International Journal of Plant & Soil Science

21(2): 1-7, 2018; Article no.IJPSS.38648
ISSN: 2320-7035

Effect of Phospho Compost and Nitrophospho-Sulpho Compost on Soil Chemical and Biological Properties under Soybean in Vertisols

Ashay D Souza[1*], P. W. Deshmukh[1], S. M. Bhoyar[1] and R. Rakesh[1]

[1]*Department of Soil Science and Agricultural Chemistry, Post Graduate Institute, Dr. PDKV, Akola, Maharashtra, India.*

Authors' contributions

This work was carried out in collaboration between all authors. Author ADS designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors PWD and SMB managed the analyses of the study. Author RR managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2018/38648
Editor(s):
(1) Olowoake Adebayo. Abayomi, Department of Crop Production, Kwara State University, Malete, Nigeria.
Reviewers:
(1) Bharat Prakash Meena, ICAR-Indian Institute of Soil Science, India.
(2) Ade Onanuga, Canada.
Complete Peer review History: http://www.sciencedomain.org/review-history/22975

Original Research Article

Received 4th November 2017
Accepted 25th January 2018
Published 1st February 2018

ABSTRACT

The present investigation entitled "Effect of Phospho compost and Nitrophospho-Sulpho compost on soil chemical and biological properties under soybean in Vertisols" was conducted at Research farm, Dr. PDKV, Akola during Kharif 2016. The experiment was laid in Randomised Complete Block Design with eight treatments and three replications. The treatments used were control,100% Recommended Dose of fertilizers (RDF) [30:75:30 NPK/ha] in form of Diammonium Phosphate and Muriate of Potash, 50% P through Phospho Compost +Remaining RDF through mineral Fertilizers, 25% P through Phospho Compost +Remaining RDF through mineral fertilizers, 50% P through Nitro PhosphoSulpho compost +Remaining RDF through mineral Fertilizers, 25% P through Nitro PhosphoSulpho compost +Remaining RDF through mineral Fertilizers,100% P through Phospho Compost, 100% P through Nitro PhosphoSulpho compost. An organic source like Phospho compost and Nitrophospho- Sulpho compost were applied. The result revealed available nutrient status of Nitrogen (253.60 Kg ha^{-1}) Sulphur (15.73 mg Kg^{-1}) were recorded the highest values significantly under 100% application of P through Nitrophospho-Sulpho compost, numerically higher

**Corresponding author: E-mail: ashaydsouza@gmail.com;*

available P (21.77 Kg ha^{-1}) with 25% P through Nitrophospho-Sulpho compost + remaining RDF through mineral fertilizers and available K (407.29 Kg ha^{-1}) was recorded with 100% RDF. In case of biological properties Soil Microbial Biomass Carbon (227.85 and 230.60 mg Kg^{-1}), Soil Microbial Biomass Nitrogen (43.90 and 47.20 mg kg^{-1}) at flowering and pod formation stage of soybean 100% P through NPS recorded highest values respectively. Hence, the combination of organics and inorganics showed better soil available nutrients and biological properties.

Keywords: Nitrophospho-sulpho compost; phosphocompost; soil microbial biomass carbon; soil microbial biomass nitrogen; vertisols.

1. INTRODUCTION

The soil is home to a large proportion of the world's biodiversity. The links between soil organisms and soil functions are observed to be incredibly complex. The interconnectedness and complexity of the soil 'food web' mean any appraisal of soil function must necessarily take into account interactions with the living communities that exist within the soil. The soil organisms break down organic matter, making nutrients available for uptake by plants and other organisms. The nutrient stored in bodies of soil organisms prevent nutrient loss by leaching microbial exudates which acts to maintain the physical soil conditions [1].

Soybean is one of the vital crop in the world cultivated over an area of 71.85 million hectares with a production of 154.32 million tons. In India, Soybean is grown over an area of 6 million tons. All India estimated production for Kharif 2016 was 118 Lakh Million tonnes compared to 104.36 Lakh Million tonnes in 2015 [2]. Soybean builds up the soil fertility by fixing a significant amount of atmospheric nitrogen through the root nodule and also through leaf fall on the ground at maturity.

