Original Research Article

Effect of integrated nutrient management on soil physical andphysico-chemical properties of soil

ABSTRACT

The research advancements in the manufacturing of inorganic fertilizers and the need to produce more to meet the food demands of growing population, has lead to the indiscriminate use of inorganic fertilizers in agriculture. The environmental impact & soil productivity constraints caused by the exaggerated usage of inorganic fertilizers has now become a serious concern. Integrated Nutrient Management (INM) is an effective approach in reducing the excessive reliance on inorganic fertilizers and in improving soil properties by substituting a part of inorganic fertilizers dose with organic manures. In this research, the influence of INM on soil physical and physicochemical properties had been evaluated. The field experiment was carried out in India, during *rabi* season of 2020 in a sandy loam soil of the order *Inceptisols*under maize (*Zea mays* L.) variety *Pioneer* - 3396 as the Test crop. Farm Yard Manure (FYM) @ 10 t/ha and Biofertilizers namely *Azospirillum and Phosphorus Solubilizing Bacteria* (*Pseudomonas sp.*) @ 5 kg/ha each were used in conjunction with inorganic fertilizers. The inorganic fertilizers @ 200:60:50 N-P_2O_5-K_2O kg ha^{-1} was followed. as recommended dose. Except control check plot, all treatments are equally provided with P and K fertilizers as per the recommended dose with varying levels of Recommended Dose of Nitrogen (RDN), FYM and biofertilizers. The experiment comprises eight treatments *viz.,* T_1: Control, T_2: 100% RDN, T_3: 125% RDN, T_4: 75% RDN+ 25% FYM, T_5: 75% RDN + 25% FYM + Biofertilizers, T_6: 100% RDN+ 25% FYM, T_7: 100% RDN+ Biofertilizers and T_8: 100% RDN+ 25% FYM + Biofertilizers. There was observed a slight decrease in bulk density and a slight increase in the porosity, Water Holding Capacity (WHC), Organic Carbon (OC), Cation Exchange Capacity (CEC) of the soil in the plots treated with integrated nutrient sources.

Keywords: *Inorganic fertilizers, Organic manures, Soil physical and physicochemical properties, Maize.*

1. INTRODUCTION

Soil physical and physicochemical properties play an important role in determining the productivity of soil and these properties are much dependent on the management practices that we adopt for cultivation. Nutrient management is a crucial factor that determines the soil physicochemical properties as well as soil fertility. The integrated nutrient management (INM) is the art of utilizing the benefits of all possible nutrient sources like organic manures, biofertilizers along with inorganic fertilizers. The organic carbon status of the soil is the most important physicochemical property that also effects the other soil properties. In INM we use manures such as farm yard manure, pig manure, sheep manure etc that improve organic carbon status of the soil which in turn effects soil physical properties such as soil structure, aeration, porosity, infiltration rate and water holding capacity and decrease soil crusting, organic matter in soil improve physical condition of the soil for better performance of micro-organism and physical status of soil which makes cultivation easier and also holds nutrients from leaching and makes them available to plant roots. Whereas the biofertilizers play role in the decomposition process and solubilization of nutrients. By adopting the integrated nutrient management approach, many challenges related to sustainable agriculture can be answered by reducing the negative impacts of long term usage of chemical fertilizes on soil health. Maize being the most versatile crop and rich source of carbohydrates and vitamins, it is a heavy feeder of nutrients from the soil which requires better nutrient management strategy. This paper presents the effect of this integrated strategy of nutrient management practice in maize and it's effect on soil physical and physicochemical properties.

2. MATERIALS AND METHODS

The field research was conducted during the *rabi* season of the year 2020 at Agricultural College Farm, Bapatla, India, situated at an altitude of 5.49 m above mean sea level, 15^{o}54' North latitude, 80^{0}30' East longitude and about 8 km away from the Bay of Bengal. It is located in Krishna agro-climatic zone of Andhra Pradesh.The average maximum and minimum temperatures recorded during the crop growth period were 30.78 ^{0}C and 19.51 ^{0}C, respectively. The weekly mean relative humidity at 8:30 a.m and 17:30 p.m was 84.67, 55.38 per cent respectively. A total rainfall of 3.33 mm was received with one rainy day during the experimentation period. The soil is sandy loam in texture and belongs to the order Inceptisols. Initial soil characteristics (0-15cm) of the experimental soil were enlisted in table-1.

