RESPONSE OF DIFFERENT LEVEL OF BULKY ORGANIC MANURE AND BIOCHAR ON SOIL PARAMETERS AND YIELD ATTRIBUTES OF MAIZE (*Zea mays* L..) var. SURABHI

ABSTRACT

A field trial was conducted on maize during *zaid* season 2023. The soil was sandy loam in texture. The experiment was laid down in randomized block design with three levels of NPK. The treatment combinations were replicated three times and allocated at random in each replication. The result shows that the application of different levels combination of NPK and FYM and Biochar T_9 - [NPK @ 120:60:40 Kg ha^{-1} + FYM @ 125 t ha^{-1} + Biochar @ 5 t ha^{-1}] showed that the slight decrease in pH, bulk density and particle density; there is significant increase in pore space, water holding capacity, EC, organic carbon, av. nitrogen, phosphorus, potassium and plant growth and yield attributes, gave best results with respect to plant height (cm), number of leaves plants (Kg ha^{-1}), number of cob plant (Kg ha^{-1}), Seed yield (Kg ha^{-1}) and Stalk yield (Kg ha^{-1}) was observed in maize , followed by T_8 - [NPK @ 60:30:20 Kg ha^{-1} + FYM @ 62.5 t ha^{-1} + Biochar @ 2.5 t ha^{-1}]. The economy of different treatment combination, the results showed that the application of NPK and FYM and Biochar in treatment T_8 - [NPK @ 60:30:20 Kg ha^{-1} + FYM @ 62.5 t ha^{-1} + Biochar @ 2.5 t ha^{-1}] provides highest net profit of Rs. ₹86,058.97 with cost benefit ratio 1:2.70, followed by T_9 - [NPK @ 120:60:40 Kg ha^{-1} + FYM @ 125 t ha^{-1} + Biochar @ 5 t ha^{-1}] provides net profit of Rs. ₹84,640.83 ha^{-1} with cost benefit ratio 1:2.2.

Keywords: Soil properties, yield attributes, maize, FYM, biochar, *etc.*

INTRODUCTION

Soil is the most wondrous gift of nature to human society. Development of soil from earth and evolution of sapiens go hand in hand. Truly, 4.5-billion-year-old earth is the mother of soil. If planet Earth is inhabited with humans (and other forms), it is because there is soil on it. “When you have land, you the world”. “Be it deep or shallow, red or black, sand or clay, the soil is the link betweenthe rock core of the earth and living things on its surface. It is the foot fold for the plants we grow, therein lies the main reason for our interest in soils” **(Simonson 1989).**

In recent years, the application of bio-char as soil amendments has generated a huge interest

for the preservation of soil fertility by improving the physico-chemical and biological properties of soil, and for the reduction of the negative effects of green house emission (climate change adaptation). Biochar derived from wood (BC), soil digested (SD), and biochar derived from soil digested (BSD), on soil parameters and their influence in maize growth performance **(Alessandro 2010).**

Maize can thrive in a diverse range of soil types, spanning from loamy sand to clay loam. Nevertheless, soils that possess ample organic matter, a strong ability to retain water, and a neutral pH are deemed favourable for achieving greater yields. Its remarkable potential has earned it the titles "Queen of cereals" and "King of fodder." Maize is cultivated extensively across numerous states in India. Grain contains about 8-10% protein, 4-5% oil, 70% carbohydrate, 2.3% crude fibre, 10.4% aluminizes, 1.4% ash, protein "Zein" is in tryptophan and lysine two essential amino acids **(Singh *et al*., 2017)**. Farmyard manure has been used as a soil conditioner since ancient times and its benefit have not been fully harnessed due to large quantities required in order to satisfy the nutritional needs of crops **(Makinde *et al.*, 2007).** Farmyard manure release nutrients slowly and steadily and activates soil microbial biomass **(Ayuso *et al.*, 1996; Belay *et al.*, 2001)**. Biochar is described as "a solid material obtained from thermochemical conversion of biomass in an oxygen-limited environment" by the International Biochar Initiative **(IBI, 2013).** Biochar is a product derived from pyrolysis of biomass that could be utilized as a soil amendment. The positive effects to crops by the addition of biochar combined with inorganic or organic fertilization have been reported **(Adekiya *et al.* 2018)**

Material and Methods

The experiment was conducted at research farm of Soil Science and Agricultural Chemistry, [NAI,] SHUATS, Prayagraj. It is situated at $25^0$24'23" N latitude, $81^0$50'38" E longitude and at an altitude of 98 meter above the sea level. During the summer season the maximum temperature of the location reaches up to 46^0C-48^0C and seldom falls as low as 4^0C - 5^0C during winter season. The relative humidity ranged between 20 to 90 percent. The average rainfall in this area is around 1100mm annually.

