EFFECT OF DIFFERENT LEVELS OF FYM, PRESS MUD AND ZINC SULPHATE APPLICATION ON SOIL PROPERTIES

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Abstract: An experiment was conducted during the years 2006-2007 and 2007-2008 at farmers field to find out the effect of farm yard manure (FYM), press mud and in combination of inorganic fertilizer zinc sulphate. The rice variety PRH 10 was grown with thirteen treatments *i.e.*T_1 = Control; T_2 = FYM 5 t ha^{-1} +0.0 kg $ZnSO_4$; T_3 = FYM 5 t ha^{-1} +2.5 kg $ZnSO_4$; T_4 = FYM 5 t ha^{-1} +5.0 kg $ZnSO_4$; T_5 = FYM 5 t ha^{-1} +7.5 kg $ZnSO_4$; T_6 = FYM 10 t ha^{-1} +0kg $ZnSO_4$; T_7 = FYM 10 t ha^{-1} +2.5 kg $ZnSO_4$; T_8 = FYM 10 t ha^{-1} +5.0 kg $ZnSO_4$; T_9 = FYM 10t ha^{-1} +7.5 kg $ZnSO_4$; T_{10} = Press mud 5 t ha^{-1} +0.0 kg $ZnSO_4$; T_{11} = Press mud 5 t ha^{-1} +2.5 kg $ZnSO_4$; T_{12} = Press mud 5 t ha^{-1} +5.0 kg $ZnSO_4$; T_{13} = Press mud 5 t ha^{-1} +7.5 kg $ZnSO_4$. After the crop harvest soil samples were analyzed for physico-chemical parameters. The results showed that application of FYM and press mud in combination enhanced the soil organic carbon, available N, available P, available K and DTPA extractable Zn in soil solution. The highest increment was observed in the application of FYM 10t ha^{-1} +7.5 kg $ZnSO_4$ compared to rest of the treatments. In conclusions, use of FYM and press mud with inorganic fertilizers enhanced the plant nutrient level in soil solution for better crop yield.

Keywords: Farm Yard Manure (FYM), press mud, soil properties, zinc sulphate

INTRODUCTION

For India with a population of 17 percent of the world's population (1.1 billion) spread across only 2.3% (329 m ha) of world's area, this problem has been giving a far greater challenge. Fertilizer have played very important role in achieving the objective of food security in India. Positive interventionist policies of the government have promoted consumption of fertilizer and production of fertilizers. But irrational use of chemical fertilizers gave up poor soil physical, chemical and biological properties. In many cases agricultural productivity stagnates or decline productivity, which is a challenge for scientific community to solve the problem (Dotaniya et al., 2014c). So, the researchers think back old practices like use of crop residue, farm waste, compost to maintain soil health and sustainable crop yield. Use of sugarcane industry byproduct for crop production, solve the storage problem at industry level and improve the soil properties (Dotaniya and Datta, 2014). The annual availability sugarcane by-products is more than 45-55 million tons bagasse and 8-10 million tons press mud in India. On an average it contains, 2.5-5% in bagasse and 5-15% sugar in press mud with significant amount of Si, Ca, P_2O_5, MgO, Fe and Mn, etc (Yadav and Solomon, 2006). Use of chemical fertilizers in combination of organic waste, enhanced the plant nutrients and enhanced the crop yield (Meena et al., 2014). Sharma et al. (2000) stated that the organic C content increased significantly (6.8 g kg^{-1}) in cultivated soil over uncultivated (5.19 g kg^{-1}) under long-term of different cropping system. Singha (2003) reported a decline in organic carbon as a result of continuous application of N fertilizer alone irrespective of cropping system and soil type. Balanced use of NPK fertilizers either maintained or slightly enhanced the organic C level over the initial values while the beneficial effect of farmyard manure (FYM) in improving organic C over control, N, NP and NPK fertilizers was more pronounced on vertic Ustocherpt (Coimbatore) Chromustert (Jabalpur) and Haplustert (Bhubaneswar). Bhat *et al.* (1991) observed that continuous recycling of crop residue (wheat straw 6 t ha^{-1} and rice straw 12 t ha^{-1}) for seven year in rice-wheat crop sequence significantly increased the available nitrogen content of soil. In these views, we have conducted a field study to find out the long term effect of FYM and press mud on soil properties.

