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Vimal Kumar Upadhyay
Research Scholar, M.Sc. Soil Science and Agricultural Chemistry, Department of Soil Science and Agricultural Chemistry, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Amreen Hasan
Assistant Professor, Department of Soil Science and Agricultural Chemistry, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Arun Alfred David
Associate Professor, Department of Soil Science and Agricultural Chemistry, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Tarence Thomas
Professor and Head, Department of Soil Science and Agricultural Chemistry, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Anurag Kumar Singh
Research Scholar, Ph.D. Soil Science and Agricultural Chemistry, Department of Soil Science and Agricultural Chemistry, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Corresponding Author:
Vimal Kumar Upadhyay
Research Scholar, M.Sc. Soil Science and Agricultural Chemistry, Department of Soil Science and Agricultural Chemistry, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Effect of integrated nutrient management on Physico-chemical properties of soil in soybean (*Glycine max* L.) *var*. PK-1029

Vimal Kumar Upadhyay, Amreen Hasan, Arun Alfred David, Tarence Thomas and Anurag Kumar Singh

Abstract
Research trial was carried out at Department of Soil Science and Agriculture Chemistry Research Farm SHUATS, Prayagraj during *kharif* season of 2021-2022 entitled "Effect of Integrated Nutrient Management on Physico-Chemical Properties of Soil in Soybean (*Glycine max L.*) var. PK-1029. The experiment was laid down in randomized block design comprised three levels of FYM [0, 50 and 100 kg ha^{-1}] and three level of Sheep manure [0, 50 and 100 kg ha^{-1}].The 9 treatment combination of FYM and SM (Control, RDF + S + 0% FYM + 50% SM, RDF + S + 0%FYM +100% SM, RDF + S + 50% FYM + 0% SM, RDF + S + 50% FYM+ 50% SM, RDF + S + 50% FYM+100% SM, RDF + S + 100% FYM+ 0% SM, RDF + S + 100% FYM+50% SM, RDF + S + 100% FYM+100% SM). Significantly Soil parameters, the treatment T_9 (RDF+S+100%FYM +100%Sheep manure) was best treatment combination with respect to BD, PD, pore space, water holding capacity, pH, EC, Organic carbon, available N, P, K and S in soil.

Keywords: FYM- Farm Yard Manure, RDF- Recommended dose of fertilizer, SM-Sheep Manure N-Nitrogen, P-phosphorous, K- potassium, S- Sulphur, EC- Electrical conductivity

Introduction

Soybean (*Glycine max* L. Merrill) is an important oil seed and protein crop in the world. It is a chief source of unsaturated fatty acids, protein, minerals such as Calcium and phosphorus apart from A, B and D vitamins that meet different nutritional needs. Its seed contains about 40-45% protein, 18-20% edible oil and 20-26% carbohydrate. It is one of the important oilseed crops of India. It is the third largest oilseed crop of India after rapeseed mustard and groundnut and ranks first in edible oil in world. It is a good source of flavones, therefore it helps in preventing heart disease, cancer and HIV's. Nowadays, the inorganic fertilizers are producing very hazardous effects on soil properties and sometimes enter in food chain and are injurious to human being. Therefore, it is essential to utilize various sources of nutrients in order to increase the production of crop by maintaining soil fertility (Verma *et al*., 2017) [24]. India ranks fifth in area and production of soybean in the world. Its Production 2020-2021 will be 361.00 million metric tons, around 1.05 million tons less than previous month's projection. Soybean Production last year was 336.47 million tons. This year's 361.00 estimated million tons could represent an increase of 24.53 million tons or 7.29% in soybean production around the globe. India harvested 12.9 million tons of soybean in 2020-21, according to ministry of agriculture. According to India's ministry of agriculture, planted area under soybean was at 12.2 million hectares in 2021-22, slightly higher than 12.1 million hectares in 2020-21 (USDA 2021). Inspite of its high yielding potential, soybean productivity is much less in India. Among the factors responsible for low productivity, inadequate fertilizer use and emergence of multiple-nutrient deficiencies due to poor recycling of organic resources and unbalanced use of fertilizers are important Soybean is an rich energy crop and hence the requirement of major nutrients including secondary and micronutrients is high (Aziz *et al*., 2015) [4].

Soybean [*Glycine max* (L.) Merrill] has become the premier oilseed crop in India by producing 14.7 mt from 10.5 m ha area. Soybean is mainly grown in central part of the country, Madhya Pradesh, Maharashtra and Rajasthan contributing about 95% of the production. Soybeans are looked upon not merely as a means to supply food for humans and animals, but also at the same time to serve as a means for improving the soil through their ability to fix atmospheric nitrogen. It has capacity to fix 49-450 kg atmospheric N/ha (Wani *et al*., 1995) [28]. Efficient management of organic and inorganic sources is a prerequisite. For achieving continuous production of crops in an economically and ecologically sustainable manner. Organic matter forms a very important source of plant nutrients whereas organic manures are used to supply both macro and micro nutrients and sustain amount of humic substances particularly humic and fulvic acid that helps to maintain soil pH. Thus, for maintenance of the soil fertility, productivity and soil health with the FYM, compost and biofertilizers cannot replace chemical fertilizers but certainly are capable of reducing their input. Seed inoculation with effective. Rhizobium inoculant is recommended to ensure additional nodulation and N_2 fixation for maximum growth and yield of pulse crop.