The design applied for statistical analysis was carried out with 3^3 randomized block designs having three levels of NPK @ 0, 50 and 100 % ha^{-1}, three levels of FYM @ 0, 50 and 100 % ha^{-1} and three levels of Biochar @ 0, 50 and 100 % ha^{-1} respectively. The details of the treatment combinations are given below table 1 and observation were recorded bulk density, particle density, water holding capacity %, p^H, organic matter, nitrogen, phosphorus, potassium, plant height, number of leaves $plant^{-1}$, number of cob $plant^{-1}$, seed yield and stalk yield.

During the experiment, observations were recorded as mean values of the data. A basal dose of fertilizer was applied in the corresponding plots according to treatment allocation in furrows opened by about 5 cm depth before sowing seeds in soil at the same time of sowing seeds on well-prepared beds in shallow furrows, at a depth of 5 cm, row to row distance was maintained at 30 cm, and plant to plant distance was 45 cm.

Table 1. Treatment combination of maize var. surabhi

Treatment	Description
T_1	Absolute Control
T_2	[NPK @ 0% + FYM @ 50% + Biochar @ 50%]
T_3	[NPK @ 0% + FYM @ 100% + Biochar @ 100%]
T_4	[NPK @ 50% + FYM @ 0% + Biochar @ 0%]
T_5	[NPK @ 50% + FYM @ 50% + Biochar @ 50%]
T_6	[NPK @ 50% + FYM @ 100% + Biochar @ 100%]
T_7	[NPK @ 100% + FYM @ 0% + Biochar @ 0%]
T_8	[NPK @ 100% + FYM @ 50% + Biochar @ 50%]
T_9	[NPK @ 100% + FYM @ 100% + Biochar @ 100%]

Note: NPK 100 % (120:60:40 Kg ha^{-1}),

FYM 100 % (125 t ha^{-1}) and

Biochar 100% (5 t ha^{-1})

ICAR (2020)

Sources of Fertilizers, Farm Yard Manure (FYM) and Biochar

Table 2. Composition of FYM, and Biochar

Source	FYM	Biochar
Nitrogen	0.5-1.5 %	7.49 g Kg^{-1}
Phosphorus	0.2-0.4 %	1.38 mg Kg^{-1}
Potassium	0.5-1.0 %	4.62 g kg^{-1}
Carbon	16.39 %	281.33g Kg^{-1}

Zhang *et al.* (2021)

Nitrogen - Urea

Phosphorus - DAP

Potassium - MoP

Table 3. Morphological analysis of soil

Particulars	Results	Method employed
Soil colour		
1. Dry soil	Pale brown colour	**Munsell (1971)**
2. Wet soil	Olive brown colour	

Table 4. Mechanical analysis of soil

S. No.	Soil separates	(%)	Methods
1.	**Sand**	61.20	(**Bouyoucos, 1927)**

2.	**Silt**	23.20
3.	**Clay**	15.60
4.	**Texture of soil**	Sandy loam

Table 5. Physical Parameters of sandy loam soil

Particulars	Methods employed	Reference Range
Bulk density (Mg m^{-3})	**(Muthuval *et al.*, 1992)**	1.45-1.8
Particle density (Mg m^{-3})	**(Muthuval *et al.*, 1992)**	2.65-2.8
Pore space (%)	**(Muthuval *et al.*, 1992)**	Less than 50%
Water holding capacity (%)	**(Muthuval *et al.*, 1992)**	Less than 50 %

Table 6. Soil Chemical Parameters

Parameters	Method employed	Reference Range		
		Low	**Medium**	**High**
Soil pH (1:2)	**(Jackson 1958)**	< 6.5	6.5-7.5	>7.5
Soil EC (dS m^{-1})	**(Wilcox 1950)**	< 0.8	0.8-2.0	> 2.0
Organic Carbon(%)	**(Walkley and Black 1947)**	< 0.50	0.50-0.75	>0.75
Available Nitrogen (Kg ha^{-1})	**(Subbaih and Asija, 1956)**	< 280	280-560	>560
Available Phosphorus (Kg ha^{-1})	**(Olsen *et al.* 1954)**	< 10	10-25	>25
Available Potassium(Kg ha^{-1})	**(Toth and Prince 1949)**	< 118	118-280	>280

TNAU (2016)