MATERIAL AND METHOD

The experiment was conducted during 2006-07 at progressive farmer's field at Dharki village of District Saharanpur. Saharanpur district lies between $77^0 15'$E longitude and $27^0 10'$ N altitude and is situated at the attitude of about 275.05 meters above mean sea level. The rice variety PRH 10 was crop with thirteen treatments i.e.T_1 = Control; T_2 = FYM 5 t ha^{-1} +0.0 kg $ZnSO_4$; T_3 = FYM 5 t ha^{-1} +2.5 kg $ZnSO_4$; T_4 = FYM 5 t ha^{-1} +5.0 kg $ZnSO_4$; T_5 = FYM 5 t ha^{-1} +7.5 kg $ZnSO_4$; T_6 = FYM 10 t ha^{-1} +0kg $ZnSO_4$; T_7 = FYM 10 t ha^{-1} +2.5 kg $ZnSO_4$; T_8 = FYM 10 t ha^{-1} +5.0 kg $ZnSO_4$; T_9 = FYM 10t ha^{-1} +7.5 kg $ZnSO_4$; T_{10} = Press mud 5 t ha^{-1} +0.0 kg $ZnSO_4$; T_{11} = Press mud 5 t ha^{-1} +2.5 kg $ZnSO_4$; T_{12} = Press mud 5 t ha^{-1} +5.0 kg $ZnSO_4$; T_{13} = Press mud 5 t ha^{-1} +7.5 kg $ZnSO_4$.

FYM and Press mud in different treatments were applied 10 days before transplanting. The initial soil properties like pH 7.86, organic carbon 0.63%, phosphorus, potassium and zinc in low category. The nutrient content of press mud and FYM was analyzed and described in Table 1& 2. Different doses of zinc sulphate were applied at the time of transplanting by hand broadcasting in each plot. Recommended doses of NPK were applied in all plots including control. Half of dose of nitrogen was applied at the time of planting and rest half dose was applied at 30 and 70 days after transplanting as topdressing in two installments. While, total P and K were applied before transplanting. All standard agronomic practices were adopted to raise the rice crop.

Table 1 Chemical composition of FYM

Property	Values %
Organic matter	31.67
Organic carbon	11.84
Nitrogen	0.93
Phosphoric acid	1.00
Potassium	1.31
Calcium oxide	5.74
Magnesium	1.14
Copper	0.40
Mangnese	0.83
Zinc	0.52
C:N ratio	9.5
pH	7.0

Table 2: Chemical characteristics of Press mud

Property	Value
Moisture %	74.0
Available N%	0.95
Available P %	0.27
Available K %	0.19
CaO %	2.38
MgO %	1.73
DTPA Ext. Zn mg/Kg	68

Statistical analysis

The experiment laid out in Randomized Block Design (RBD) design with three replications The soil samples was collected from each treatment after harvesting of rice crop in 2006-07 and 2007-08 and analyzed for different physico-chemical properties viz. pH, EC, organic carbon, available N, available N, available K and DTPA extractable Zn. The data collected from field and laboratory was analyzed statistically at 5% level of significance using standard statistical programmes (Snedecor and Cochran, 1967).

RESULT AND DISCUSSION

Before transplanting soil pH in 2006-07 was 6.80 while after harvesting the pH was significantly decreased in the plots treated FYM 10 t ha^{-1} with Zinc sulphate @ 2.5, 5.0 and 7.5 Kg ha^{-1} with 6.71, 6.75 and 6.60, respectively. Press mud 5 t ha^{-1} without zinc sulphate significantly reduced the pH (Table 3). In 2007-08 the soil pH before transplanting was 6.70. The soil pH was significantly increased in control. FYM 10 t ha^{-1} reduced pH to 6.61, 6.65 and 6.50 when applied with zinc sulphate @ 2.5, 5.0 and 7.5 Kg ha^{-1}, respectively. Press mud alone and with zinc sulphate @ 2.5 Kg ha^{-1} also significantly reduced the soil pH (Table 4). The addition of FYM 10 t ha^{-1} with $ZnSO_4$ @ 2.5, 5.0 and 7.5 Kg ha^{-1} significantly reduced the pH in comparison to pre-planting condition in both the years of 2006-07 and 2007-08. Addition of press mud @ of 5 t ha^{-1} with 2.5 Kg $ZnSO_4$ also reduced the pH in 2007-08. The decrease in pH with addition of FYM increase the production of carbonic acids and it also improve the soil permeability due this basic cations leached and creates acidity up to some extant. The reduction in pH with the addition of press mud also reported by Rai *et al.* (1980). Borde *et al.* (1984) also reported that the application of press mud with P fertilizer reduced soil pH.