A phospho-compost application is essential concerning soil fertility and plant nutrition and also for increasing biological activity in soil. Because enzyme produced by microorganisms are directly responsible for reducing the activation energy necessary to break down the bonds of different organic materials. The phosphorous applied in the form of phospho-compost, as compared to rock phosphate and super phosphate increases microbial activity. The probable chelating effect from phospho-composting increased the phosphorous use efficiency and resulted in higher relative agronomic efficiency in phospho-compost [3].

Increase in an application of phosphorus and sulphur in the soil increases the availability of phosphorus and sulphur from native as well as applied sources and have both synergistic and antagonistic relationship [3].

Enzymes are the direct mediators for biological catabolism of soil organic and mineral components. Thus, these catalysts provide a meaningful assessment of reaction rates for essential soil processes. Soil enzyme activity is often closely related to soil organic matter, soil physical properties and microbial activity. Changes much sooner than other parameters, thus providing an early indication of soil health. Also, soil enzyme activities can be used as a measure of microbial activity, soil productivity and inhibiting effects of pollutants [4].

2. MATERIALS AND METHODS

The present investigation was undertaken at Research Farm of Department of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during Kharif season of 2016-17. The experimental soil was developed on basaltic platue on plain land and classified under Vertisols.

The nitrogen, phosphorus, potassium applied in the form of Urea, Diammonium phosphate, Muriate of potash respectively and also in combination with organic manures i.e Phospho-Compost and Nitrophospho-Sulpho compost.

Available nitrogen was determined by alkaline potassium permanganate method [5]. Available phosphorous was determined calorimetrically by Olsen's method [6]. Available potassium was determined using flame photometer by neutral normal ammonium acetate method [6]. Available sulphur was determined by turbidimetric method by Morgan's reagent using spectrophotometer [6]

Table 1. Treatment details of an experiment

Sl. no.	Treatment details
T_1	Control
T_2	100% Recommended Dose of Mineral Fertilizers(RDF) [30:75:30 NPK] using DAP and MOP
T_3	50% P through PC +Remaining RDF through mineral Fertilizers
T_4	25% P through PC+ Remaining RDF through mineral Fertilizers
T_5	50% P through NPS +Remaining RDF through mineral Fertilizers
T_6	25% P through NPS +Remaining RDF through mineral Fertilizers
T_7	100% P through PC
T_8	100% P through NPS

RDF- Recommended Dose of Fertilizer
PC - Phospho Compost
NPS – Nitro-phospho - Sulpho compost
DAP- Diammonium Phosphate
MOP- Muriate of Potash

Table 2. Nutrient content of Phosphocompost and nitro phospho-sulpho compost on oven dry basis (2016)

Organics	N	P	K	S	C:N
Phosphocompost	0.80	1.65	0.68	0.39	20.44
Nitro phospho-sulpho compost	1.85	1.76	0.92	1.58	19.30

Soil Microbial Biomass Carbon was determined by Modified direct extraction method [7]. Soil Microbial Biomass Carbon was determined by Chloroform fumigation and extraction method [8].

The data was subjected to Analysis of Variance (ANOVA) in Randomized Block Design with 8 treatments and 3 replications as per standard statistical method and standard error was used to calculate Critical Difference to know the significant different among treatments and mean were separated by using F test [9].

3. RESULTS AND DISCUSSION

'Nutrients' may be defined as the chemical compounds required by an organism for it's growth and development. The available nutrients should be optimally allocated among the crop to get maximum returns by allowing optimization of nutrient production function which relate the crop response to applied nutrients under given soil, climate, especially rainfall and management factor.

3.1 Available Nitrogen

The N needs of soybean are quite high due to the higher protein content in soybean grain. The main sources of N that are available to meet the N needs of soybeans are the atmosphere and the soil. In some cases, commercial fertilizers and/or manure may also be used to meet N needs of soybean. The data from the Table 3 revealed that the soil available nitrogen ranged from 220.57. to 253.60 kg ha^{-1}. The significantly highest available nitrogen content after harvest of crop was noticed in the treatment of application 100% P through NPS (253.60 kg ha^{-1}). However, it was at par with the treatment T_7 100% P through NPS. There were significantly increase in available nitrogen content in all the treatments over control which was at par with each other. The increase in fertilizer dose in combination with organic manure in the form of both compost resulted in increase in soil available nitrogen content.

