS m^{-1}) of the post-harvest soil
- Bulk density of soil.
- Organic matter content the post-harvest soil
- Total Nitrogen content of the soil the post-harvest soil

2.3. Statistical Analysis

ANOVA procedures suitable for RCB design was used for data statistical analysis. Means value were compared using LSD test at $p<0.05$ when the F values were significant. Jan et al. (2009). The data was then also analyzed by computer software programs such as Excel 2014 and STATISTIX 10.1.

3. Results and Discussion

3.1. Initial chemical status of soil

The analysis of soil sample taken before the initiation of the experiment showed that the soil has 18.8% lime and was slightly alkaline (pH= 7.75), non-saline (E.C = 2.17dSm^{-1}), silty loam in texture and was deficit in organic matter (0.81%), total nitrogen (0.46%), extractable phosphorous (3.73 kg/ha) and potassium (91.65 kg/ha).

Table2. *Physical and chemical properties of experimental site*

Physical and Chemical Property	Value and Unit
Soil Texture	Silty Loam
pH	7.90
Electrical conductivity	2.17 dSm^{-1}
Lime	18.8%
Organic matter	0.81%
Bulk density	1.25%
Total Nitrogen	0.46%
Extractable Phosphorous	3.73 kg/ha
Extractable Potassium	91.65g/ha

3.2. Nutrient Content of Organic Manures

The samples taken from various types of organic manures used in the experiment and was analyzed for different chemical properties and its data is shown in table 3. It shows that all the organic manures were non saline and slightly alkaline in nature. Maximum organic carbon (43.7%), total potassium content (1.58 %) was recorded for soya bean straw biochar (SSB), whereas maximum total nitrogen (1.58 %) and total phosphorous content (2.12 %) was analyzed for poultry litter (PL). Wider CN ratio (32.6) was calculated for farmyard manure (FYM).

Table3. *Chemical Properties of organic manures used in the experiment*

Chemical Property	Different types of organic manures			
	SSB	**SCB**	**PL**	**FYM**
pH	7.90	7.68	7.60	7.20
Electrical conductivity (dsm^{-1})	2.86	3.11	3.08	2.66
Organic carbon (%)	43.7	28.3	35.1	28.9
CN ratio	29.3	25.7	22.2	32.6
Total Nitrogen (%)	1.14	1.10	1.58	0.86
Total Phosphorous (%)	0.74	0.70	2.12	1.14
Total Potassium (%)	1.58	1.48	1.34	1.20

3.3. pH and E.C (dSm-1) of post-harvest soil

The mean values in table 4 shows that pH and electrical conductivity (E.C) of post-harvest soil of maize was significantly affected ($P>0.05$) by various treatments of organic manures of various

sources applied alone and in combination with urea. The highest pH (7.80) was noted for T10 treatment receiving 100 % N from SSB followed by treatment T11receiving 100 % N from alone SCB. Which has given the pH of 7.78. While lowest pH (7.50) was calculated for treatment T2 receiving Urea and SSB in 1:1 ratio. The main reason for the decrease in pH (7.90) before initiation of the experiment) isdue to release of various acids during mineralization process in soil.(Kapoor et al. 1989),The application of organic manures might have increased the activity of microbes in rhizosphere thus making the conditions favorable for mineralization of nitrogen, also urea upon solubilization give rise H+ ions in soil thus lowering the pH of rhizosphere soil. The ideal pH for plant growth is from 6.50 to 7.50 meaning that combined application of urea and organic mediates the pH of soil thus making it favorable for supreme crop production. Mean values of Electrical conductivity (E.C) in table 4 shows that all the treatments have significantly enhanced the E.C of post-harvest soil of maize. In case of electrical conductivity (E.C) maximum value (0.53 dS/m) was noted for T4 receiving 1:1 ratio of Urea and poultry litter (PL) successfully followed by results (0.51dS/m) from T3 receiving Urea+ SCB in 1:1 ratio while the minimum E.C of 0.30 dS/m was recorded for T1 treatment control receiving only 100% Urea. The possible reasons may be that decomposition of organic manure give rise to certain organic acids by activity of microbes which plays a vital role in solubilization of inorganic fertilizers and thus releasing soluble salts to soil resulting in increase of electrical conductivity of soil. These results show resemblance to findings of (Singh and Naryanasamy, 2006); Mussaddiq et al. (2019) who examined variations in pH and E.C of soil when organic manures along with mineral fertilizers was added to it.