Vegetable soybean (edamame) [*Glycine max* (L.) is a low input, short crop cycle and soil-enriching profitable crop. It offers quick economic return and provides health benefits to the consumers. The market demand for edamame has begun to flourish and expand dramatically in recent decades due to increase awareness of nutritional properties and the change in life styles towards healthier food. Then the consumption of edamame can also really contribute to reducing deficiencies in children and eve adults, through its great nutritional content and good health benefits (Darini *et al*., 2020) [10]. Soybean, which is a hardly crop has the ability to grow well even in marginal soils. It is grown on wide range of soils varying in texture and soil fertility. The soil texture varies from sandy to clay. (Hellal *et al*., 2013) [29]. Integrated nutrient management practices applied for soybean contributes to the sustainable growth of yield and quality, influences soil health and reduces environmental risks. The use of organic manures with an optimum rate of fertilizers under intensive farming system increased the turnover of nutrients in the soil-plant system. The organic manures along with biofertilizers help in reducing the dose of inorganic fertilizer; which in turn reduces the cost of cultivation and help in improving the soil health (Farhad *et al*., 2017) [30]. Sheep Manure and Farm-Yard Manure like other animal manure is a Natural slow-release fertilizer. Nutrients in sheep Manure fertilizer provide adequate nourishment for a field. It is a high in both Phosphorous and Potassium, essential element for Optimal Plant growth. These nutrients help plant to establish strong root defend against pest grow into vibrant and productive plants. The average nutrient content of farm yard manure is 0.5% N, 0.2% P_2O_5 and 0.5%K_2O in the sheep manure the average nutrient content is 3% N 1%P_2O_5 and 2% K_2O found approximately.

Nitrogen is a major essential plant nutrient element. It has the quickest and most pronounced effect on plant growth and yield of crops. Plants receiving insufficient Nitrogen are stunted in growth with restricted root systems. The leaves turn yellow or yellowish green and tend to drop off. N demand for seed may be determined by the product of three factors: seed number, the rate of N filling in individual seeds, and the length of the reproductive period. N fertilization may not stimulate the rate of N filling in individual seeds when sink activities are limited. Soybean plants obtain Nitrogen from three sources; 1. Nitrogen derived from biological N_2 fixation by root nodule; 2. Soybean's requirement for nitrogen can be fulfilled by soil nitrogen, high levels of nitrogen in soil inhibit symbiotic N_2 fixation and under there condition, soil provides the majority of the plants needs for nitrogen. Conversely, N_2-fixation supplied the majority of the plant's requirements for Nitrogen under conditions of low level of nitrogen in soil, and 3. Nitrogen from applied fertilizer. For optimum soybean yield, it is necessary to use both biological N_2-fixation and absorption of Nitrogen uptake by soybean roots. Application of FYM increased the activity of acid and alkaline phosphatase, phosphodiesterase, inorganic pyrophosphatase and dehydrogenase leading to faster hydrolysis of easter-bond P to plant available P (Dinesh *et al*., 2003) [31].

Materials and Methods

The field experiment was conducted at Research Farm of Soil Science and Agricultural Chemistry at Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj. The experiment comprised two fertility level of (control, 100% RDF), three level of FYM [control, 50 and 100 kg ha^{-1}] and also three level of Sheep manure [control, 50 and 100 kg ha^{-1}]. One of the treatment combinations comprised the recommended doses of 20 kg N, 60 kg P_2O_5 and 60 kg K_2O per hectare. Recommended dose of P_2O_5 (60 kg ha^{-1}) in form DAP (Di-ammonium Phosphate) and K_2O (60 kg ha^{-1}) in form of MOP (Muriate of Potash) was applied at the time of sowing. FYM and Sheep manure were applied as split as per the treatments.