Similar results was observed by [10] who reported that available nitrogen content of soil increase with combined application of organics and inorganics.

3.2 Available Phosphorous

The term available phosphorus refers to the inorganic form occurring in soil solution which is almost exclusively 'Orthophosphate'. This Orthophosphate occurs in several forms and combinations. The availability of P is considered to be a fairly good indicator or measure of the P supplying capacity of soil.

The data pertaining to soil available phosphorous content is presented in Table 3. The available phosphorous content ranged from 15.92 to 21.77 kg ha^{-1}. The significantly highest available phosphorous content (21.77 kg ha^{-1}) was recorded by the treatment where 25% P through nitro phospho-sulpho compost +remaining RDF through mineral fertilizers was applied which is followed by the treatment of application of 100% P through NPS (T_8).However these two treatments were statistically at par and also with all other treatments T_2, T_3, T_4, T_5 and T_7. There were slight increase in available phosphorous content in remaining treatments except control were observed due to the addition of combination of both the compost along with inorganic fertilizer.

The significantly lowest soil available phosphorous content (15.92 kg ha^{-1}) was observed in control treatment. The increase in soil available phosphorous content may be due to the addition of 100% RDF as well as addition of organic manures in various combinations with inorganic fertilizer as obtained by [10].

3.3 Available Potassium

Soils contains large amounts of K but only a small parts usually less than 1% of the total K is in exchangeable form and much smaller amounts are in soil solution. Most of the K in the soil is present in the non exchangeable forms. The slowly and readily available forms of K may comprise a substantial portion of the K that is available for plant uptake during the growing season.

The data on soil available potassium content is presented in Table 3. The available potassium content in soil is ranged from 383.67 to 407.29 kg ha^{-1}.The significantly highest potassium content after harvest of soybean was reported in the treatment of application of 100% RDF which is followed by the treatment where 50% P through NPS + Remaining through mineral fertilizer is applied 398kg ha^{-1} (T_5).

However, the available soil potassium content in soil in all treatments 100%, 50% and 25% P through PC and NPS and 100% RDF were found statistically at par. The lowest value of available soil potassium content was reported in the treatment where no fertilizer was applied (T_1).

The combinations of organic and inorganic fertilizer have increased the available soil potassium content in the experimental soil. This may be due to balanced fertilization. Similar result was found by [11].

3.4 Available Sulphur

Most of the sulphur in soils is found soil organic matter. However, it is not available to plants in this form. In order to become available to plants, the sulphur must be first released from the organic matter and go through mineralization process.

The result on soil available sulphur content is presented in Table 3. Available sulphur content in soil after harvest of soybean is ranged from 10.56 to 15.73 mg Kg^{-1}.The significantly highest available sulphur content (15.73 mg ha^{-1}) was recorded in the treatment of application of 100 % P through NPS (T_8) followed by 100% P through PC (T_7) i.e. 14.08 mg Kg^{-1}.

Significant increase in the available sulphur content was recorded in all the treatment where 100% RDF, both the compost in the tune of 25% to 50% in combination with fertilizers which were at par with each other.

Significantly lowest available sulphur was reported in control treatment. The increase in sulphur content in various treatments may be due to addition of organic matter in the form of Phospho-compost and Nitrophospho-sulpho compost the similar trend of increase in available sulphur after harvest of crop was reported by [12].

The results on available nutrient status showed that incorporation of organic source along with inorganic source helps to get good stabilized nutrient status in soil.

3.5 Effect on Soil Microbial Biomass Carbon (SMBC) Activity

Microbial biomass carbon is a measure of the carbon (C) contained within the living component of soil organic matter (i.e. bacteria and fungi).Microbes decompose soil organic matter releasing carbon dioxide and plant available nutrients. Farming systems that maximize organic matter returns to soil and minimize soil disturbance tends to increase the microbial biomass. Soil properties such as pH, clay, and the availability of organic carbon all influence the size of the microbial biomass.

