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Assessing comparative effectiveness of Phospho-compost and Nitro-Phospho-Sulpho compost on yield, nutrient uptake of soybean crop and soil fertility on Vertisols

Abhisek Pal, PW Deshmukh, PR Chaure and SM Bhoyar

Abstract
A field experiment was conducted during rainy (*kharif*) seasons of 2018-19 at research farm of Dr. PDKV Akola (M.S) to examine the assessing comparative effectiveness of Phospho-compost and Nitro-Phospho-Sulpho compost on yield, nutrient uptake of soybean crop and soil fertility on Vertisols. The experiment was laid out in Randomized block design with eight treatments replicated thrice. Soybean is a species, widely grown for its high oil content and dietary protein, which also possess multiple uses with specialty of atmospheric nitrogen fixation. The results obtained disclosed that the significant highest grain yield of soybean was recorded by the application of 50% P through NPS + Remaining through chemical fertilizer, followed by of application of 100% RDF. The nutrient uptake status culminated that application 50% P through NPS + Remaining through chemical fertilizer recorded significantly highest grain uptake of nitrogen and potassium whereas phosphorus & Sulphur grain uptake was significantly highest with the application of 100% P through NPS. All the treatments in combination of organic and inorganic showed higher nutrient uptake over the control. Taking the available nutrient status into consideration post-harvest the significantly highest available nitrogen i.e. (267.20 kg ha^{-1}), phosphorous (21.05 kg ha^{-1}) and sulphur (18.83 mg kg^{-1}) was noticed in T_8 i.e. by application of 100% P through NPS. Whereas the significantly highest potassium content (416.10 kg ha^{-1}) was reported in T_5 i.e. application of 50% P through NPS + Remaining P through chemical fertilizer.

Keywords: NPKS uptake, Nitro-phospho-sulpho compost, phospho-compost, soil fertility, soybean & Vertisols

Introduction
Soybean (Glycine max (L) Merril), is an important legume and oilseed crop which provides cheap and balanced diet (Ogundipe *et al*., 1989) [9]. Soybean is a miracle golden bean, wonder crop and miracle crop of 20th century. It is also known as gold of the soil due to its advantages such as easy cultivation and assisting to enrich the soil fertility by fixing the atmospheric nitrogen via root nodules. The crop has been described as the world's chief source of edible vegetable oil and high protein feed for livestock (Dashiell, 1993) [5]. Soybean contributes significantly to the Indian edible oil pool Soybean in Indian agriculture as a pulse and an oilseed crop has attained importance due to its nutritional and industrial value. Soybean possess capability to give profitable returns with even under minimum agricultural inputs. Farm residues, city rubbish and agro-based industrial wastes could be used as alternatives to FYM to maintain soil physical, chemical and biological quality (Swarup *et al*. 2000) [16] and to sustain crop productivity. Agriculture sustainability depends to a large extent on enhancing soil properties, which are controlled by multiple factors of which mineral nutrition and precise nutrient uptake by plant is largely indispensable. The continued use of chemical fertilizers causes health and environmental hazards (Pimentel, 1996) [10]. Additionally, recycling of indigenous agricultural wastes should be done properly. Compost handling is less dangerous than raw material handling in terms of ammonia volatilization and leaching of N and P (Arja and Maritta, 1997) [1]. Declining trend in productivity due to continuous use of chemical fertilizers alone has been observed in long term experiments all over India (Nambiar,1994) [8]. Composting is recognized as an economical and sustainable option for waste management as it is easy to undertake and can be conducted in the local site of the produce (Singh and Amberger 1998; Biswas *et al*. 2009) [17]. The application of crop residues, FYM and manure are increasingly important aspect of environmentally sound sustainable agriculture (Timsina and Connor, 2001) [18]. The present study was undertaken to investigate the following parameters i) to assess the impact of enriched compost i.e PC & NPS on nutrient uptake and yield of soybean. ii) To assess the impact of enriched compost on soil fertility status.

Materials and Methods

The present research entitled "Assessing comparative effectiveness of Phospho-compost and Nitro-Phospho-Sulpho compost on yield, nutrient uptake of soybean crop and soil fertility on Vertisols" was assessed at Research Farm of Department of Soil Science and Agricultural Chemistry, Dr. PDKV, Akola during Kharif season of 2018-19.