The area of Prayagraj district comes under subtropical belt in the South east of Uttar Pradesh, which experience extremely hot summer and cold winter. The maximum temperature of the location reaches up to 46 °C-48 °C and seldom falls as low as 4 °C-5 °C. The relative humidity ranged between 20 to 94%. The average rainfall in this area is around 1100 mm annually. Treatments and Design of Experiments: The experiment was conducted using a randomized block design (RBD). The experimental area was divided into twenty-seven plots with the plot size was 2m x 2m. All nine treatments were replicated three times starting from T_1 Control (Absolute Control), T_2 (RDF + S + 0% FYM + 50% Sheep manure), T_3 (RDF + S + 0% FYM + 100% Sheep manure), T_4 (RDF + S + 50% FYM + 0% Sheep manure), T_5 (RDF+S+50%FYM+50% Sheep manure), T_6 (RDF + S + 50% FYM + 100% Sheep manure), T_7 (RDF + S + 100% FYM + 0% Sheep manure), T_8 (RDF + S + 100% FYM + 50% Sheep manure), T_9 (RDF + S + 100% FYM + 100% Sheep manure). In the pre analysis of soil the textural class was found sandy loam by Bouyoucous (1927) [32], soil colour was found pale brown by Munsell (1971), BD (1.23 Mg m^{-3}), PD (2.37 Mg m^{-3}), Pore space (47.53%) and Water Retaining Capacity (41.62%) was determined by Graduated Measuring Cylinder and soil texture by hydrometer. In chemical properties, pH (7.58) was determined by potentiometric method by making soil water suspensions where as a digital EC metre was used to determine the EC (0.177 dS m^{-1}). The wet-oxidation method was used to evaluate Organic Carbon (0.45%) (Black, 1965) [25]. The alkaline permanganate method was used to assess available Nitrogen (238.21 kg ha^{-1}) in an 800 ml kjeldahl flask (Subbiah and Asija 1956) [33]. The amount of available Phosphorus (20.73 kg ha^{-1}) was calculated using a colorimetric technique and a spectrophotometer (Olsen *et al.,* 1954) [20]. The amount of available Potassium (127.5 kg ha^{-1}) and neutral ammonium acetate solutions (Toth and Prince 1949) [23]. The data was statistically analysed as per the procedure given by Aziz *et al.*, 2015 [4].

Results and Discussion

Bulk density (Mg m^{-3})

As depicted in table 1 the maximum soil bulk density (Mgm^{-3}) at was recorded 1.198 Mg m^{-3}in T_1 and 1.204 Mg m^{-3}in T_7, T_5 respectively, the minimum was recorded in T_9 1.185 Mgm^{-3}and in T_6 1.185 Mg m^{-3} in T_9 respectively and found to be non- significant. It might due to use of INM that increased biomass of plant that biomass increase the organic carbon resulted in more pore space and good soil aggregation. Similar results were also reported by (Paliwal and Golani. 2021) [21].

Particle density (Mg m^{-3})

As depicted in table 1 the maximum soil particle density (Mgm^{-3}) at 0-15 cm were recorded 2.208 Mg m^{-3}in T_2, the minimum was recorded in T_1 2.186 Mg m^{-3} and 2.019 Mg m^{-3} in T_9 respectively and found to be non-significant. INM fertilizer impact on particle density at 0-15 cm soil depth. Due to FYM and Sheep manure pore space will be increased and impact on particle density at 0-15 cm depth positively means lowest particle density observed in T_1. This may be due to higher organic carbon concentration in soil which is an important component of soil solids. Similar results were also reported by (Paliwal and Golani (2021) [21].

Pore space (%)

As depicted in table 1 the maximum soil pore space (%) at 0-15 cm were recorded 46.41% in T_9, the minimum was recorded in T_5 45.38% and 44.22% in T_4 respectively and found to be Significant. It's indicated that when dose of INM fertilizer increases pore space also increased in 0-15 cm soil depth but when depth increases pore space decreased means at 15-30 cm, and leguminous crop is also nitrogen fixation crop, its clearly show that INM changed non-significant on pore space. Similar results were also reported by (Paliwal and Golani (2021) [21].

Water holding capacity

As depicted in table 1 the maximum soil water holding% at 0-15 cm were recorded 46.910% in T_9, the minimum was recorded in T_4 41.25% and 39.21% in T_1 respectively and found to be significant. Due to use of INM fertilizer influence biomass production and these biomass soil organic carbon into soil that organic carbon increased the water holding capacity positively. Similar results were also reported by Hanoon *et al.*, (2020) [15].

Soil pH

As depicted in table1 the maximum soil pH at 0-15 cm were recorded 7.70 in T_1 the minimum were recorded in T_7 7.10 and found to be non-significant. Application of INM fertilizer not significantly influence that the soil pH at 0-15 cm and 15-30 cm soil depth. Due to use of INM soil is not able to be attributed to the acid producing nature and release of organic acids during mineralization of FYM and Sheep manure helps to decrease soil pH. Similar results were also reported by Mamatha *et al*. (2018) [19]

EC (dS m^{-1})

As depicted in table1 the maximum soil electrical conductivity (dS m^{-1}) was recorded 0.201 in T_9 and 0.216, the minimum was recorded in T_1 0.172 and 0.189 in T_7 respectively and found to be non-significant. The EC value of soil was comparatively high in 100%NPK +FYM treated plots which might be due to the higher organic colloids in these plots the increase in EC with addition of FYM can attributed to increase in root biomass and crop residue production and then incorporation in soil. The decrease EC might be due to the release of different organic acid during the decomposition process which solubilized the salt and that leached down trough irrigation. Similar results were also reported by Meena *et al.*, (2017) [19].

Organic carbon (%)

As depicted in table 1 the maximum soil percentage organic carbon was recorded 0.469% in T_9, the minimum was recorded in T_1 0.460% and found to be significant. It might due to INM fertilizer effect is further enhanced that improved the root and shoot growth. Higher production of root biomass might have increased the organic carbon content. Similar findings were recorded by Wang *et al.*, (2020) [20].

