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CHANGES IN SOIL PHOSPHORUS AND HUMIC SUBSTANCES UNDER INTEGRATED NUTRIENT MANAGEMENT PRACTICES FOR WHEAT IN VERTISOL

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ABSTRACT

The field investigation was carried out during r*abi* season for the year 2019-20 at Botany research farm, College of Agriculture, Nagpur with the objective to assess the phosphorus availability at physiological growth stages and humic substances in soil and yield of wheat as influenced by integrated nutrient management. Results revealed that, the application of ghanajivamrut 5 t ha^{-1} at incorporation of green manuring + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos slowly released of phosphorus and maintained the amount of soil available phosphorus at latter stage of crop. The humic acid (2.25%) in soil was increased with the application of Vermicompost 5 t ha^{-1}at incorporation of green manuring + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos and per cent of fulvic acid ranged from 3.50 to 4.75. The grain yield (34.66 qha^{-1}) of wheat was increased with the application of ghanajivamrut 5 t ha^{-1} at incorporation of green manuring + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos by 4.52 and 14.40 per cent over 100 % RDF + green manuring and neem cake 2 t ha^{-1} with incorporation of green mnauring + jivamrut + Azophos., respectively. However, 37.97 to 44.49 per cent grain yield of wheat was reduced with the application of organic sources alone.

(Key words: Phosphorus availability, humic substances, green manuring and wheat)

INTRODUCTION

Response of P fertilizer in Vertisols of India has been reported to be unpredictable and this has been ascribed to high P fixation due to high clay content and high content of smectite. Soil of Vidarbha are dominated in smectite and varied from 40 to 78%. Soil P fertility map showed that out of 500 districts, soils of 257 districts (51%) under low, 200 districts (40%) medium and 43 districts (9%) high in available soil P (Dey *et al.*, 2017). Solubility of P through all the interventions is due to action of acids either organic or mineral which are the sources of H^+ ion and lead to release of phosphorus. Green manure crops and organic resources upon decomposition of organic acids which not only dissolving phosphate but also reduce the P fixation and increase the native phosphorus availability for crops. Organic materials are gaining popularity. FYM, compost and green manures are organic materials, commonly used as a source of nutrient. Since, availability of FYM and compost is limited but green manures offer greater potential as feasible and cheaper substitute of fertilizer nitrogen as well as other plant nutrients. Green manures on decomposition liberate phosphorus in the soil in available form. In addition to this, CO_2 and other intermediates organic products are formed during the course of decomposition of green manures (Hesse,1962).Under intensive cropping system, chemical fertilizers or organic manures/ bio-fertilizers alone cannot sustained the productivity of land. It is impossible to supply every nutrient in natural balanced form or for organic manures or bio-fertilizers, being low in nutrient content. Therefore, to have sustainable crop productivity and nutrient efficiency integration of reduced dose and chemical fertilizers with continuous used of various sources of organic manures and their judicial management practice is an important for release of phosphorus availability of soil and humic substances.

MATERIALS AND METHODS

The field experiment was carried out at Botany research farm, college of Agriculture, Nagpur. The soils of the experimental site was clayey in texture, slightly alkaline in soil reaction 7.55 with medium in organic carbon 5.24 g kg^{-1}, low in available nitrogen 200.7 kg ha^{-1}, medium in available phosphorus 16.60 kg ha^{-1} and high in available potassium 478 kg ha^{-1}.The field experiment was laid out in randomized block design with seven treatments replicated thrice. The treatments comprised of T1 -GM + 100% RDF,