Table:1Initial soil characteristics (0-15cm) of the experimental soil

Particulars	Readings
Physical properties	
I. Mechanical analysis 1. Sand (%) 2. Silt (%) 3. Clay (%) Textural class	 72 % 13 % 15 % Sandy loam
Bulk density (Mg m^{-3})	1.44
Water holding capacity (%)	13.92
Porosity (%)	38
Physico- chemical properties	
pH	7.2
EC (dS m^{-1})	0.25
CEC [Cmol (p+) kg^{-1}]	13.73
Organic carbon (%)	0.21

The experiment consisted of eight treatments which are replicated thrice. The normal recommend dose (RDN) of fertilizer is followed as 200:60:50 N-P_2O_5.K_2O kg ha^{-1} applied through Urea, SSP & MOP respectively. The biofertilizers namely *Azospirillum* + PSB {Phosphorus Solubilizing Bacteria (*Pseudomonas* sp.)} @5 kg ha^{-1} each. The control treatment is devoid of any fertilization and all remaining treatments were commonly supplied with inorganic P and K doses at recommended level whereas the dose of inorganic nitrogen, FYM (farm yard manure), biofertilizers dose is varied among the treatments.

The treatments are as follows ; T_1: Absolute Control, T_2: 100% RDN, T_3: 125% RDN, T_4: 75% RD + 25% FYM, T_5: 75% RDN+ 25% FYM+ Biofertilizers, T_6: 100% RDN+ 25% FYM, T_7: 100% RDN+ Biofertilizers and T_8: 100% RDN + 25% FYM + Biofertilizers. Regarding the analysis of soil physical properties, the texture analysis was carried out by the bouyoucos hydrometer method given by (Bouyoucos, 1962). Bulk density(Mg m^{-3}) was estimated by core method as per the procedure given by (Dastane,1967). Water holding capacity (%) was estimated by the method described by (Sankaram, 1966). Porosity(%) was calculated by using the formula as described by (Black, 1965).The Physicochemical properties of soil namely soil reaction (pH)

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was measured by using a glass electrode pH meter in 1 : 2.5 ratio of soil water suspension (Jackson, 1973). Electrical conductivity (EC) (dSm^{-1}) of soil samples was determined in 1 : 2.5 soil water suspension using electrical conductivity bridge (Jackson, 1973). Organic carbon (%) was estimated by Walkley and Black's method as described by (Piper, 1966).The Cation exchange capacity (CEC) (C mol (P^{+}) kg^{-1}) was measured by the method described by Bower *et al.* (1952).

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3. RESULTS AND DISCUSSION

Table:2 Effect of integrated nutrient management on soil physical properties at harvest stage of maize crop

Treatments	B.D ($Mg\ m^{-3}$)	Porosity (%)	WHC (%)
T_1: Control	1.43	40.56	13.92
T_2: 100% RDN	1.44	40.90	14.02
T_3: 125% RDN	1.44	41.47	14.33
T_4: 75% RDN + 25% FYM	1.42	42.46	16.71
T_5: 75% RDN + 25% FYM + Biofertilizers	1.41	42.78	17.12
T_6: 100% RDN + 25% FYM	1.42	42.53	16.76
T_7: 100% RDN + Biofertilizers	1.42	42.11	14.78
T_8: 100% RDN + 25% FYM +	1.41	42.91	17.14

Biofertilizers			
SEm (±)	0.01	0.79	1.08
CD (P=0.05)	**NS**	**NS**	**NS**
CV (%)	7.31	7.69	12.53

Bulk density (B.D), Water Holding Capacity (WHC), Porosity :-

The data presented in table-2 indicated that bulk density of soil at harvest of the crop was not significantly influenced by the various treatments imposed. However there was observed a ~~marginal reduction in B.D~~ and increase in WHC in the integrated treatments which received FYM as an organic source of fertilization along with 100 and 75 per cent of nitrogen through urea. The treatments 125 % RDN (T_3) and 100 % RDN (T_2) has recorded a ~~slightly higher (1.44) B.D which also~~ has recorded lower WHC. A comparatively lower BD, highest porosity and highest WHC was recorded in treatment 100% RDN + 25% FYM + Biofertilizers (T_8) than all other treatments due to the application of FYM, Biofertilizers (Upadhyay *et al.,* 2016) (Tadesse *et al*., 2013). The non-significant effect on bulk density of soil even after applying organic manures and inorganic fertilizers was also reported by **(**Singh *et al.,* 2015) who revealed that reduction in bulk density is due to higher organic carbon, more pore space and good soil aggregation which was a long term change. Hence the non-significant effect of manures on bulk density, WHC and porosity of the present experiment might be because of the shorter period of study. It has also been well documented by several scientists that a greater quantity of organic material is needed to improve soil structural properties. However an increase in water stable aggregates and soil organic matter with FYM application was reported by (Shahzad *et al.,* 2021) indicating the critical role of O.C in forming aggregates and the aggregate stability which is important for improving soil WHC. Unlike the physicochemical properties of soil, the physical properties of soil are the long term properties that cannot be changed easily.There was noticed a no change in the texture of the soil which was found sandy loam by its nature.

Comment [KV1]: The variation of BD is so small that this cannot be said.