Table 3. Effect of various treatments on nutrient status of soil after harvest of soybean

	Treatments	Av. N (kg ha^{-1})	Av. P (kg ha^{-1})	Av. K (kg ha^{-1})	Av. S (mg kg^{-1})
T_1	Control	220.57	15.92	383.67	10.56
T_2	100% RDF	241.47	21.25	407.29	13.09
T_3	50% P through PC + Remaining P through chemical fertilizers	234.51	20.43	386.63	13.92
T_4	25% P through PC + Remaining P through chemical fertilizer	245.12	21.00	388.14	13.95
T_5	50% P through NPS + Remaining P through chemical fertilizer	240.60	21.01	398.00	14.71
T_6	25% P through NPS + Remaining P through chemical fertilizer	242.76	21.77	388.37	14.00
T_7	100% P through PC	250.40	20.40	385.48	14.08
T_8	100% P through NPS	253.60	20.81	392.75	15.73
	SE(m)±	**1.82**	**1.10**	**2.25**	**0.50**
	CD at 5%	**5.50**	**3.34**	**6.81**	**1.51**

Initial status: Av. N - 215.12 kg ha^{-1}, Av. P -10.32 Kg ha^{-1}, Av. K– 374.12 Kg ha^{-1}, Av. S -8.45 Kg ha^{-1}

Table 4. Effect of different treatments on soil microbial biomass carbon activity at flowering and pod formation stage

	Treatments	SMBC (mg kg^{-1})	
		Flowering stage	Pod formation stage
T_1	Control	193.52	198.30
T_2	100% RDF	206.19	210.53
T_3	50% P through PC + Remaining P through chemical fertilizers	217.56	220.27
T_4	25% P through PC + Remaining P through chemical fertilizer	212.07	216.80
T_5	50% P through NPS + Remaining P through chemical fertilizer	218.55	221.47
T_6	25% P through NPS + Remaining P through chemical fertilizer	214.62	218.67
T_7	100% P through PC	223.88	227.93
T_8	100% P through NPS	227.85	230.60
	SE(m)±	**0.80**	**2.63**
	CD at 5%	**2.43**	**7.95**

The Soil Microbial Biomass Carbon of the soil as affected by various treatment of crop is presented in Table 4. Soil Microbial Biomass Carbon in soil at soybean flowering stage ranged from 193.52 to 227.85 mg kg^{1}.The significantly highest SMBC (227.85 mg kg^{-1}) was observed with 100% nitrophospho-sulpho compost (T_8). Followed by the treatment-(T_7) 100% phospho-compost was applied i.e. 223.88 mg kg^{-1}.

The treatment with 100% P through PC, 50% and 25% p through PC and NPS and 100% RDF showed at par results with each other.

The lowest SMBC (193.52mg kg^{-1}) was recorded in the control treatment, which is at par with all other treatments.

The soil Microbial Biomass Carbon at pod formation stage of soybean crop showed values ranged from 198.30 to 230.60 mg Kg^{-1} with highest value of 230.60 mg kg^{-1} with application of 100% P through Nitro phospho-Sulpho compost followed by treatment T_7 with 100% P through PC which is at par with each other.

The treatment with 25% and 50% P through PC and NPS and 100% RDF showed statistically at par results with each other and also with lowest value of 198.30 mg Kg^{-1} which was the control treatment.

The similar result was observed by [13] and [1] where combined application of various source of organic manures like FYM, Compost and oil cakes showed good activity than the untreated plots.

3.6 Effect on Soil Microbial Biomass Nitrogen (SMBN) Activity

The microbial biomass consists mostly of bacteria and fungi, which decompose crop residues and organic matter in soil. This process releases nutrients, such as nitrogen (N), into the soil that are available for plant uptake The residues of legume crops can increase microbial biomass due to their greater N contents. Rotations that have longer pasture phases increase microbial biomass because soil disturbance is reduced.

Soil Microbial Biomass Nitrogen activity at different stages of soybean plant growth is presented in Table 5. SMBN activity at flowering stage of soybean crop shows lowest to highest values of 30.29 to 43.90 mg Kg^{-1} .The highest activity is shown in treatment T_8 with application of 100% P through Nitrophospho-sulpho compost (43.90 mg Kg^{-1}) followed by treatment with 100% P through phospho compost (38.75 mg Kg^{-1}).

SMBN activity with 100% P through PC, 25% and 50% P through PC and NPS and 100% RDF treated treatment were at par with each other. However the lowest enzyme activity is seen in control unit (30.29 mg Kg^{-1}).