Table 7. Crop Calendar of Pre sowing of Maize

S. No.	Date	Operation	Remark
1.	01/04/2023	Tillage operation	Open ploughing by mould board plough

			followed by harrowing and ploughing.
2.	03/04/2023	Layout and demarcation of plot	Manually
3.	05/04/2023	Collection of soil sample for analysis	Randomly from a depth of 0-15cm
4.	07/04/2023	Organic manure application	Biochar
5.	13/04/2023	Inorganic fertilizer application	Urea, SSP and MOP
6.	13/04/2023	Seed sowing	Manually

Table 8. Crop calendar of post sowing of maize

S. No.	Date	Operation	Remark
1.	25/04/2023	Gap filling and resowing	12 days after sowing
2.	20/04/2023	First Irrigation	By irrigation channel
3.	10/05/2023	First weeding	By Khurpi at 27 days aftersowing
4.	30/04/2023	Second Irrigation	By irrigation channel
5.	11/06/2023	Second weeding	By Khurpi 58 days after sowing
6.	11/06/2023	Thinning	58 days after sowing
7.	20/06/2023	Third Weeding	By Khurpi 67 days after sowing
8.	23/06/2023	Third Irrigation	By irrigation channel
9.	15/07/2023	First Picking of fruits	92 days after sowing
10.	20/07/2023	Second Picking of fruits	97 days after sowing

11.	27/07/2023	Final Picking of fruits	104 days after sowing
12.	02/08/2023	Display of Crop	109 days after sowing
13.	10/08/2023	Collection of soil sample after harvest	Randomly from a depth of 0-15cm

RESULTS AND DISCUSSION

The chapter is **written on topic (**Response of different level of bulky organic manure and biochar on soil parameters and yield attributes of maize (*zea mays* L.) var. surabhi**"** written with concern objectives

(1.) To study the effect of inorganic fertilizers bulky organic manures and biochar on soil parameters.

(2.) To compare the interaction of inorganic fertilizers bulky organic manures and biochar in the yield attributing of maize.

The as presented in table 9 the bulk density (Mg m^{-3}) of soil was found to be significant in levels of NPK FYM and biochar was recorded 1.247 Mg m^{-3} in treatment T_1- [Absolute control] and minimum bulk density (Mg m^{-3}) of soil was recorded 1.171 Mg m^{-3} in treatment T_9 - [NPK @ 100% + FYM @ 100% + biochar @100%]**.** The particle density (Mg m^{-3}) of soil was found to be significant in levels of NPK FYM and biochar, maximum particle density (Mg m^{-3}) of soil was recorded 2.14 Mg m^{-3} in treatment T_9-[NPK @ 100% + FYM @ 100% + Biochar @ 100%] and minimum particle density (Mg m^{-3}) of soil was recorded 2.30 Mg m^{-3} in treatment T_1-[Absolute control]**,** the maximum soil water holding capacity was recorded 59.09 % in treatment T_9 -[NPK @ 100% + FYM @ 100% + Biochar @ 100%] and minimum soil was recorded 53.27 % in treatment T_1-[Absolute control], the maximum soil pore space was recorded 46.765 % in treatment T_2-[NPK @ 100% + FYM @ 100% + Biochar @ 100%] and minimum soil pore space was recorded 45.155 % in treatment T_9-[Absolute control], similar findings were reported by (**Kumar *et al.* 2020** and **Singh *et al.* 2023).**