Table:3 Effect of Integrated nutrient management on soil physicochemical properties

Treatments	pH	EC (dSm^{-1})	OC (%)	CEC (C mol (p^+) kg^{-1})
T_1: Control	7.20	0.23	0.21	13.75
T_2: 100% RDN	7.10	0.24	0.22	14.33
T_3: 125% RDN	7.08	0.24	0.22	14.69
T_4: 75% RDN + 25% FYM	6.98	0.26	0.23	16.07
T_5: 75% RDN + 25% FYM + Biofertilizers	6.97	0.27	0.24	16.47
T_6: 100% RDN + 25% FYM	6.98	0.26	0.23	15.39
T_7: 100% RDN + Biofertilizers	7.09	0.25	0.22	15.03
T_8: 100% RDN + 25% FYM + Biofertilizers	6.96	0.27	0.25	17.13
SEm (±)	0.09	0.03	0.01	1.13
CD (P=0.05)	**NS**	**NS**	**0.02**	**NS**
CV (%)	7.09	7.23	7.24	8.26

~~Soil Reaction (pH) :-~~

The data presented in table-3 revealed that there was no significant effect on soil reaction and electrical conductivity by the imposed treatments. Numerically highest pH (7.2) was observed in absolute control treatment and the lowest (6.96) was observed in the treatment which received 100% RDN + 25% FYM + Biofertilizers (T_8).The decrease in pH of INM plots was also confirmed by the findings of (Bhatt *et al.,* 2019 ; Kumar and Thomas, 2017 ; Masood *et al.,* 2014 ; Pandey and Awasthi, 2014). However the pH decreased in all treatments as compared to the initial pH of experimental soil and the decline was more pronounced in the

treatments which received organic and inorganic doses of nutrients in combination. The addition of organic manure results in organic matter oxidation and release of carbon dioxide in the soil. The release of organic acids during decomposition of manure will in turn causes a slight decline in pH. However the effect was not significant because of the short duration of present study.

Electrical Conductivity (EC) :-

Non-significant effect of sole inorganic nitrogen fertilizers or in combination with FYM on electrical conductivity of soil might be due to the balanced fertilization, which might not have allowed significant changes in salt concentration. However a numerically higher EC was recorded in the treatment 100% RDN + 25% FYM + Biofertilizers (T_8) and lower in absolute control treatment. This was in line with the research findings of (Abhimanyu ey al., 2017, Singh *et al.,* 2015) who also reported no significant change and slight increase in electrical conductivity of soil under INM. The total salt concentration is not highly altered also due to the fact that the doses of fertilizers added in different treatments were quite small and salts added through fertilizers might have been leached down due to the good number of irrigations received during the crop growth period.

Cation Exchange Capacity (CEC) :-

The CEC of soils was not significantly influenced by different treatments and it ranged from 13.75 to 17.13 Cmol (p^+) kg^{-1}. The highest CEC was observed in treatment 100% RDN + 25% FYM + Biofertilizers (T_8) which was followed by treatment 75% RDN + 25% FYM + Biofertilizers (T_5) *i.e*16.47 Cmol (p^+) kg^{-1}. The lowest was observed in the control treatment . It was inferred that the CEC of the soil was increased at harvest as compared to that of initial soil and the increase was higher in treatment which received higher levels of organic manure through FYM. Similar influence of integrated nutrient supply systems on CEC was earlier reported by (Pandey and Avasthi, 2014 ; Pareek and Yadav, 2011) . Applied organic manures decompose in soils to form humus and humic substances, which play a dominant role along with clay micelle in the complex soil reactions that enhance the CEC of soils (Adeniyan*et al.*, 2011).

Organic Carbon (OC) :-

The organic carbon content was found significantly influenced by different treatments imposed and it had ranged from 0.21 to 0.25 %. There was a significant difference in organic carbon content with increase in inorganic nitrogen levels from control *i.e* zero to 100 % either by sole or in integrated approach. The slight increase in organic carbon content in all the treatments with integrated use of nutrient sources as compared to control might be due to direct incorporation of organic matter through farmyard manure into the soil and also due to enhancement of root growth which leads to the accumulation of organic residues. These findings are in agreement with that of (Saha*et al.,* 2010) who also reported an improvement in organic carbon status to increased biomass production (Tiwari *et al*., 2017 ; Mustafa *et al.,* 2021).

4. CONCLUSION

It can be concluded that the improvement of soil physical and physicochemical properties can be effectively noticed in a long term practice of INM but due to the short period of study the effect was found insignificant regarding most of the soil properties studied. There was found no

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influence on the soil physical and physicochemical properties~~texture of soil~~, and a significant influence was noticed regarding soil organic carbon content. When compared with sole inorganic and un fertilizer control treatments, the integrated treatments were found beneficial in improving soil physical and physicochemical properties and among all the treatments imposed the integrated treatment T_8: 100% RDF + 25% FYM + Biofertilizers, and T_5: 75% RDN+ 25% FYM + Biofertilizers are the best performed treatments. ~~To sum up, conjunctive use of all different sources of nutrients namely organic manures, biofertilizers along with inorganic fertilizers is a viable option that contribute for a better soil health.~~

Comment [KV3]: You haven't studied soil health to say that.

5. LITERATURE CITED

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