Plant Archives Vol. 18 No. 2, 2018 pp. 2297-2302 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

PROBING THE IMPACT OF DIFFERENT PROCESSED ORGANIC MANURES ON PHYSICAL CHEMICAL AND BIOLOGICAL CHARACTERISTICS OF SOIL UNDER MAIZE (*Zea mays L*) CULTIVATION

Vivek Kumar*, Arun Kumar, Arshdeep Singh, Anita Jaswal, Mulla Mohammad Salman Khan

Department of Agronomy, School of Agriculture, Lovely Professional University, Phagwara-144411 (Punjab) India, School of Agriculture, Lovely Professional University, Phagwara-144411 (Punjab) India

Abstract

A field experiment was conducted to evaluate "Probing the impact of different processed organic manures on physical, chemical and biological characteristics of soil under Maize (*Zea mays* L) cultivation" at the Experimental Farm of School of Agriculture at Lovely Professional University, Phagwara, during *Kharif* season 2015. The treatment were comprised of various fertilizers and these were, T_1- Control, T_2 (100% RDF of NPK + 50% VC), T_3 (50% RDF of NPK + 50% FYM), T_4 (50% RDF of NPK +50%), T_5 (50% RDF of NPK +50% NC), T_6 (50% RDF of NPK + 50% Bone Meal), T_7 (50% RDF of NPK + 50% Poultry Manure), T_8 (50% RDF of NPK). The experiment was laid out in Randomized Complete Block Design. The best impact of organic manures on soil physical, chemical and biological properties were shown by T_6 having a pH (8.02), EC (0.39 dsm-1), OC (1.34%), N (572kgha-1), P (13.37kg ha-1), K (328.5kgha-1) followed by T_7. The organic manures also showed positive impact on plant growth parameters. The highest plant height (167.5cm), stem girth (7.8cm), cob length (17.68cm), 100 grain weight (31.5g), grain yield (4434kgha-1), straw yield (6820.3kgha-1) and harvest index (37.9%) was observed in T_6. The lowest growth parameters and yield was recorded in control. In terms of economics, the highest net return and B: C ratio was obtained from T_6. So, to sustain the fertility of soil, integrated use of 50% RDF of NPK + Bone meal was recommended.

Key words: Bone meal, RDF, NPK, poultry manure and integrated.

Introduction

Maize is one of the most versatile crops among the family of cereals occupying third position after rice and wheat with respect to area and productivity in the world (Shah and Zamir, 2009) which has originated from Mexico. It is a cross pollinated crop having diploid chromosomes number 10 (2n=20). Maize is physiologically short day plant with shallow root system having height of 2.5 m (8 ft.) with a leaf width is about 9 cm (3.5 inch) and 120 cm. (4 ft.) in length, generally grown from each Internode. Maize is used for many purposes like culinary purpose, ethanol production, medicinal use, making popcorns, salads and in food beverages.

The worldwide production of maize was estimated at 817 million tonnes (FAO, 2009) while in India, the total area under maize cultivation is 8.71 million hectares, and production is 22.55 million tons (anonymous, 2012) and in Punjab, the total area under maize cultivation is 130 thousand hectares and production is 507 thousand tons (anonymous, 2014). In 2013–2014, the average yield of maize in Punjab was 39.0 quintal per hectare.

Human activity plays a vital role in degradation of soil physical, chemical and biological properties of soils (Leita, *et al.,* 1999) which results in loss of soil quality, manifested by a decrease in the productive capacity of the soil and changes in soil ecological functions (Granadstein and Bezdicek, 1992). It is important to determine the extent of usage of soil, which affects soil quality and the parameters used to estimate the quality. One of the best ways of restoring soil productivity involves the addition of organic materials or amendments like FYM, vermi compost, poultry manure, bone meal and neem cake (Melero *et al.,* 2007). However a great deal of research indicates that better nutrient release from

Author for correspondence :

organic fertilizer is obtained, and crop requirements during the initial stage of growth and development are better met, if organic and inorganic fertilizers are used together rather than on their own. It thus appears that intensification of crop production on tropical soils requires the combined used of organic and inorganic fertilizers (Ghosh *et al.,* 2004).