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T2-Ghanajivamrut 5 t ha^{-1}at incorporation of GM + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos ,T3-Vermicompost 5 t ha^{-1}at incorporation of GM + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos,T4-Neem cake 2 t ha^{-1}at incorporation of GM + 50% RD of NP through inorganic fertilizer + Jivamrut + Azophos,T5-Ghanajivamrut 5 t ha^{-1}at incorporation of GM+ Jivamrut + Azophos,T6-Vermicompost 5 t ha^{-1}at incorporation of GM + Jivamrut + Azophos,T7-neem cake 5 t ha^{-1}at incorporation of GM + Jivamrut + Azophos. GM means green manuring of sunhemp was harvested after 30 days sowing and incorporated into the field by tractor drawn rotavator. Sowing of wheat variety AKW-1071 was done in an experimental site on 15th November 2019 by drilling. The chemical fertilizers and ghanjivamruit (combination of FYM and jivamruit) were applied as per the treatments details. Doses of nitrogen through urea was applied in two splits, 1st dose at the time of sowing and 2nd at 30 DAS. P and K were applied through SSP and muriate of potash at sowing. Jivamruit spraying @ 500 l ha^{-1} was applied at tillering and jointing stage of wheat. Seed treatment was done with Azophos (Azotobactor+PSB @ 25 g kg^{-1} each of seed at the time of sowing).The soil samples were collected at tillering, flowering and harvest stage of wheat. Soil samples were analyzed by adopting standard methods for various soil properties in order to assess the nutrient availability and humic subtances in soil. Organic carbon was assessed by wet oxidation method (Walkley and Black, 1934). Available nitrogen was analysed by using Kjeldahl's method (Subbiah and Asija, 1956), Phosphorus estimated by using Olsen's method (Jackson, 1973) and potassium was estimated from 1N ammonium acetate extract using flame photometer (Jackson,1973).

Preparation of Amrutpani: It was prepared in proportion of 10 kg cow dung +10 litre cow urine.+ 1 kg Jaggary . Mixtures were prepared in earthen pots, stirred daily for 10 minutes upto 7 days. Mixtures were diluted 10 times with water and applied ha^{-1} basis.

Preparation of Jivamrut: It was prepared with cow dung 10 kg + cow urine 10 litres.+ Jaggary 2 kg + gram flour 2 kg and half kg soil from bunds(organic rich soil) with 100 litres water. Above mixture was poured in the plastic drums and mixing all materials continue until they are thoroughly mixed. It was stirred properly 2-3 times with wooden stick in a day for increasing aeration and enhancing microbial activity and keep it for one week. It was diluted in 100 litres of water with 10 litres of jivamrut and applied @ 500 l ha^{-1}. The whole process was made and left in shade for increase the activity of microorganism.

Preparation of Ghanjivamrut: Make a pit size of 10x5x2.5 feet dimension. Take 500 kg fresh FYM and 50 l jivamrut in the pit. Cover the mixture properly with any straw material available, wait for one week for decomposition of material. After one week mix the mixture of FYM and jivamrut properly. Fallow the similar process for 3-4 times at an interval of one week. If procedure followed properly, 40-45 days is required to complete the material of ghanajivamrut.

RESULTS AND DISCUSSION

Grain yield of wheat (q ha^{-1})

The data pertaining to grain yield of wheat as affected by various treatments are presented in Table 1.The results reveals that, the grain yield of wheat was significantly influenced due to incorporation of green manuring (GM) and inorganic fertilizer in combination with organic manure and biofertilizers.The highest grain yield of wheat (34.66 q ha^{-1}) was obtained with the application of ghanajivamrut 5 t ha^{-1} at incorporation of GM + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos and it was found at par with the application of 100 % RDF + GM (33.40 q ha^{-1}) and vermicompost 5 t ha^{-1}at incorporation of GM + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos.It clearly indicates that the decomposition of succulent green manure and well decomposed ghanaji-vamrut, vermicompost which favoured for greater release of nutrients, better functioning of microbial activity and continuous availability of major, secondary and micronutrient in the soil for sustaining higher grain yield of wheat and efficiency of inorganic fertilizer might have also been increased when applied with well decomposed organic manure and brought a beneficial effect on grain yield. Balpande *et al.* (2013) reported that significantly higher grain yield of wheat (23.69 q ha^{-1}) was recorded under 100 % RDF with three sprays of amritpani at the rate of 200 l ha^{-1}.