Available Nitrogen (kg ha^{-1})

As depicted in table 1 the maximum soil available Nitrogen (kg ha^{-1}) were recorded 297.39 (kg ha^{-1}) in T_9, the minimum was recorded in T_1 280.75 (kg ha^{-1}) and found to be significant. The lower content in untreated plots is a result of mining of available nitrogen with INM fertilizer over a period of time might have helped in the mineralization of soil nitrogen leading to build up of higher available nitrogen leguminous family crop are also nitrogen fixation crop. Similar findings were also recorded by Biswash *et al.*, (2014)[34].

Available Phosphorus (kg ha^{-1})

As depicted in table 1 the maximum soil available Phosphorus (kg ha^{-1}) were recorded 35.37 (kg ha^{-1}) in T_9 and 30.73 (kg ha^{-1}) in T_2 respectively, the minimum was recorded in T_1 24.50 (kg ha^{-1}) and 18.92 (kg ha^{-1}) in T_4 respectively and found to be significant. Buildup of Available Phosphorous fertilizer with the application of INM might be due to during decomposition which is turn helped in releasing Phosphorous action of native nitrogen in the Soil, this helps in the release of Phosphorous. Similar findings were also recorded by Amrita *et al.*, (2017).

Available Potassium (kg ha^{-1})

As depicted in table 1 the maximum soil available Potassium (kg ha^{-1}) were recorded 226.23 (kg ha^{-1}) in T_9, the minimum was recorded in T_1 218.52 (kg ha^{-1}) and found to be significant. Similar trend was recorded in both soil depth. Increase in available potassium due to addition of may be ascribed to the reduction of potassium fixation and release of potassium due to interaction of INM fertilizer with clay, besides the direct potassium addition to the pool of soil such increase in the content of available potassium with the use of INM fertilizer has also been reported by Ali *et al.*, (2021) [35].

Available Sulphur (mg kg^{-1})

As perusal of table 1 the maximum soil available sulphur (mg kg^{-1}) was recorded 14.90 (mg kg^{-1}) in T_3 and 13.40 ((mg kg^{-1}) in T_9 respectively, the minimum was recorded in T_1 11.73 (mg kg^{-1}) and found to be significant. Sulphur applied treatment were superior in available macro and micro nutrient content in soil sulphur significantly influenced the microbial properties. Similar findings were also recorded by Biswas *et al.*, (2014) [7] and Amrita *et al.*, (2017).

Table 1: Effect of different levels of FYM and Sheep manure on soil propertie

Treatment	BD (Mg m^{-3})	PD (Mg m^{-3})	WHC (%)	PS (%)	pH (w/v)	EC (dS m^{-1})	OC (%)	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})	S (kg ha^{-1})
T_1	1.198	2.186	41.62	46.27	7.70	0.172	0.460	280.75	15.41	139.82	11.73
T_2	1.188	2.208	41.38	46.31	7.63	0.180	0.461	283.25	18.33	140.31	14.25
T_3	1.186	2.194	42.13	46.28	7.61	0.193	0.461	286.38	20.42	143.42	14.90
T_4	1.189	2.204	41.25	46.33	7.45	0.176	0.463	289.36	15.04	145.51	13.28
T_5	1.187	2.202	41.92	45.38	7.38	0.180	0.464	287.14	19.98	149.62	13.45
T_6	1.185	2.202	41.57	46.39	7.26	0.198	0.466	285.96	21.64	153.26	12.81
T_7	1.187	2.200	41.87	46.37	7.10	0.185	0.467	291.97	20.05	156.31	13.75
T_8	1.186	2.199	42.19	46.40	7.20	0.195	0.468	293.08	21.95	157.42	13.11
T_9	1.185	2.202	46.91	46.41	7.43	0.201	0.469	297.39	22.07	158.62	14.25
S.Em (±)	0.188	0.020	0.04	1.38	0.04	0.05	0.004	5.65	0.51	2.39	0.35
C.D.	NS	0.059	3.11	2.94	NS	0.01	0.011	16.93	1.54	7.16	1.10

Note: BD- Bulk Density, PD- Particle Density, WHC- Water Holding Capacity, PS- Pore Space, EC- Electrical Conductivity, OC- Organic Carbon, N-Nitrogen, P- Phosphorus, K- Potassium