Soil organic matter influences a wide range of physical, chemical and biological properties of soil, which is considered to be as the vital soil quality indicator (Larson and pierce 1991). Most SOM properties are not independent (*i.e.*, a change in one will usually result in a change in others). When erosion does not exceed the rate of soil formation, biological properties are considered the major factors that regulate soil quality (Elliot *et al.,* 1994). SOM plays a significant role in encompassing various attributes including total soil organic C and N, light fraction and micro organic (particulate) matter, mineralizable C and N, microbial biomass soil carbohydrate and enzymes rather than single entity Gregorich *et al.,* (1994).

Organic components of soil, *i.e.* soil organic matter (SOM) are the major factor that determines soil fertility. SOM serves as a nutrient pool that also provides the factors responsible for nutrient exchange between soil and plant. Globally, soil organic matter (SOM) contains more than three times as much carbon as either the atmosphere or terrestrial vegetation. Yet it remains largely unknown how soil organic matter regulates soil fertility. Organic matter has significant impact on plant nutrient and through microbes mineralization soil organic matter influence the soil fertility. Soil organic carbon, a component of soil organic matter plays an important role in determining the physical and chemical characteristics of a soil and therefore its fertility. Currently, there has been an additional interest in the role of SOC as a potential sink for atmospheric CO2 (Post and Kwon, 2000). Soil organic carbon influence the soil microorganism which is the dominant factor in cycling of plant nutrients (e.g., nitrogen, phosphorus, sulphur) and decomposition of organic residues (Pankhurst *et al.,*1997). Biological components of the soil, which are the driving force behind the nutrient transformations, are largely unknown. Microbes respond quickly to the changes of environmental conditions, and microbial populations and activities are often considered as the best indicators of soil health (Kennedy *et al.*1995; Pankhurst *et al.,*1995).The general objectives of the study was to consider the impact of different processed organic manures on physical chemical and biological features of soil under Maize .

Marerials and method

The experiment was conducted at Experimental Farm of School of Agriculture in Lovely Professional University, Phagwara (Punjab) during *Kharif* 2015-16. The soil was sandy loam in texture having medium in available nitrogen, high in available phosphorus and potassium. Soils were sufficient in all micronutrients. The experimental site enjoys the sub-tropical type of weather conditions with cool winter and hot summer. The experiment was comprised of eight treatments *viz.* T_1-Control, T_2- 100% of RDF NPK ,T_3 (100% RDF of NPK + 50% VC), T_3 (50% RDF of NPK + 50% FYM), T_4 (50% RDF of NPK +50%FYM), T_5 (50% RDF of NPK +50% Neem Cake), T_6 (50% RDF of NPK + 50% Bone Meal), T_7 (50% RDF of NPK + 50% Poultry Manure), T_8 (50% RDF of NPK) and laid out in Randomized Complete Block Design with three replications. After mixing the fertilizers, seeds of maize variety PMH- 2252 were sown in June at the spacing of 60×20cm between row to row and plant to plant. The crop was harvested in month of October. Soil samples from each plot at 0-15cm depth was collected at different stages were air- dried, grind and passed through a 2 mm sieve and finally stored in polythene bags for analysis of different physic-chemical parameters and changes in available N, P and K content. The soil sample was analyzed for Bulk density, particle density, water holding capacity, % pore space, soil texture, pH, EC, Organic carbon, Available N, P and K.

The half dose of N along with full dose of P_2O_5, K_2O, FYM, neem cake, bone meal and poultry manure were applied at the sowing time during land preparation. The ¼ dose of nitrogen was applied at knee high stage and the remaining dose of nitrogen was applied at tasseling stage. The different growth parameters like (plant height, stem girth, number of leaves per plant, cob length and number of grains per cob) were recorded at 25, 50 DAS and at harvesting stage. 0.25 square meters quadrate (0.5 X 0.5m) was placed randomly in each plot at different five places and then the growth parameters and yield parameters were recorded. The analysis of variance (ANOVA) was used to obtain the data of various observations which were subjected and tabulated to their analysis. The F test was used to test the treatments (Gomez and Gomez, 1984).