ECe of composite sample before transplanting in 2006-07 was 0.25 dSm^{-1}, while after harvesting was lowest (0.17 dSm^{-1}) in T_9 followed by T_8 (0.18dSm^{-1}). While, in the rest all treatments ECe was ranged from 0.21 to 0.30 dSm^{-1} (Table 3). Similarly, in 2007-08 ECe was lowest in T_6 (0.16 dSm^{-1}) followed by 0.19 in T_8, while in rest of all treatments, ECe was ranged from 0.21 to 0.31 dSm^{-1} (Table 4). There was no clear cut trend of increase or decrease observed except in T_9 and T_8 where significant reduction in ECe was observed in comparison to pre-transplanting condition of 2006-07. In 2007-08 lowest ECe was recorded in T_6 (0.16 dSm^{-1}) followed by T_8. The reduction in electrical conductivity was also reported by Rai *et al.* (1980) and Borde *et al.* (1984).

Organic carbon was significantly increased by all organics treatments in 2006-07 (Table 3). The maximum increment was observed by application of FYM 10 t ha^{-1} (0.90 to 1.00 per cent) followed by FYM 5 t ha^{-1} (0.76-0.85 per cent), while, least increase in per cent in organic carbon by press mud 5 t ha^{-1} (0.74 to 0.78 per cent). However in control (T_1) the organic carbon was at par (0.68 per cent) with pre- transplanting condition (0.65 per cent). Similar trend was also observed in 2007-08 (Table 4) but the per cent organic carbon was higher than 2006-07 in all treatments.

Table 3: Effect of different levels of organics and zinc sulphate soil properties 2006-2007

Treatments	pH 1:2 soil : water	ECe dSm^{-1}	Organic carbon%	Av. N $mgkg^{-1}$	Av. P $mgkg^{-1}$	Av. K $mgkg^{-1}$	DTPA Ext. Zn $mgkg^{-1}$
Pre-Transplanting	6.80	0.25	0.65	140	15.0	091.6	1.53
T_1 = Control	6.92	0.30	0.68	140	16.1	093.0	1.56
T_2 = FYM 5 t ha^{-1} +0.0 kg Zn SO_4	6.87	0.28	0.76	142	17.3	094.3	1.59
T_3 = FYM 5 t ha^{-1} +2.5 kg Zn SO_4	6.85	0.24	0.80	145	18.6	095.2	1.63
T_4 = FYM 5 t ha^{-1} +5.0 kg Zn SO_4	6.78	0.22	0.83	146	19.5	096.0	1.66
T_5 = FYM 5 t ha^{-1} +7.5 kg Zn SO_4	6.85	0.23	0.85	147	20.0	098.4	1.71
T_6 = FYM 10 t ha^{-1} +0kg Zn SO_4	6.78	0.21	0.90	154	22.5	104.0	1.61
T_7 = FYM 10 t ha^{-1} +2.5 kg Zn SO_4	6.71	0.26	0.91	158	22.7	104.4	1.68
T_8 = FYM 10 t ha^{-1} +5.0 kg Zn SO_4	6.75	0.18	0.93	160	23.0	105.6	1.73
T_9 = FYM 10t ha^{-1} +7.5 kg Zn SO_4	6.60	0.17	1.00	165	23.5	107.0	1.80
T_{10} = Press mud 5 t ha^{-1} +0.0 kg Zn SO_4	6.69	0.24	0.75	141	17.0	095.2	1.56
T_{11} = Press mud 5 t ha^{-1} +2.5 kg Zn SO_4	6.79	0.25	0.77	144	18.4	096.8	1.60
T_{12} = Press mud 5 t ha^{-1} +5.0 kg Zn SO_4	6.75	0.28	0.78	145	19.0	099.0	1.63
T_{13} = Press mud 5 t ha^{-1} +7.5 kg Zn SO_4	6.81	0.29	0.74	147	19.6	100.0	1.70
F-Test **CD at 5%** **C.V**	Sig. 0.127 1.117	Sig. 0.0497 12.434	Sig. 0.0491 3.615	Sig. 3.237 1.302	Sig. 1.144 3.507	Sig. 2.719 1.643	Sig. 0.0823 2.983

Table 4: Effect of different levels of organics and zinc sulphate on soil properties 2007-2008.