Soil Microbial Biomass Nitrogen activity at flowering stage is found to ranged from 32.42 to 47.20 mg Kg^{-1}. Application of 100% P through NPS showed highest enzyme activity (47.20 mg Kg^{-1}) followed by application of 100% P through PC (42.93 mg Kg^{-1}).The lowest activity was noticed with plot without application of fertilizer or manure (32.42 mg Kg^{-1}) which was at par with all other treatments with combination of organics and inorganics.

The results showed highest enzyme activity with application of organics in form of composts, similar results were obtained by [14] where the application of organic source like crop residue and organic manure showed highest SMBN activity than control.

Table 5. Effect of different treatments on soil microbial biomass nitrogen SMBN activity at flowering and pod formation stage

	Treatments	**SMBN (mg kg^{-1})**	
		Flowering stage	**Pod formation stage**
T_1	Control	30.29	32.42
T_2	100% RDF	35.26	37.86
T_3	50% P through PC + Remaining P through chemical fertilizers	33.13	36.02
T_4	25% P through PC + Remaining P through chemical fertilizer	33.99	37.35
T_5	50% P through NPS + Remaining P through chemical fertilizer	34.56	35.98
T_6	25% P through NPS + Remaining P through chemical fertilizer	34.40	38.93
T_7	100% P through PC	38.75	42.93
T_8	100% P through NPS	43.90	47.20
	SE(m)±	**0.64**	**1.12**
	CD at 5%	**1.93**	**3.40**

4. CONCLUSION

The experiment was carried out with view of determining the chemical properties and biological properties revealed that Available nutrients and soil enzymatic activity were better in organic and inorganic balanced supplied plots (50% and 25%) as well as organics as composts (100%) treated plots showing judicious combination of organics and inorganics are must for good soil health and soil properties.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Manna MC, Ganguly JN. Comparative performance of cowdung slurry, microbial inoculation and inorganic fertilizer on maize. J. Maharashtra Agric. Univ. 1998; 44(30):526-528.
2. Anonymous. Soybean report of India. 2015;45-50.
3. Randhawa NS, Arora PN. Major nutrient research in India. Ferti News. 1997;1:11-19.
4. Tate RL. Soil microbiology. John Wiley, New York; 1995.
5. Subbiah BV, Asija GV. A rapid procedure for estimation of available nitrogen in soils. Current Science. 1956;25:259-260.
6. Jackson ML. Soil chemical analysis. Prentice Hall Publication Pvt. Ltd., New Delhi, India. 1973;426.
7. Jenkinson DS, Ladd JN. Microbial biomass Nitrogen in soil: measurement and turnover. Soil Biochemistry. 1981;5:415-417.
8. Jenkinson DS, Powlson DS. The effects of biological treatments on metabolism in soil by the method for measuring soil biomass. Soil Biol. Biochem. 1976;8:209-213.
9. Panse VG, Sukhatme PV. Statistical methods for agricultural workers. ICAR, New Delhi; 1985.
10. Sharma MB, Mishra SV, Singh R. Long term effect of fertilizers and manures on physical and chemical properties of Mollisol. J. Indian Soc. Soil Sci. 2007; 55(4):523-524.
11. Shivkumar BG, Ahlawat IPS. Integrated nutrient management in soybean (*Glycine max*)-wheat (*Triticum aestivum*) cropping system. Indian J. Agron. 2008;53(4):273-278.
12. Singh VK, Pramod Kumar. Effect of INM on soil fertility Nutrient uptake and yield of Rice-pea cropping system on an upland acid soil of Jharkhand. J. Indian Soc. Soil Sci. 2011;59(2):158-163.
13. Sarode PB, More SD. Long term effects of integrated nutrient management on active pool of soil organic carbon and nutrients. Abst.State level seminar on soil resource management for sustainablesoil health and food security, January 2-3, 2010. Akola chapter of ISSS, Dept. SSAC, Dr. PDKV, Akola. 2010;7.
14. Baaru WR, Sinaram P, Kumari K, Pal S. Long-term effect of FYM and fertiliser on enzyme dynamics of soil. Journal of Indian Soc. Soil Sci. 2003;43:378-380.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history/22975