Results and discussions

Effect of different minerals and organic amendments on Growth parameters: The present study indicated that the organic amendments recorded maximum plant height at different durations (30, 60 days of sowing and at harvesting stage) in T_6 (50%RDF of

Table 1: Effect of different minerals and organic amendments on Plant height at 30days, 60 days and at harvesting.

Treatment	Plant height (30 DAS)	Plant Heights (60DAS)	Plant Height At harvest
T_1 Control	$30.1^d\pm0.77$	$57.93^d\pm0.91$	$133.17^g\pm0.33$
T_2 (100% RDF of NPK)	$32.5^c\pm0.72$	$63.33^c\pm0.43$	$147.63^e\pm0.69$
T_3 (50% RDF of NPK + 50% VC)	$43.4^b\pm0.45$	$68.7^b\pm0.20$	$155.1^d\pm0.72$
T_4 (50% RDF of NPK +50% FYM)	$43.13^b\pm0.18$	$70.83^{ab}\pm0.32$	$163.57^c\pm1.22$
T_5 (50% RDF of NPK +50% NC)	$41.93^b\pm0.34$	$69.93^{ab}\pm0.34$	$163.33^c\pm0.43$
T_6 (50% RDF of NPK +50% BM)	$45.46^a\pm0.44$	$72.86^a\pm0.20$	$170.37^a\pm0.34$
T_7 (50% RDF of NPK +50% PM)	$43.33^b\pm0.49$	$71.26^{ab}\pm0.72$	$167.5^b\pm0.52$
T_8 (50% RDF of NPK)	$29.46^d\pm0.29$	$62.36^c\pm0.72$	$140.37^f\pm0.75$

Table 2: Effect of different minerals and organic amendments on Stem girth at 30 days after sowing.

Treatment	Stem Girth At 30 DAS	Stem Girth At 60 DAS	Stem Girth At harvest
T_1 Control	$6.73^d\pm0.12$	$8.6^d\pm0.17$	$5.56^e\pm0.14$
T_2 (100% RDF of NPK)	$7.56^{bc}\pm0.28$	$9.3^c\pm0.20$	$6.8^{bc}\pm0.15$
T_3 (50% RDF of NPK + 50% VC)	$7.2^{cd}\pm0.05$	$9.3^c\pm0.11$	$6.3^d\pm0.05$
T_4 (50% RDF of NPK +50% FYM)	$8.03^b\pm0.08$	$10.3^b\pm0.17$	$7.13^b\pm0.08$
T_5 (50% RDF of NPK +50% NC)	$7.63^{bc}\pm0.20$	$9.46^c\pm0.12$	$6.53^{cd}\pm0.23$
T_6 (50% RDF of NPK +50% BM)	$8.73^a\pm0.12$	$11.3^a\pm0.11$	$7.8^a\pm0.05$
T_7 (50% RDF of NPK +50% PM)	$7.83^b\pm0.14$	$10.43^b\pm0.23$	$7.03^b\pm0.08$
T_8 (50% RDF of NPK)	$7^d\pm0.057$	$9.33^c\pm0.08$	$6.2^d\pm0.05$

NPK+ bone meal) and lowest in T_1 (control). The main reason for increasing plant height in T_6 (45. 46, 72.86, 170.37cm) was that, the organic amendments increased the soil aeration, which was resulted in maximum plant growth and gave highest plant height. The lowest plant height was observed in control plot (30.1, 57.93, 133.17 cm) because there was no application of any organic and inorganic fertilizer sources. Bharvand *et al.* (2014) and Zeimal Amanolahi *et al.* (2014). Maize plant height under all the treatments increased with time and a peak elevation of 48.8 centimeter. The rate of growth was fast during the vegetative phase of maize plants. The combination of mineral + organic amendments improved the physical and chemical properties of soil, which results higher plant height (table1) Further results showed that, the rate of growth progressively increased with time during the vegetative phase of maize plant up to the 8th week after plantation (50-55 days). After 50-55 days the growth slowed down as reproductive phase was begun. The course followed the normal development curve of maize plant and this might be due to remobilization of restored carbohydrates in filling the cob/ear. This result contradicts with the findings of Palta *et al.,* (1994), Riccardi and Sttelluti, 1995. The high levels of soil amendments generally recorded greater plant height than lower levels, thus higher rates of application appeared to have a positive effect on plant growth especially in case of organic inputs plus inorganic mineral fertilizers. The result contradicts with the findings of Copedal *et al.,* 2007, Bending *et al.,* 2004 (table1).