As derived in table 9 the response of soil pH was found to be significant in levels of NPK FYM and biochar. Maximum soil pH was recorded 7.25 in treatment T_1 – [Absolute control] and minimum soil pH was recorded 6.89 in treatment T_9 – [NPK@ 100% + FYM @ 100% + Biochar @ 100%], similar findings were reported **(Singh *et al.* 2023 and Murtaza *et al.* 2021).** The Response of EC (dS m^{-1}) of soil was found to be non-significant in levels of NPK FYM and biochar. The maximum EC (dS m^{-1}) of soil was recorded 0.223 dS m^{-1} in treatment T_9 – [NPK @ 100% + FYM @ 100% + Biochar @ 100%] and minimum EC (dS m^{-1}) of soil was recorded 0.203 dS m^{-1} intreatment T_1 [Absolute control], similar findings were reported by **(Singh *et al.* 2023 and Murtaza *et al.* 2021).** The organic carbon (%) in soil increased significantly with the increase in level of NPK FYM and biochar. The maximum organic carbon (%) in soil was recorded 0.488 % in treatment T_9 – [NPK @ 100% +FYM @ 100% + Biochar @ 100%], which was significantly higher than any other treatment combination and the minimum organic carbon (%) in soil was recorded 0.404 % in treatment T_1 – [Absolute control], similar findings were reported by **(Singh *et al.* 2023 and Murtaza *et al.* 2021).** The available nitrogen (kg ha^{-1}) in soil increased significantly with the increase in levels of NPK FYM and biochar. Maximum available nitrogen in soil was recorded 246.44 (Kg ha^{-1}) in treatment T_9- [NPK @ 100% + FYM @100% + Biochar @ 100%] which was significantly higher than any other treatment combination and the minimum available nitrogen in soil was recorded 175.52 (Kg ha^{-1}) in treatment T_1 – [Absolute control], similar findings were reported by **(Singh *et al.* 2023 and Murtaza *et al.* 2021)**. The available phosphorus (Kg ha^{-1}) in soil increased significantly with the increase in levels of NPK FYM and biochar. The maximum available phosphorus in soil was recorded 39.80 (Kg ha^{-1}) in treatment T_9- [NPK @ 100% + FYM @ 100% + biochar @ 100%] which was significantly higher than any other treatment combination and the minimum available phosphorus in soil was recorded 24.09 (Kg ha^{-1}) in treatment T_1 – [Absolute control], similar findings were reported by **(Singh *et al.* 2023 and Murtaza *et al.* 2021).** The available potassium in soil increased significantly with the increase in levels of NPK FYM and biochar. Maximum available potassium in soil was recorded 232.05 (Kg ha^{-1}) in treatment T_9 - [NPK @ 100% + FYM @ 100% + Biochar @ 100%], which was significantly higher than any other treatment combination and the minimum available potassium in soil was recorded 202.99 (Kg ha^{-1}) in treatment T_1 – [Absolute control], similar findings were reported by **(Singh *et al.* 2023 and Murtaza *et al.* 2021).**

Table 9. Effect of different level of NPK FYM and Biochar on Physico-chemical properties of Maize

Treatment	Bd (Mg m^{-3})	Pd (Mg m^{-3})	Water holding capacity (%)	Pore space (%)	pH (1:2.5)	EC (dS m^{-1})	OC (%)	N (Kg ha^{-1})	P_2O_5 (Kg ha^{-1})	K_2O (Kg ha^{-1})
T_1	1.247	2.30	53.27	45.797	7.25	0.203	0.404	175.52	24.09	202.99
T_2	1.207	2.27	54.57	46.765	7.21	0.207	0.423	187.97	24.69	219.71
T_3	1.196	2.25	55.61	46.745	7.08	0.213	0.428	196.97	28.76	223.14
T_4	1.205	2.22	55.00	45.737	7.13	0.211	0.425	191.97	27.08	222.69
T_5	1.193	2.21	55.96	45.930	7.07	0.215	0.433	200.30	30.43	224.27
T_6	1.185	2.20	58.10	46.203	7.02	0.217	0.442	240.24	34.12	226.95
T_7	1.191	2.19	56.32	45.671	7.06	0.215	0.435	202.97	32.02	226.06
T_8	1.181	2.18	58.18	45.891	6.95	0.218	0.448	242.64	36.64	229.58
T_9	1.171	2.14	59.09	45.155	6.89	0.223	0.488	246.44	39.80	232.05
F- test	**S**	**S**	**S**	**S**	**S**	**NS**	**S**	**S**	**S**	**S**
S. Em. (±)	0.010	0.03	0.62	0.956	0.05	0.010	.012	1.11	0.76	1.38
CD@0.05	0.031	0.08	1.83	2.866	0.16	0.02	0.036	3.32	2.36	4.15