Table 1: Treatment details of the experiment

T_1	Control
T_2	100% RDF
T_3	50% P Through PC + Remaining through fertilizer
T_4	25% P Through PC + Remaining through fertilizer
T_5	50% P Through NPS + Remaining through fertilizer
T_6	25% P Through NPS + Remaining through fertilizer
T_7	100% P Through PC
T_8	100% P Through NPS

The experimental soil was developed on basaltic plateau on plain land and classified under Vertisols. The morphological characteristics of soil is medium deep, clayey in texture. PC stands for Phospho-compost whereas NPS stands for Nitro-Phospho-Sulpho compost. For analysing the nutrient uptake status by soybean, plant samples from rhizosphere were collected after harvest of the crop and stored carefully and processed for further analysis. For analysing available nutrient status, soil samples were collected from field after harvest from 15 cm depth using spade. The enriched compost was applied a week before sowing of crop whereas fertilizer application was done post-sowing.

Table 2: Nutrient content of PC and NPS (mg/kg)

Compost	N	P	K	S	C:N
Phospho-compost	0.80	1.85	0.70	0.39	20.44
Nitro-Phospho Sulpho compost	1.76	1.92	0.92	1.59	20.21

Results and Discussion

Effect of enriched compost on plant nutrient uptake

A. Effect on Nitrogen Uptake

Nitrogen uptake by both grain and straw as influenced by various treatment is presented in Table 3 which lies in the range from 38.49 to 133.29 kg ha^{-1}. The study culminated that application of T_5 i.e. 50% P through NPS + Remaining through chemical fertilizer recorded significantly highest grain uptake of N (133.29 kg ha^{-1}) followed by T_2 i.e.100% RDF (132.80 kg ha^{-1}) which was at par with each other. Subsequently, the plant N uptake received by treatments T_2 i.e.100% RDF, T_5 i.e. 50% P through NPS + Remaining through chemical fertilizer and T_8, i.e. 100% P through NPS were found statistically at par with each other. These findings are in conformity with Chaturvedi and Chandel (2005) [4] influence of organic and inorganic fertilization on soil fertility and productivity of soybean.

B. Effect on Phosphorous Uptake

Phosphorous uptake by both soybean grain and straw as affected by various treatment is presented in Table 3 which lies in the range from 3.24 to 12.57 kg ha^{-1}.The study concluded that application of T_8 i.e. 100% P through NPS recorded significantly highest uptake (12.57 kg ha^{-1}) followed by T_5 i.e. 50% P through NPS + Remaining through chemical fertilizer (12.32 kg ha^{-1}).

However, the plant uptake received by treatments T_2 i.e. 100% RDF, T_3, T_4 i.e. 50% P, 25% P through PC + Remaining through chemical fertilizer, T_5 & T_6 i.e. 50% P, 25% P through NPS + Remaining through chemical fertilizer were found statistically at par with each other. This may be owing to conjunctive application of both PC and NPS on the basis of phosphorous content and simultaneously due to application of chemical fertilizer.

The significantly lowest uptake of P was recorded by treatment T_1 i.e. control plot whose uptake was only 3.44 kg ha^{-1}. The results are in close conformity with the finding reported by Garrido *et al.*, (2009) [6].

C. Effect on Potassium Uptake

Potassium uptake by both grain and straw as affected by various treatment is presented in Table 3 which lies in the range from 13.19 to 45.57 kg ha^{-1}. The study indicated that application of T_5 i.e. 50% P through NPS + Remaining through chemical fertilizer recorded significantly highest grain uptake (45.57 kg ha^{-1}) followed by T_8 100% P through NPS (44.48 kg ha^{-1}).

However, the plant uptake received by treatments T_2 i.e. 100% RDF, T_3, i.e. 50% P through PC + Remaining through chemical fertilizer, T_5 & T_6 i.e. 50% P, 25% P through NPS + Remaining through chemical fertilizer were found statistically at par with each other except T_4 i.e. 25% P through PC + Remaining through chemical fertilizer. The significantly lowest uptake of K was recorded by treatment T_1 i.e. control plot whose uptake was only 13.19 kg ha^{-1}. Similar results were found for K uptake by Santhy *et al.*, (1998) [12] Long term effect of continuous cropping and fertilization on crop yields and soil fertility status.

D. Effect on Sulphur Uptake

The soil organic matter is a primary and major reservoir of sulphur, where crop residues, composts serve as an excellent source. Soils rich in organic matter possess higher levels of sulphur.