The stem girth was calculated at 30 DAS, 60 DAS and at harvest. There was a significant difference in stem girth under different treatments. The maximum stem girth ($8.73^a\pm0.12$ cm, 11.3 cm, 7.8 cm) was recorded in the T_6 (Recommended dose of NPK 50% + BM 50%) which was at par with T_4 (Recommended dose of NPK 50% + FYM 50%) and T_7 (Recommended dose of NPK 50% + PM 50%) with $8.03^b\pm0.08$ cm and $7.83^b\pm0.14$ cm. Altogether these three treatments showed similar effects, but statistically identical. The minimum stem girth ($6.73^d\pm0.12$ cm, 8.6 cm) was recorded in control which was at par with T_8 (Recommended dose of NPK 50%) with $7^d\pm0.057$ cm. All the treatment demonstrated significantly more dependable results over control. The above results indicated that, there was a significant difference in the stem girth among the treatments The maximum stem girth recorded in (R.D.F 50% NPK + BM 50%) due to bone meal contain some growth promoting substances like natural hormones and vitamin B. It is evident from the data that stem girth was significantly impressed by different treatment. The maximum girth was noted under T_6 and T_4 and minimum in T_1 and T_8. The plant girth increased slowly in 50-55 days due to translocation of photosynthesis to grain formation, *i.e.* the reproductive stage of maize growth started. FYM increased the stem girth, due to the proper supply of nutrients, micronutrients. The organic matter, nitrogen content of surface soil was increased due to the application of constitutional amendments. NPK full dose also gave comparable result to organic amendment in stem girth thickness. This result contradicts with the finding of Quansah *et al.,* 1998 and Pimpini *et al.,* 1992 who reported that FYM and mineral fertilizer produced excellent responses towards stem girth. The result is in conformity with the findings of Leonard, 1986, Pimpini *et al.,* 1992 and Eck *et al.,*1990 (table 2).

Effect of different minerals and organic amendments on yield parameters: The cob length varies significantly with the treatment. The highest cob length (17.68a±0.34) was observed in the treatment having 50% RDF of NPK + 50% bone meal. The

Table 3 Effect of different minerals and organic amendments on yield parameter's:

Treatment	Grain Yield	Straw Yield	Harvest Index	100 Grain Weight	Cob Length
T_1 Control	1613.3f±17.63	2933.3h±60.64	35.46b±0.24	27.50c±0.90	9.37d±0.41
T_2 (100% RDF of NPK)	3136.7b±69.36	5898.3c±29.20	34.63bc±0.40	27.57c±0.26	12.37c±0.14
T_3 (50% RDF of NPK + 50% VC)	2433.3d±23.33	4866.7f±60.98	33.26d±0.08	29.31b±0.42	15.43b±0.53
T_4 (50% RDF of NPK +50% FYM)	2691.3cd±50.81	5356e±97.51	33.73cd±0.33	30.30ab±0.48	15.43b±0.20
T_5 (50% RDF of NPK +50% NC)	2853c±38.63	5606d±23.86	34.2cd±0.45	29.34b±0.45	15.99b±0.10
T_6 (50% RDF of NPK +50% BM)	4434.3a±2.30	6820.3a±56.33	37.9a±0.05	31.15a±0.20	17.68a±0.34
T_7 (50% RDF of NPK +50% PM)	3363.3b±58.98	6196.3b±45.16	35.5b±0.69	29.85ab±0.27	17.56a±0.17
T_8 (50% RDF of NPK)	1950.7e±39.28	3756g±80.22	33.76cd±0.28	27.3c±0.51	11.58c±0.34