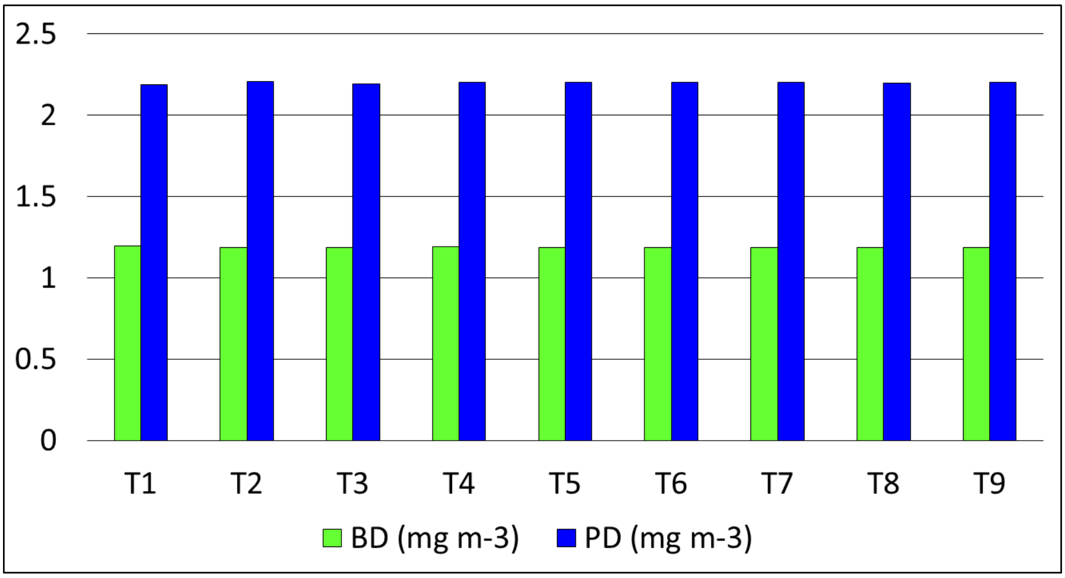

Fig 1: Bulk density and particle density on different level of FYM and Sheep manure

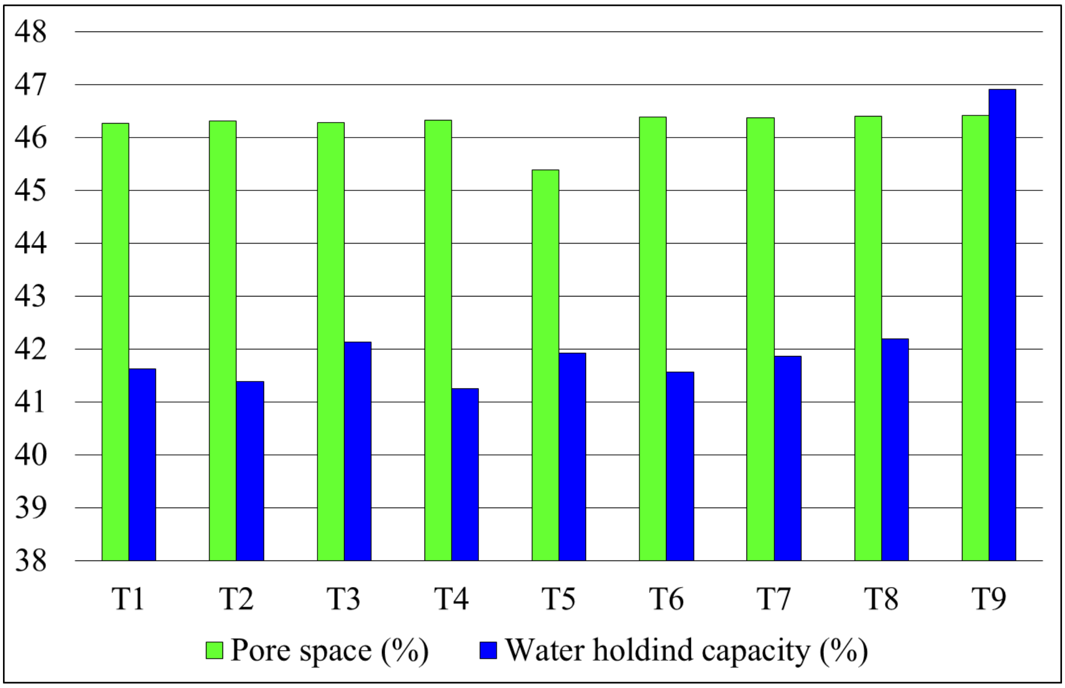

Fig 2: Pore space and Water holding capacity on different level of FYM and Sheep manure