3.4. Organic Matter, Total Nitrogen and Bulk Density of Post-Harvest Soil

Mean values of organic matter, total nitrogen content and bulk density of after harvest soil in table 4 shows that various types of organic manures supplemented with urea in dynamic ratios has significantly affected($P>0.05$) the of organic matter and total nitrogen content while the bulk density was non significantly affected. Maximum organic matter concentration was2.88% which was calculated for T12 receiving alone poultry litter (100 %N from PL) significantly tailed by (2.86%) given by T10 receiving alone soya bean straw biochar (100 %N from SSB). While the minimum organic matter concentration of was recorded for was recorded for T1 (control having alone Urea).Total nitrogen content of post-harvest of soil was significantly influenced by different treatments used in the experiment. Maximum N concentration (0.46%)was obtained from treatment T2 getting urea and SSB in 1:1 ratio (based on %N), significantly followed by (0.45%) treatment T4receiving Urea and PL in 1:1 ratio and treatment T8 receiving urea and PL in 1:3 ratio, while minimum total nitrogen content of 29% was found for treatment T13 receiving alone FYM as shown in table 4.

By comparing the performance of various treatments groups, maximum values of organic matter concentrations were recorded for treatments receiving 1:0 combinations (T10, T11, T12 and T13). In case of total nitrogen content, maximum values were obtained by treatments having 1:1 ratio combination (T2, T3, T4 and T5). Presumably it may be due to better mineralization of nitrogen in urea offered by different organic manures. The enhanced microbial activity in soil will convert the organic N into exchangeable form. Organic manures like biochar plays a vital role in retaining the soil nutrients from losses by increasing water and nutrient holding capacity of soil. The above results lie in par with Ndor et al. (2015); Waqar et al. (2019) who concluded that soil organic matter and nitrogen content can be enhanced by integration of organic manures and mineral fertilizers

Table4. *pH, E.C, total nitrogen content, organic matter content and bulk density of post-harvest soilas affected by treatments having integration of various organic manures and urea in diverse ratios.*

Treatments	pH	E.C	Organic matter content	Total N in Soil	Bulk Density
	-	dSm^{-1}	%	%	%
T1= Alone Urea (control)	7.60cde	0.30f	1.10f	0.35cd	1.25
T2= Urea+ SSB (1:1)	7.50f	0.49bc	2.59bc	0.46a	1.24
T3= Urea+ SCB (1:1)	7.52ef	0.51ab	2.48cd	0.42b	1.25
T4= Urea+ PL (1:1)	7.53e	0.53a	2.54c	0.45ab	1.24
T5= Urea+ FYM (1:1)	7.60cde	0.48bc	2.24de	0.33de	1.24
T6= Urea+ SSB (3:1)	7.55de	0.43de	2.12def	0.35d	1.23
T7= Urea+ SCB (3:1)	7.68bc	0.46cd	2.09e	0.40bc	1.25

T8= Urea+ PL (3:1)	7.55de	0.46cd	2.20de	0.45ab	1.24
T9= Urea+ FYM (3:1)	7.63cd	0.40def	1.89ef	0.31e	1.25
T10= Alone SSB	7.80a	0.37ef	2.86a	0.39c	1.25
T11= Alone SCB	7.78ab	0.40def	2.72ab	0.37cd	1.24
T12= Alone PL	7.72abc	0.38ef	2.88a	0.44abc	1.25
T13= Alone FYM	7.77ab	0.40def	2.65abc	0.29f	1.24
LSD	1.96**	1.48*	1.77**	0.17**	NS
NS (Non-significant) if P> 0.05; *if P ≤ 0.05; ** if P≤ 0.01; ***if P≤ 0.001					

Abbreviations: SSB= Soya bean straw biochar, **SCB**= Sugar cane bagasse, **PL**= Poultry Litter, **FYM**= Farm yard Manure, **LSD**= Least Significant Difference

4. CONCLUSION

From the present study it is concluded that all the treatments receiving alone and integration of organic and inorganic fertilizers in diverse ratios have significantly affected the chemical properties of post-harvest soil of maize crop such as pH, E.C, total nitrogen content and organic matter content while bulk density was non-significant. By comparing the performance of various treatments groups, maximum values of organic matter concentrations were recorded for treatments receiving 1:0 combinations (T10, T11, T12 and T13). In case of total nitrogen content, maximum values were obtained by treatments having 1:1 ratio combination (T2, T3, T4 and T5).From the present study it was concluded that all the treatments except control have altered the chemical status of soil to a favorable soil enviro responsive microbial activity and plant growth. Such studies on different soil series under different climatic conditions is advised for wide spread application and authorization of results.

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