Application of ghanajivamrut 5 t ha^{-1} at incorp-oration of GM + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos produced significantly more grain yield of wheat by 3.63, 4.52 and 14.40 per cent higher over 100 % RDF + GM, Vermicompost 5 t ha^{-1}at incorporation of GM + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos and Neem cake 2 t ha^{-1}at incorporation of GM + jivamrut + Azophos respectively. 43.47, 37.97, and 44.49 per cent grain yield of wheat was reduced with the treatments of Ghanajivamrut 5 t ha^{-1}at incorporation of GM*+ Jivamrut + Azophos (T_5), vermicompost 5 t ha^{-1}at incorporation of GM*+ Jivamrut + Azophos (T_6) and neem cake 2 t ha^{-1}at incorporation of GM*+ Jivamrut + Azophos (T_7), respectively over Ghanajivamrut 5 t ha^{-1}at incorporation of GM* + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos (T_2). Application of organic manure alone cannot sustained grain yield of wheat. Singh *et al.* (2018) also reported the grain yield of 48.45 q ha^{-1} and straw yield of 62.82 q ha^{-1} of wheat with the application of 100 %RDF + 2 t ha^{-1} vermicompost + PSB.

Soil available phosphorus (kg ha^{-1})

The data in relation to available phosphorus of soil at tillering, flowering and harvest stages of wheat was found significant. Application of Vermicompost 5 t ha^{-1}at incorporation of GM + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos had an impact on dynamics of phosphorus release during different physiological growth stage of crop because of mineralization of phosphorus.

Table 1.Grain and straw yield of wheat (q ha^{-1}) as influenced byintegrated plant nutrient system

Treatments	Yield (q ha^{-1})	
	Grain	Straw
T1-GM*+100%RDF	33.40	43.66
T2-Ghanajivamrut 5 t ha^{-1}at incorporation of GM* + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos	34.66	43.95
T3-Vermicompost 5 t ha^{-1}at incorporation of GM* + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos	33.09	42.68
T4-Neem cake 2 t ha^{-1}at incorporation of GM* + 50% RD of NP through inorganic fertilizer + Jivamrut + Azophos	29.67	38.42
T5-Ghanajivamrut 5 t ha^{-1}at incorporation of GM*+ Jivamrut + Azophos	19.59	26.41
T6-Vermicompost 5 t ha^{-1}at incorporation of GM* + Jivamrut + Azophos	21.50	28.23
T7-Neem cake 2 t ha^{-1}at incorporation of GM* + Jivamrut + Azophos	19.24	24.18
SE(m) ±	1.18	1.30
CD at 5%	3..49	3.83

* GM= Green manuring of Crotolariajuncea (Sunhemp)

Table 2. Changes in available phosphorus of soil at tillering, flowering stageand harvest of wheat as influenced by integrated plant nutrient system

Treatments	Available P (kg ha^{-1})		
	At tillering	flowering	harvest
T1-GM+100%RDF	16.85	17.99	16.60
T2-Ghanajivamrut 5 t ha^{-1}at incorporation of GM* + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos	17.40	18.30	19.80
T3-Vermicompost 5 t ha^{-1}at incorporation of GM* + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos	17.42	19.01	21.07
T4-Neem cake 2 t ha^{-1}at incorporation of GM* + 50% RD of NP through inorganic fertilizer + Jivamrut + Azophos	16.81	17.93	18.70
T5-Ghanajivamrut 5 t ha^{-1}at incorporation of GM*+ Jivamrut + Azophos	16.15	17.53	18.93
T6-Vermicompost 5 t ha^{-1}at incorporation of GM* + Jivamrut + Azophos	16.54	17.71	19.01
T7-Neem cake 2 t ha^{-1}at incorporation of GM* + Jivamrut + Azophos	16.18	17.44	18.40
SE (m) ±	0.27	0.16	0.20
CD at 5%	0.80	0.47	0.59