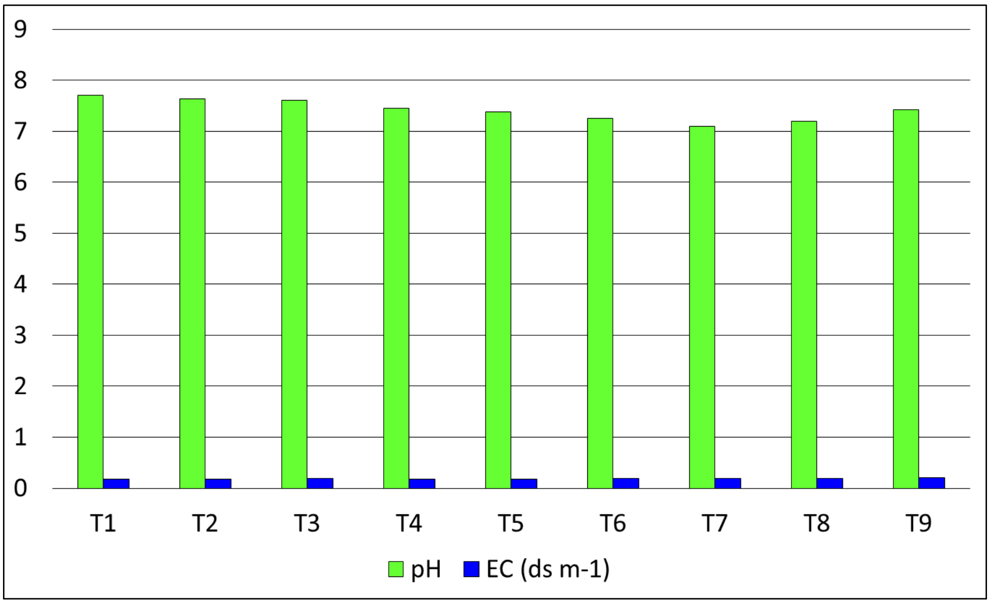

Fig 3: Soil pH and EC on different level of FYM and sheep manure

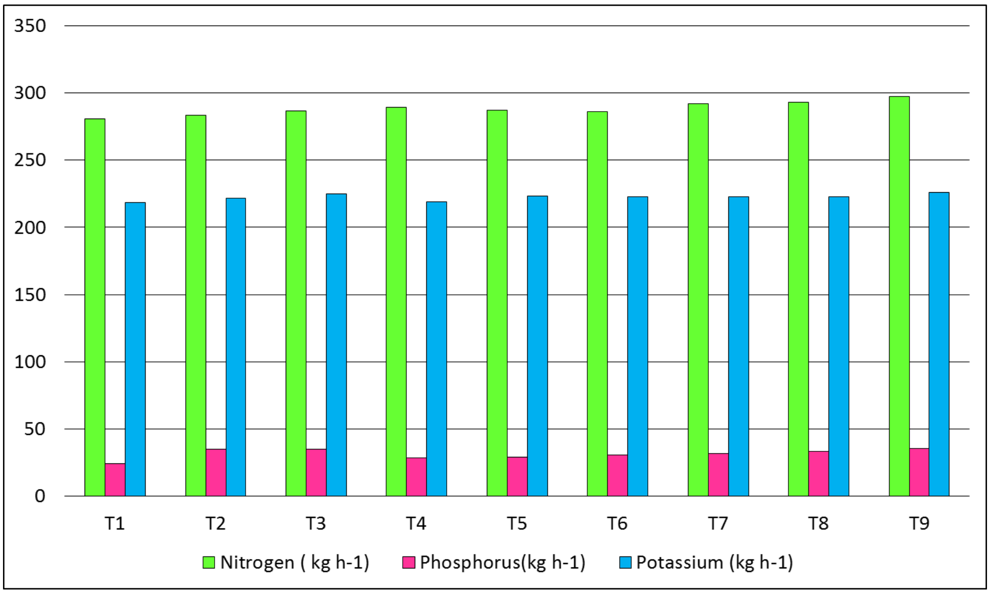

Fig 4: NPK on different level of FYM and Sheep manure

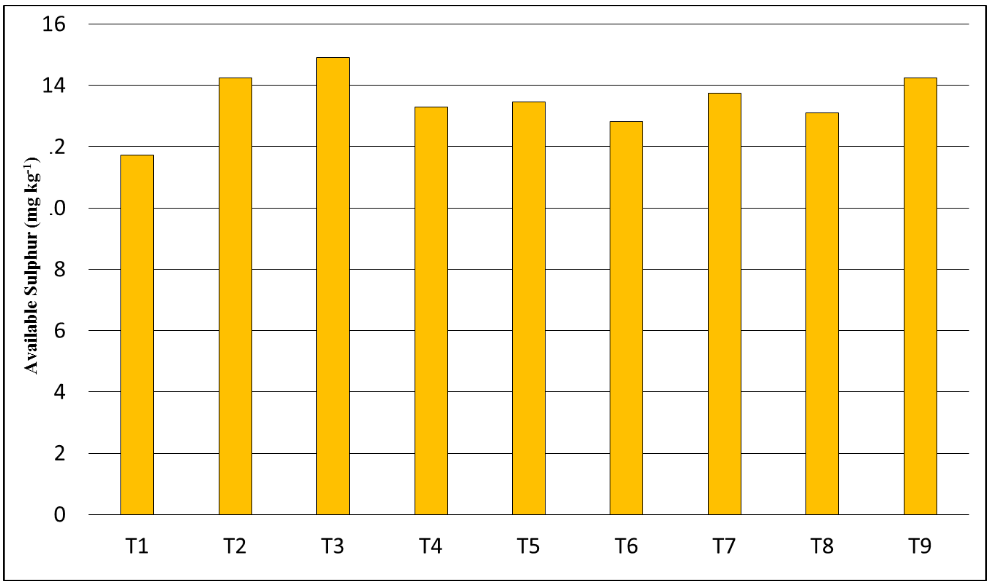

Fig 5: Available sulphur on different level of FYM and Sheep manure

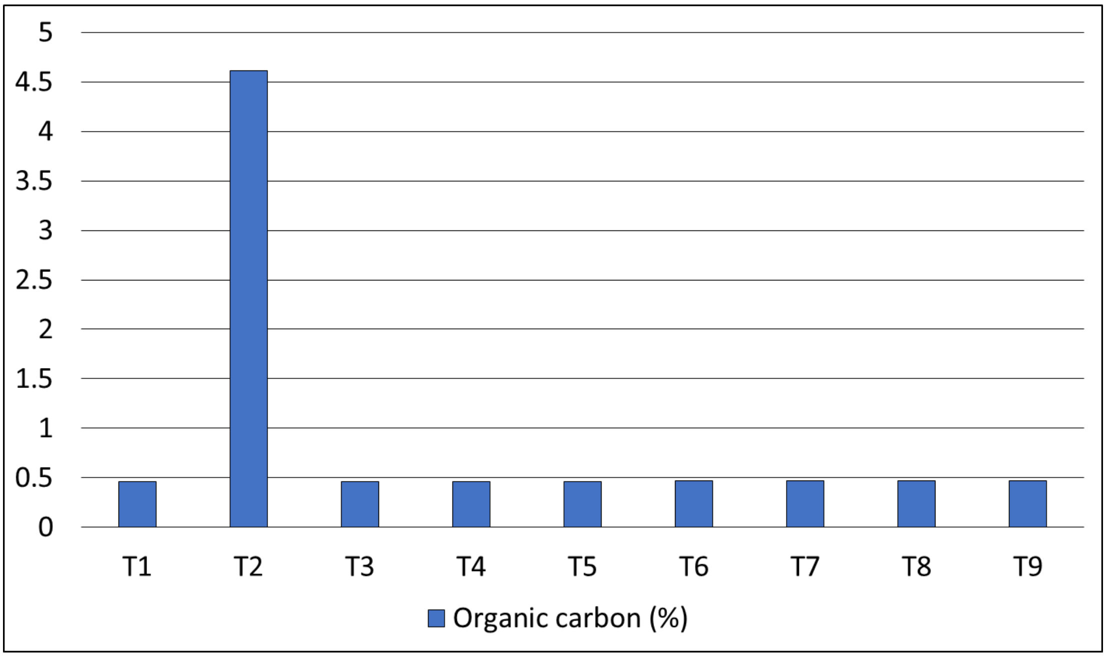

Fig 6: Organic Carbon on different level of FYM and Sheep manure

Conclusion

It is concluded from the trial that the improve soil health, increase the crop production, increase vegetative growth. The treatment T_9 [RDF + S + 100%FYM + 100% Sheep manure] was best treatment combinations with respect to Bulk density, particle density, pore space, water holding capacity, pH, EC, Organic Carbon, available N, P, K on soil. Integrated nutrient management seems to be viable option rather than chemical fertilizer alone for maintenance of soil productivity and fertility. It plays an essential role in plant growth.

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References

1. Abebe A, Mekonnen Z. Common Bean (*Phaseolus Vulgaris* L.) Varieties Response to Rates of Blended N, P, K, S, B Fertilizer at Arba Minch, Southern Ethiopia. Adv. Crop Sci. Tech. 2019;7:429.
2. Ali ZA, Hassan DF, Mohammed RJ. Effect of irrigation level and nitrogen fertilizer on water consumption and faba bean growth. Earth and Environmental Science. 2021, 722(1).
3. Ates AM, Hubbs T, Ash M. Oil Crops Outlook. U.S. Department of Agriculture, Economic Research Service. 2021.
4. Aziz MA, Ali T, Mushtaq ST, Sherazmadhi Islam T, Mir SA, Raj AP. Integrated nutrient management of Soybean (*Glycine max* L.) under temperate condition of Kashmir valley, Elixir International Journal Agriculture. 2015, 78.
5. Basal O, Szabo A. Physio morphology of Soybean as Affected by Drought Stress and Nitrogen Application. Hindawi Scientifica. 2020.
6. Begum MA, Islam MA, Ahamad QM, Rahman MM. Effect of nitrogen and phoshorus on the growth and yield performance of soybean. Res. Agric. Livest. Fish. 2015;2(1):35-42.