Table 4: Effect of different minerals and organic amendments on soil properties

Treatment	pH	EC	OC	N	P	K
T_1 Control	7.22^e±0.05	0.33^f±0.001	0.37^f±0.008	363.6^h±0.41	7.18^f±0.07	158^g±2.08
T_2 (100% RDF of NPK)	7.52^c±0.02	0.37^{de}±0.003	0.62^d±0.01	438.87^f±0.08	9.05^e±0.04	201.48^e±0.49
T_3 (50% RDF of NPK + 50% VC)	7.82^b±0.01	0.37^{cd}±0.003	0.92^c±0.01	450.67^e±0.79	9.04^d±0.008	224.5^d±0.17
T_4 (50% RDF of NPK +50% FYM)	7.84^b±0.01	0.38^c±0.002	1.14^b±0.008	464.2^d±0.26	12.19^c±0.16	306.39^c±0.16
T_5 (50% RDF of NPK +50% NC)	7.89^b±0.02	0.38^{bc}±0.002	1.15^b±0.01	539.07^c±0.20	12.35^c±0.17	314.57^b±0.14
T_6 (50% RDF of NPK +50% BM)	8.02^a±0.03	0.41^a±0.002	1.37^a±0.01	572.7^a±2.40	13.37^a±0.05	328.57^a±0.37
T_7 (50% RDF of NPK +50% PM)	7.99^a±0.006	0.39^b±0.007	1.34^a±0.01	563.91^b±0.80	13.02^b±0.03	314.33^b±0.31
T_8 (50% RDF of NPK)	7.32^d±0.02	0.36^e±0.004	0.42^e±0.01	400.84^g±0.52	8.09^e±0.02	198.54^f±0.29

highest test weight (31.15a±0. 20) was observed in the treatment having 50% RDF of NPK + 50% bone meal. However, it was at par with treatment T_4 (30.30ab±0. 48) having 50% RDF of NPK +50% FYM. There was significant variation in the grain yield. The maximum grain yield was (4434.3a±2.30) recorded in those plots which were treated with (R.D.F 50% NPK + bone meal 50%) T_6 followed by T_7 with 3363.3b±58.98. The minimum grain yield was recorded with (1613.3f±17.63) by control. The maximum straw yield was (6820.3a±56.33) recorded in those plots which were treated with (R.D.F 50% NPK + bone meal 50%) T_6 followed by T_7 with 6196.3b±45.16. The minimum straw yield was recorded with (2933.3h±60.64) by T_3. This result contradicts with the findings of Boateng and Oppong (1995) who reported that plots treated with manures and NPK gave more straw yield. The maximum harvest index were (37.9a±0.05) recorded in those plots which were treated with (R.D.F 50% NPK + bone meal 50%) T_6 followed byT_7 with 35.5b±0.69. The minimum harvest index was recorded with (33.26d±0.08) by T_3. This result contradicts with the findings of Qasim, *et al.* 2001 who reported that combined soil amendments produced more harvest index mentioned in table 3.

Effect of different minerals and organic amendments on Soil Parameters: The soil parameters, differs significantly with the treatment. The soil parameters like pH, EC, OC, available nitrogen, phosphorous and potassium showed incomparably different due to impact of organic and inorganic amendments to the soil physiochemical characters of the stain. The highest soil pH (8.02^a±0.03) was noticed in the T_6 which was on par with other treatments (7.99^a±0.006 and 7.89^b±0.02). While the lowest with control (7.22^e±0.05). Similarly the highest EC was observed with T_6 (0.41^a±0.002) and the lowest with T_1 (0.33^f±0.001) in the same way highest OC, N, P and K was observed with T_6 (1.37^a±0.01, 572.7^a±2.40 13.37^a±0.05 and 328.57^a±0.37 respectively) mentioned in table 4.

Conclusion

The present study concluded that, all the organic manure of fact the physical, chemical and biological characteristics of soil. The T_6 (50% RDF of NPK +50% BM) showed the best result. By the single use of organic and inorganic sources, it is not possible to maintain the fertility of soil. The result of this experiment clearly indicates a positive role of organic manures on the soil properties, yield and crop growth. Thus to maintain the soil fertility and productivity on a long term basis, the combined use of organic + inorganic fertilizers is recommended for getting the optimum yield of crop.

Acknowledgement

The first author is thankful to School of Agriculture, Lovely Professional University, Phagwara, Punjab to provide the scholarship and funding for the completion of

his Master dissertation research.

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