Table 3. Effect of integrated plant nutrient system on humic substances in soil after harvest of wheat

Treatments	Humic acid (%)	Fulvic acid (%)	Humin (%)
T1-GM+100%RDF	1.75	4.25	94.00
T2-Ghanajivamrut 5 t ha^{-1}at incorporation of GM* + 50% RD of NP through inorganic fertilizer + Jivamrut + Azophos	2.00	4.75	93.25
T3-Vermicompost 5 t ha^{-1}at incorporation of GM* + 50% RD of NP through inorganic fertilizer + Jivamrut + Azophos	2.25	4.00	93.75
T4-Neem cake 2 t ha^{-1}at incorporation of GM* + 50% RD of NP through inorganic fertilizer + Jivamrut + Azophos	1.00	4.50	94.50
T5-Ghanajivamrut 5 t ha^{-1}atincorporation of GM*+ Jivamrut + Azophos	1.15	4.00	94.85
T6-Vermicompost5 t ha^{-1}at incorporation of GM* + Jivamrut + Azophos	1.65	3.50	94.85
T7-Neem cake 2 t ha^{-1}at incorporation of GM* + Jivamrut + Azophos	1.00	3.75	95.25

The amount of available phosphorus in soil were maintained due to application of Vermicompost 5 t ha^{-1}at incorporation of GM + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos and foliar application of jivamrut @ 500 l ha^{-1} at tillering and jointing stage of wheat. However, treatment with Vermicompost 5 t ha^{-1} at incorporation of GM* + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos (T_3) registered changes in amount of available phosphorus in soil at latter stage (19.01 kg ha^{-1}) particularly at flowering stage which was comparable to 100 % RDF+GM treated plot at tillering stage (16.85 kg ha^{-1}). This might be due to slowly release and solubility of phosphorus and ultimately maintained greater amount of P in soil at the latter stage of crop.The significant released of available P due to combined application of inorganic fertilizer and organic inputs clearly indicates beneficial effect of integrated plant nutrient management in enhancing available P in soil during different growth stages of wheat. Moharana *et al.* (2015) reported that application of enriched compost and chemical fertilizer to wheat had an immense effect on phosphorus availability during physiological growth stage of wheat.

Increase in soil available phosphorus during growth stages of wheat may attributed to the microbial activity due to secretion of organic acids like oxalic, malic, citric, acetic, lactic, gluconic which released during the decomposition of organic materials and PSB are the major solubilizers of not only dissolving phosphate but also reduce the P fixation in soil and thereby increase the native P availability for crop. Khamparia *et al.*(2018) reported that the use of recommended dose of fertilizer with organic manure resulted in an increase in the available P status of soil.

Humic substances (%)

The data with respect to effect of integrated plant nutrient system on humic substances in soil after harvest of wheat are summarized in Table 3.The results revealed that the humic acid obtained from 1 to 2.25 per cent with the application different treatments.The highest value of humic acid 2.25 per cent was obtained with the application of Vermicompost 5 t ha^{-1}at incorporation of GM + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos and fulvic acid obtained in the range of from 3.50 to 4.75 per cent.The highest value of fulvic acid i. e..4.75 per cent was obtained with the application of ghanajivamrut 5 t ha^{-1}at incorporation of GM + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos. The per cent of humin in soil after harvest of wheat was obtained from 93.25 to 95.25 per cent with the application of different treatments and management practices.Ravichandran (2011) reported that humic acid content of various materials from the natural resources *viz.,* soil 1%, compost 2%, dung 5%, brown coal10% and black peat10% and the fulvic acid concentration in soil 5 %, compost 5 %, dung 15 %, brown coal 30 % and black peat 40%.

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