Treatments	pH 1:2 soil : water	ECe dSm^{-1}	Organic Carbon%	Av. N $mgkg^{-1}$	Av. P $mgkg^{-1}$	Av. K $mgkg^{-1}$	DTPA Ext. Zn $mgkg^{-1}$
Pre-Transplanting	6.70	0.26	0.70	145	15.5	91.0	1.58
T_1 = Control	6.94	0.31	0.67	141	16.2	93.0	1.60
T_2 = FYM 5 t ha^{-1} +0.0 kg Zn SO_4	6.73	0.28	0.79	144	17.8	96.0	1.63
T_3 = FYM 5 t ha^{-1} +2.5 kg Zn SO_4	6.75	0.24	0.83	146	19.1	98.1	1.66
T_4 = FYM 5 t ha^{-1} +5.0 kg Zn SO_4	6.62	0.23	0.85	149	20.2	99.5	1.70
T_5 = FYM 5 t ha^{-1} +7.5 kg Zn SO_4	6.75	0.22	0.87	150	20.8	100.0	1.74
T_6 = FYM 10 t ha^{-1} +0kg Zn SO_4	6.65	0.21	0.92	157	23.1	106.3	1.67
T_7 = FYM 10 t ha^{-1} +2.5 kg Zn SO_4	6.61	0.20	0.95	160	23.4	109.5	1.73
T_8 = FYM 10 t ha^{-1} +5.0 kg Zn SO_4	6.65	0.19	0.97	163	23.8	109.7	1.78
T_9 = FYM 10t ha^{-1} +7.5 kg Zn SO_4	6.50	0.16	1.02	170	24.0	110.0	1.85

T_{10} = Press mud 5 t ha^{-1} +0.0 kg Zn SO_4	6.65	0.23	0.77	143	17.5	99.8	1.60
T_{11} = Press mud 5 t ha^{-1} +2.5 kg Zn SO_4	6.49	0.24	0.80	148	18.9	100.0	1.64
T_{12} = Press mud 5 t ha^{-1} +5.0 kg Zn SO_4	6.60	0.28	0.82	151	19.5	103.5	1.66
T_{13} = Press mud 5 t ha^{-1} +7.5 kg Zn SO_4	6.65	0.29	0.78	153	20.1	105.8	1.73
F- test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
CD at 5%	0.106	0.0466	0.0482	4.505	1.074	3.443	0.0501
C.V.	0.952	11.631	3.429	1.772	3.202	2.109	1.777

The increase in the level of organic carbon per cent by application of FYM and press mud was because of these both are rich source of carbon. When level of FYM increase from 5t ha^{-1} to 10 t ha^{-1} maximum increase (0.90 to 1.00 per cent) followed by FYM 5 t ha^{-1} (0.76 to 0.85 per cent) and press mud 5t ha^{-1}. The increase in organic carbon per cent with the application of FYM and press mud earlier reported by Tiwari and Nema (1999). Singh *et al*. (1990) also reported that application of 8.5 to 17 t ha-1 FYM ha^{-1} in maize-wheat rotation also increase the organic carbon in soils. The use of organic amendment enhanced the soil organic C and other plant nutrients like N, K, P in soil (Shukla et al., 2013).

The available N in control after harvesting was equal to pre- transplanting conditions (Table 2). The available N was significantly increased when FYM 5 t ha^{-1}, FYM 10 t ha^{-1} and press mud 5 t ha^{-1} was applied with 0.0, 2.5, 5.0 and 7.5 Kg ha^{-1} zinc sulphate except in T_2 where only FYM 5 t ha^{-1} was applied. The maximum available N was observed in plots treated with FYM 10 t ha^{-1} (154 to 165mg Kg^{-1}). Perusal of (Table 3) reveled that available N was decreased in control (141 mg Kg^{-1}) and FYM 5 t ha^{-1} + 0.0 Kg $ZnSO_4$ ha^{-1} (144 mg Kg^{-1}). Press mud + 0.0 Kg $ZnSO_4$ ha^{-1} (143 mg Kg^{-1} than the pre-transplanting condition (145 mg Kg^{-1}). Furthermore as the dose of $ZnSO_4$ was increased with FYM 5 and 10 t ha^{-1} or press mud 5 t ha^{-1} the values of available N was also increased in both the years of the experiment. The available nitrogen also increases with increasing levels of FYM and $ZnSO_4$ and the rate of increase in nitrogen with the application of press mud was less than the FYM. The trend was similar to as was in case of organic carbon. This is because of organic carbon works as pool source of organic nitrogen which converts in available form. Singh *et al*. (1985) reported similar results increase in the level of available nitrogen when they applied FYM in maize- wheat rotation. Indulkar and Malewar (1996) also reported increase in available N content over control in sorghum.