The Sulphur uptake by both soybean grain and straw as affected by various treatment is presented in Table 3 which lies in the range from 2.74 to 12.28 kg ha^{-1}. The study stated that application of T_8 i.e. 100% P through NPS + recorded significantly highest grain uptake (12.28 kg ha^{-1}) followed by T_7 i.e. 100% P through NPS (12.10 kg ha^{-1}). However, uptake received from T_5 and T_6 i.e. 50, 25% P through NPS + Remaining through chemical fertilizer were statistically found at par with each other.

However, the lowest uptake of Sulphur was recorded in control plot i.e. T_1 whose uptake was limited to 2.74 kg ha^{-1} where no manure and fertilizers were applied. Similar findings were recorded by D. souza *et al.* (2017) [3] in Vertisols at Vidarbha region.

Table 3: Uptake of nutrient by soybean as influenced by various treatments

Treatments		Grain Nutrient uptake (kg ha^{-1})			
		N	P	K	S
T_1	Control	38.49	3.24	13.19	2.74
T_2	100% RDF	132.80	11.86	43.33	10.19
T_3	50% P through PC + Remaining through chemical fertilizer	119.24	11.35	40.48	10.62
T_4	25% P through PC + Remaining through chemical fertilizer	115.17	11.02	39.64	9.89
T_5	50% P through NPS + Remaining through chemical fertilizer	133.29	12.32	45.57	11.75
T_6	25% P through NPS + Remaining through chemical fertilizer	119.72	11.92	41.57	11.42
T_7	100% P through PC	123.71	12.20	43.58	12.10
T_8	100% P through NPS	125.00	12.57	44.48	12.28
	SE(m)±	2.96	0.63	1.94	0.46
	CD at 5%	8.96	1.90	5.86	1.41

Effect of enriched compost on yield of soybean

A. Effect on Grain Yield

Soybean is a high yielding crop rich in protein and oil content which has very high nutrient requirement (Aulakh *et al*.1985) [2]. The soybean grain yield received by the various treatments is presented in table 4. The grain yield of soybean as influenced by application various treatments is ranged between 6.62 to 21.92 q ha^{-1}. The significantly highest grain yield of soybean was recorded by the application of 50% P through NPS + Remaining through chemical fertilizer (21.92 q ha^{-1}), followed by the treatment of application of 100% RDF (21.35 q ha^{-1}), However the yield obtained from T_2 i.e. 100% RDF and by both the treatment of T_7 100% PC & T_8 100% NPS were statistically at par.

The grain yield received by the treatment T_2, T_5, T_7 & T_8 i.e. 100% RDF, combination of 50% P through NPS + Remaining through chemical fertilizer, 100% P through PC and 100% P through NPS were found at par among each other indicating the beneficial effect of integrated nutrient management in enhancing the yield. However, grain yield received by the treatment T_3, T_4, T_6 i.e. 25%, 50% P through PC + Remaining through chemical fertilizer and 25% P through NPS + Remaining through chemical fertilizer were also found at par with each other.

The significantly lowest grain yield of soybean was noticed in T_1 i.e. control treatment (6.62 q ha^{-1}) where no fertilizers were applied. Similar trend was reported by Prabhakar and Deshmukh (2004) [11] where the treatment with application of FYM and compost showed highest grain yield compared to without application of organic manures.

B. Effect on Straw Yield

The straw yield of soybean as influenced by application different treatments is reported in Table 4. The straw yield of soybean was ranged from 8.18 to 27.01 q ha^{-1}.

Significantly highest straw yield of soybean was obtained in the treatment T_5 i.e. application of 50% P through NPS +Remaining through chemical fertilizer (27.01 q ha^{-1}) followed by treatment T_2 i.e. application of 100% RDF (26.33 q ha^{-1}), However the yield obtained by both these treatments were found statistically at par with each other.

The straw yield received by the treatments T_2, T_7, T_8 i.e. 100% RDF (26.33 q ha^{-1}), 100% P through PC (25.17 q ha^{-1}), & 100% P through NPS (25.49 q ha^{-1}) were statistically at par with each other. The straw yield received by the treatment T_3, T_4, T_6 i.e. 25% P, 50% P through PC + Remaining through chemical fertilizer and 25% P through NPS + Remaining through chemical fertilizer were statistically at par among each other.