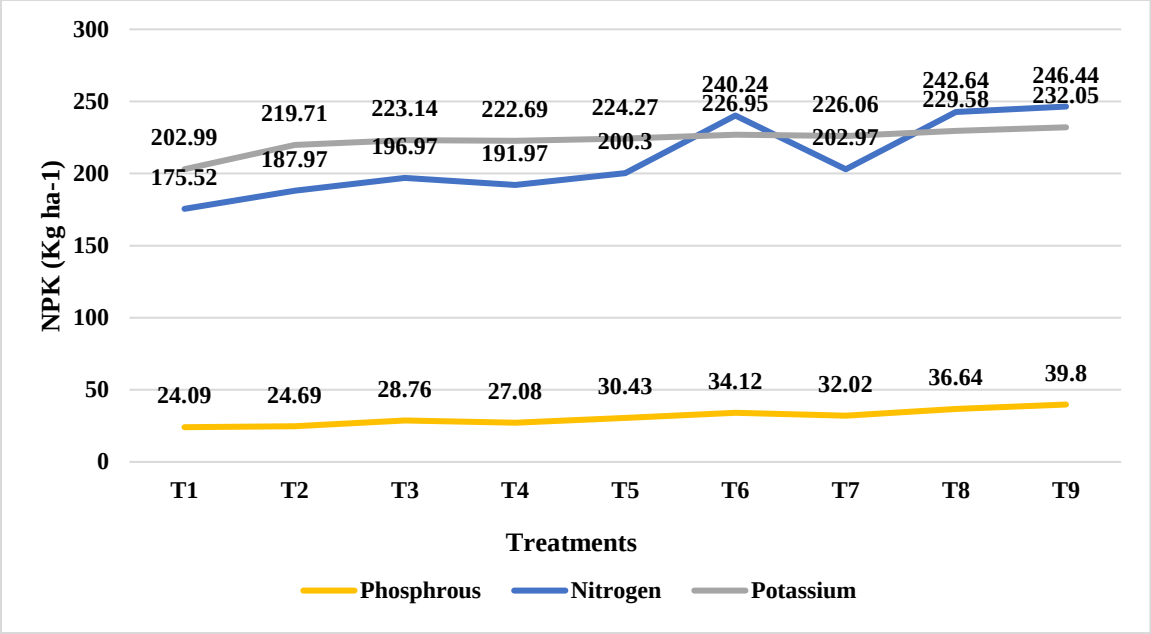

Fig 1. Effect of different level of NPK FYM and Biochar on Soil

I revealed in table 10. plant height was exhibited maximum in T_9-[NPK @ 100% + FYM @ 100% + Biochar @ 100%], 194.45 cm at crop harvesting (90 DAS) and found to be lowest in T_1-[Absolute control] 158.25 cm at crop harvesting (90 DAS), similar findings were reported by (**Kumar *et al.* 2020 and Faisal *et al.* (2017).** The number of leaves plant^{-1} was exhibited maximum in T_9 – [NPK @ 100% + FYM @ 100% + Biochar @ 100%], 15.2, 39.4 and 44.2 at 30, 60 and 90 DAS respectively and found to be lowest in T_1 – [Absolute control] 8.2, 31.2 and 36.4 at 30, 60 and 90 DAS respectively, similar findings were reported by (**Kumar *et al.* 2020 and Faisal *et al.* (2017).** The mean value of number of cob plant^{-1} was exhibited maximum in T_9 – [NPK @ 100% + FYM @ 100% + Biochar @ 100%], 2.06 and found to be lowest in T_1 – [absolute control] 1.18, similar findings were reported by (**Kumar *et al.* 2020 and Faisal *et al.* (2017)..** The Seed yield (kg ha^{-1}) was exhibited maximum in T_9 – [NPK @ 100% + FYM @ 100% + Biochar @ 100%], 5331.11 and found to be lowest in T_1 – [Absolute control], 1580.00, similar findings were reported by (**Kumar *et al.* 2020 and Faisal *et al.* (2017).** The Stalk yield was exhibited maximum in T_9 - [NPK @ 100% + FYM @ 100% + Biochar @ 100%], 6983.13 Kg ha^{-1} and found to be lowest in T_1 – [Absolute control] 1983.33 Kg ha^{-1}, similar findings were reported by (**Kumar *et al.* 2020 and Faisal *et al.* (2017).**

Table 10. Effect of different level of NPK FYM and Biochar on Growth and Yield parameters of Maize

Treatment	Plant height (cm)	Number of Leaves plant	Cob Plant^{-1}	Seed Yield (Kg ha^{-1})	Stalk Yield (Kg ha^{-1})
T_1	158.25	39.4	1.18	1580.00	1983.33
T_2	173.39	40.0	1.42	2116.50	3352.64
T_3	180.96	40.0	1.60	2735.86	4019.69
T_4	174.98	40.8	1.49	2292.96	3744.75
T_5	183.44	41.8	1.70	2809.33	4293.66
T_6	189.26	42.4	1.96	4601.19	6816.67
T_7	184.91	43.0	1.83	2850.28	5561.79
T_8	189.66	44.2	2.03	4943.43	6867.37
T_9	194.45	45.2	2.06	5331.11	6983.13
F- test	**S**	**S**	**S**	**S**	**S**
S. Em. (±)	0.60	0.75387	0.03	42.28	54.76
C.D. @ 0.05%	1.80	2.26938	0.10	126.75	164.16

Conclusion

It revealed from the trial that application of different level of N P K, FYM and Biochar used for Maize, the treatment combination T_8- [@ 100 % NPK + @ 50 % FYM + @ 50 % Biochar] was found to be the best treatment for soil health parameters . Thus, treatment T_8 could be recommended for sustainable soil health

and maize. Since the results is based on one season experiment, further trail is needed to substantiate the result.

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