The available phosphorus was lowest in 16.1 mg Kg^{-1} in control and at par with pre-transplanting condition (Table 2). All organic treatments significantly increased the available P after harvest, the 10 t ha^{-1} FYM with 0.0, 2.5, 5.0 and 7.5 Kg ha^{-1} $ZnSO_4$ significantly increased the amount of available P compared to 5 t ha^{-1} FYM and 5 t ha^{-1} press mud with corresponding doses of $ZnSO_4$ in 2006-07. In 2007-08 the available P in composite sample of pre-transplanting was 15.5 mg Kg^{-1} and at par with control (16.2mg Kg^{-1}). The maximum available P was observed in treatments of 10 t ha^{-1} FYM with 0.0 to 7.5 Kg ha^{-1} $ZnSO_4$ (23.1 to 24.0 mg Kg^{-1}). Similar in case of nitrogen, available phosphorus content also increase as level of FYM increases and maximum increase was observed at the level of FYM 10 t ha^{-1} with 7.5 Kg $ZnSO_4$. Organic residue released organic acids, which solubilize the insoluble soil P, and enhanced the P availability in soil solution (Dotaniya et al., 2014a; Dotaniya, 2013)

Perusal of data on available K in Table 3 revealed that the lowest available K observed in control (93.0 mgkg^{-1}) which was at par with pre-transplanting sample and T_2 where FYM 5 t ha^{-1} was applied without $ZnSO_4$ (T_3). Rest of all treatment significantly increased the available K as compare to Pre-transplanting composite sample. FYM 5t ha^{-1} with all doses of $ZnSO_4$. Further more FYM 10 t ha^{-1} with different doses of $ZnSO_4$ significantly increased the available K over FYM 5 t ha^{-1} and press mud 5t ha^{-1} with different doses of $ZnSO_4$. The available K in 2007-08 in pre-transplanting sample was 97.0 mg Kg^{-1} and was at par with control. But among organic treatments the highest K was observed in different treatments of $ZnSO_4$ with 10 t ha^{-1} FYM followed by 5 t ha^{-1} press mud and 5 t ha^{-1} FYM (Table 3). The per cent of available K observed to increase over control which was also at par with pre-transplanting condition. When we increase the FYM level concentration of K also increase and it was maximum in T_9. Crop residues having significant amount of potassium, it was released due to microbial decomposition during the study and enhanced the available K in soil (Dotaniya et al., 2014b)

DTPA Ext. Zn in 2006-07 was minimum (1.56 mg Kg^{-1}) in control and press mud 5 t ha^{-1} without $ZnSO_4$ treatment (Table 3) while, in pre-transplanting composite sample it was 1.53 mg Kg^{-1}. Zn concentration was significantly increased by application of FYM 10 t ha^{-1}with 2.5, 5.0 and 7.5Kg $ZnSO_4$(1.68, 1.73 and 1.80 mg Kg^{-1}) FYM 5 t ha^{-1} with 2.5, 5.0 and 7.5 Kg $ZnSO_4$ (1.63, 1.66 and 1.71 mg Kg^{-1}) and press mud 5 t ha^{-1} with 5.0 and 7.5 Kg $ZnSO_4$ (1.63 and 1.70 mg Kg^{-1}). But in 2007-08 FYM 10 t ha^{-1} with 0.0, 2.5, 5.0 and 7.5 Kg ha^{-1} $ZnSO_4$. FYM 5 t ha^{-1} with 2.5, 5.0 and 7.5 Kg $ZnSO_4$ and press mud 5 t ha^{-1} with 2.5, 5.0 and 7.5 Kg $ZnSO_4$ significantly increased the DTPA ext. Zn (Table 4). The amount of DTPA ext. Zn in pre-transplanting sample and all other treatment samples were higher in 2007-08 than 2006-07.The minimum concentration of Zn was in control followed by 5 t ha^{-1} press mud without $ZnSO_4$. Concentration of Zn increases as level of $ZnSO_4$ and FYM increase. This is because of $ZnSO_4$ is the direct source of Zn and FYM and press mud works as pool of most of the micronutrients. Sakal *et al*. (1981) reported that $ZnSO_4$ application raised level of available Zn in soils and left substantial amount of Zn for succeeding crop.

CONCLUSION

Use of crop residue for agricultural crop production was an old practice. But during the green revolution inorganic fertilizer consumption high and farmers mostly dependent only on chemical fertilizers, without applying organic manure. The increasing population growth, enhanced the pressure to produce more from limited land. So to overcome the crop yield stagnation and improve the soil health, farmers again applying the organic manure in combination to inorganic fertilizers. it improved the soil physico-chemical properties. In this experiment application of FYM 10t ha^{-1} +7.5 kg $ZnSO_4$ improved the soil OC, available N, P and K in soil compared to rest of the treatments.

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