7. Biswas B, Gresshoff PM. The role of symbiotic nitrogen fixation in sustainable production of biofuels. International Journal of molecular sciences. 2014;15(5):7380-7397.
8. Chattha MU, Hassan MU, Khan I, Chattha MB, Ashraf I, Ishque W. Effect of Different Nitrogen and Phosphorus Fertilizer Levels in Combination with Nitrogen and Phosphorus Solubilizing Inoculants on the Growth and Yield of Mung bean. Pak. J life soc. Sci. 2017;15(1):31-36.
9. Dar JS, Pushpa Rehmani, MIA, Abbassi ZA, Magsi AG. Effect of starter nitrogen on yield and yield components of chickpea (*Cicer arietinum* L.) at Dokri, Larkana. Pure and Applied Biology. 2016;5(4):1296-1303.
10. Darini Maria Theresia, Sri Widata, Wahyu Setya Ratri. Response of vegetable soybean (*Glycine max* L. Merr.) plant by application of integrated fertilizers in volcanic soil. Asian Journal of plant science. 2020;19:246-251.
11. Dwivedi BS. Nurtient uptake and yield enhancement of soybean by integrated application of farm yad manure and NPK. International journal of current microbiology and applied science 2018, 7.
12. Gai Z, Zhang J, Li C. Effects of starter nitrogen fertilizer on soybean root activity, leaf photosynthesis and grain yield, PLOS ONE. 2017, 12(4).
13. Gelfand I, Robertson GP. A reassessment of the contribution of soybean biological nitrogen fixation to reactive N in the environment. Biogeochemistry. 2015;123:175-184.
14. Ghodke Pallavi Dipak, Madane Ananda Jagannath, takankhar VJ. Effect of integrated nutrient management on growth and yield of soybean. International journal of chemical studies. 2018, 12-15.
15. Hanoon MB, Haran MS, Sahi MK. Effect of Rhizobium inoculation and different levels of organic and nitrogen fertilizers on growth and production of broad bean (*Vicia faba* L.) and nitrogen readiness in soil. Int. J Agricult. Stat. Sci, 2020;16(1):229-236.
16. Jackson ML. Soil chemical analysis, second edition