The Significantly lowest yield of 8.18 q ha^{-1} was recorded by the treatment T_1 where no fertilizer and no manure were applied. The results obtained from various treatments are in confirmative with the results recorded by Shivkumar and Ahlawat (2008) [14] where application of poultry and city compost showed highest straw yield compared to without application of same.

The highest soybean grain and straw yield received by the application of 50% P through NPS + Remaining through chemical fertilizer and this may be due to balanced or integrated nutrition to the crop and simultaneously rainfall received during grand growth stages of crop was ideal and convenient.

Table 4: Yield of soybean as influenced by various treatments

Treatments		Yield (q ha^{-1})	
		Grain	Straw
T_1	Control	6.62	8.18
T_2	100% RDF	21.35	26.33
T_3	50% P through PC + Remaining through chemical fertilizer	19.60	24.15
T_4	25%P through PC+ Remaining through chemical fertilizer	19.13	23.59
T_5	50% P through NPS +Remaining through chemical fertilizer	21.92	27.01
T_6	25% P through NPS+ Remaining through chemical fertilizer	19.15	23.62
T_7	100% P through PC	20.41	25.17
T_8	100% P through NPS	20.66	25.49
	SE (m)±	0.58	0.68
	CD at 5%	1.75	2.06
	CV	7.48	7.86

Effect of enriched compost on soil fertility status

A) Available Nitrogen

The data from Table 5 states that the soil available nitrogen ranged from 150.50 to 267.20 kg ha^{-1}. The significantly highest available nitrogen content after harvest of crop was noticed in T8 i.e. application of 100% P through NPS (267.20 kg ha^{-1}). This was in consonance with the findings of D. souza *et al*. (2017) [3] in black soils of Vidarbha region.

There were significantly increase in available nitrogen content in all the treatments over control. The increase in fertilizer dose in combination with organic manure in the form of both

composts resulted in boosting soil available nitrogen content status after harvest of crop.

B) Available Phosphorous

The data pertaining to soil available phosphorous content is presented in Table 5. The available phosphorous content ranged from 13.40 to 21.05 kg ha^{-1}. The significantly highest available phosphorous content (21.05 kg ha^{-1}) was recorded by the treatment T_8 where 100% P through NPS was applied. There was 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 (13.40 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 Sharma *et al.,* (2007) [13].

C) Available Potassium

The data on soil available potassium status is presented in Table 5. The available potassium content in soil is ranged from 358.40 to 416.10 kg ha^{-1}. The significantly highest potassium content after harvest of soybean was reported in T_5 i.e. treatment of application of 50% P through NPS + Remaining P through chemical fertilizer (416.10 kg ha^{-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 Shivkumar and Ahlawat (2008) [14].

D) Available Sulphur

The result on soil available sulphur content is presented in Table 5. Available sulphur content in soil after harvest of soybean is ranged from 9.62 to 18.83 mg kg^{-1}. The significantly highest available sulphur status (18.83 mg kg^{-1}) was recorded in T_8 100% P through NPS. The upscale status of sulphur may be owing to high content of sulphur in enriched compost.

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 Singh and Pramod (2011) [15].

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

Table 5: Nutrient status of soil after harvest as influenced by various treatments

	Treatments	Av. N (kg ha^{-1})	Av. P (kg ha^{-1})	Av. K (kg ha^{-1})	Av. S (mg kg^{-1})
T_1	Control	150.50	13.40	358.40	9.62
T_2	100% RDF	245.25	20.27	414.40	14.52
T_3	50% P through PC + Remaining P through chemical fertilizers	244.50	20.17	394.20	15.20
T_4	25% P through PC + Remaining P through chemical fertilizer	238.70	19.30	386.10	14.18
T_5	50% P through NPS + Remaining P through chemical fertilizer	246.66	20.85	416.10	15.80
T_6	25% P through NPS + Remaining P through chemical fertilizer	254.94	20.12	395.10	14.22
T_7	100% P through PC	256.71	20.86	404.30	17.85
T_8	100% P through NPS	267.20	21.05	405.20	18.83
	SE(m)±	7.20	1.04	5.44	0.33
	CD	21.74	3.16	16.43	1.02

Conclusion

From the above study it can be concluded that the soybean grain and straw yield, uptake of nutrients i.e. N, P, K and S was significantly improved by the treatments of application of 50% P through NPS + remaining through chemical fertilizer. However, the available nutrient & soil fertility status, was enhanced due to application of both the compost.

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