Indian reprint, prentice hall of India. New Delhi. 1958, 498.

17. Konthoujam NDS, Tensubam B, Athokpam HS, Naorem B, and Samurailatpam D. Influence of inorganic biological and organic manures on nodulation and yield of soybean and soil properties. Australian journal of crop science, 2013, 1407-1415.
18. Meena SC, Singh DP, Meena SR. Effect of Long-Term Application of Fertilizer and Manure on Establish Relationship between Soil Organic Carbon Fractions with Yield of Maize and Wheat Crops under Maize-Wheat Sequence in Heplustepts. In International Journal of Current Microbiology and Applied Sciences. 2017;6(9):600-606.
19. Mamatha N, Chandra SK, Padmaja G, Malla RM. Influence of nitrogen and sulphur application on yield and quality of soybean (*Glycine max* L.). Int. J Curr. Microbiol. App. Sci. 2018;7(12): 3452-3457.
20. Olsen SR, Cole CV, Watnahe FS, Dean LA. Estimation of available phosphorus in soils by extraction with sodium bicarbonate.US Deptt. Agri, Circ. 1954, 939.
21. Paliwal K, Golani M. Integrated Nutrient Control for Enhancing Growth and Yield Properties, Monetary Performance and Soil Health in Soybean (Glycine Max) Cropping System. 2021, 10.
22. Singh N, Kushwaha HS, Singh A. Integrated Nutrient Management on Growth, Yield, Nutrient Uptake and Fertility Balance in Soybean (*Glycine max* L.). Wheat (*Triticum aestivum* L.) Cropping Sequence. International Journal of Bio-resource and Stress Management. 2020;11(4):405-413.
23. Toth SJ, Prince AL. Estimation of cation exchange capacity and exchangeable Ca, K and Na content of soil by flame photometer technique. Soil Sci. 1949;67:439-445.
24. Verma SN, Sharma M, Verma A. Effect of integrated nutrient management on growth, quality and yield of soybean. Annals of plant and soil research. 2017;19:372-376.
25. Walkley A, Black IA. Estimation of soil organic carbon by the chromic acid titration method. Soil Science. 1934;47:29-38.
26. Wang H, Gu C, Liu X, Yang C Li, Wang S. Impact of soybean nodulation phenotypes and nitrogen fertilizer levels on the rhizosphere bacterial community. Frontiers in microbiology. 2020;11:750.
27. Wilcox LV. Electrical conductivity Am. water works Assoc. 1950;42:775-776.
28. Wani SP, Rupela OP, Lee KK. Sustainable agriculture in the semi-arid tropics through biological nitrogen fixation in grain legumes. Management of biological nitrogen fixation for the development of more productive and sustainable agricultural systems. Springer, Dordrecht, 1995. p. 29-49.
29. Hellal FA, Abdelhamid MT. Nutrient management practices for enhancing soybean (*Glycine max* L.) production. Acta Biológica Colombiana. 2013 Aug;18(2):239-50.
30. Farhad H, Seidelmann SB, Vigneault D, Abbasi SA, Yang E, Day SM, *et al*. Left Atrial structure and function in hypertrophic cardiomyopathy sarcomere mutation carriers with and without left ventricular hypertrophy. Journal of Cardiovascular Magnetic Resonance. 2017 Dec;19(1):1-0.
31. Dinesh-Kumar SP, Anandalakshmi R, Marathe R, Schiff M, Liu Y. Virus-induced gene silencing. InPlant Functional Genomics. 2003. p. 287-293. Humana Press.
32. Bouyoucos GJ. The hydrometer as a new method for the mechanical analysis of soils. Soil science. 1927 May 1;23(5):343-54.
33. Subbiah BV, Asija GL. A rapid method for the estimation of nitrogen in soil. Current Science. 1956;26:259-60.
34. Biswash MR, Rahman MW, Haque MM, Sharmin M, Barua R. Effect of potassium and vermicompost on the growth, yield and nutrient contents of mungbean (BARI Mung 5). Open Science Journal of Bioscience and Bioengineering. 2014;1(3):33-9.
35. Ali SS, Elsamahy T, Koutra E, Kornaros M, El-Sheekh M, Abdelkarim EA, *et al*. Degradation of conventional plastic wastes in the environment: A review on current status of knowledge and future perspectives of disposal. Science of the Total Environment. 2021 Jun 1;771:144719.