Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(6): 765-769
Received: 23-09-2020
Accepted: 26-10-2020

Suresh M Dalvi
PG Student, Soil Science and Agricultural Chemistry Section, College of Agriculture, Nagpur, Maharashtra, India

RM Ghodpage
Associate Professor, Soil Science and Agricultural Chemistry Section, College of Agriculture, Nagpur, Maharashtra, India

SS Balpande
Associate Professor, Soil Science and Agricultural Chemistry Section, College of Agriculture, Nagpur, Maharashtra, India

WP Badole
Associate Professor, Soil Science and Agricultural Chemistry Section, College of Agriculture, Nagpur, Maharashtra, India

Sagar S Patil
PG Student, Soil Science and Agricultural Chemistry Section, College of Agriculture, Nagpur, Maharashtra, India

DD Sirsat
PG Student, Soil Science and Agricultural Chemistry Section, College of Agriculture, Nagpur, Maharashtra, India

Corresponding Author:
Suresh M Dalvi
PG Student, Soil Science and Agricultural Chemistry Section, College of Agriculture, Nagpur, Maharashtra, India

Effect of integrated plant nutrient system on phosphorus solubilisation and productivity of wheat in vertisols

Suresh M Dalvi, RM Ghodpage, SS Balpande, WP Badole, Sagar S Patil and DD Sirsat

DOI: https://doi.org/10.22271/phyto.2020.v9.i6k.13035

Abstract
The present investigation in relation to **"**Effect of integrated plant nutrient system on phosphorus solubilisation and productivity of wheat in Vertisols" was conducted during rabi season of 2019-20 at Botany Research Farm, College of Agriculture, Nagpur. The results revealed that the use of ghanjivamrut @ 5 t ha^{-1} at incorporation of green manuring in combination with 50 % RD of chemical fertilizers + bio-fertilizers is the suitable nutrient source for maintaining soil available phosphorus nutrient at physiological growth stage and fertility status and it also improve the uptake of nutrient and yield of wheat. The grain yield of wheat was 3.63, 4.52 and 14.40 per cent higher over 100 % RDF + GM with the IPNS practice, there by 50 % chemical fertilizers can be saved and increase solubility.

Keywords: Wheat, INM, ghanjivamrut, jivamrut, azophos and vermicompost

Introduction
Wheat plays an important role in total cereal production and global food security. Wheat is the second most important crop in India after rice and contributes nearly 35% to the national food basket. India will require 109 million tons of wheat to feed the population of 1.25 billion by 2020 A.D, which can be achieved by growth rate of 2.2% but the current growth rate is only 1.0%. Wheat cultivation in India occupies 30.42 million hectare area with the production of 99.87 million tones and productivity of 32.83 q ha^{-1}.
Wheat production of India is 99.87 million tons during 2017-18 which is higher by 1.26 million tonnes than the production of 98.61 million tonnes achieved during 2016-17 [1].It is very difficult to meet the food demand in future because land is shrinking and pressure on productivity enhancement is also increasing. To curb this trend there is a need to adopt the concept of integrated nutrient management. Improving and maintaining soil quality for enhancing and sustaining agricultural production is of utmost importance for India's food and nutritional security. Integrated plant nutrient system (IPNS) has assumed a great importance and has vital significance for the maintenance of soil productivity. However, organic manures particularly FYM are important components of integrated nutrient management. Phosphorus plays a vital role in several key physiological process *viz*., photosynthesis, respiration, energy storage, cell division and cell enlargement. Moreover, it is essential for seed formation and root development [5].
Phosphorus is the major plant growth limiting nutrient despite being abundant in soil in both organic and inorganic form the P content in inorganic soil is about 0.5% (w/w) but only 0.1% of the total P is available to plant because of its low solubility, availability and its fixation in soil. P is limiting factor to crop productivity on an estimated 40% of the world's arable soil. Phosphate solubilizing bacteria (PSB) as bio-fertilizers have been found effective in solubilizing the fixed soil P and applied phosphates resulting in higher crop yields [7]. Therefore, to prove the advancement in agriculture, suitable nutrient management practices combined with organic resources technology should be practiced.

Materials and Methods
The field experiment entitled "Effect of integrated plant nutrient system on phosphorus solubilisation and productivity of wheat in Vertisols" was carried out at Botany Research Farm, College of agriculture, Nagpur. The soil of the experimental field was clayey in texture, slightly alkaline in reaction with medium in organic carbon, low in available nitrogen, medium in available phosphorous and high in available potassium. The field experiment was laid out in randomized block design with seven treatment comprises GM* + 100 % RDF (T_1), Ghanjivamrut 5 t ha^{-1} at incorporation of GM* + 50% RD of NP through inorganic fertilizer

+ jivamrut + Azophos (T_2), Vermicompost 5 t ha^{-1}at incorporation of GM* + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos,(T_3) Neem cake 2 t ha^{-1}at incorporation of GM* + 50% RD of NP through inorganic fertilizer + Jivamrut + Azophos (T_4), Ghanjivamrut 5 t ha^{-1}at incorporation of GM* (T_5), Vermicompost 5 t ha^{-1}at incorporation of GM* + Jivamrut + Azophos (T_6), Neem cake 2 t ha^{-1}at incorporation of GM* + Jivamrut + Azophos (T_7) with three replication. In which GM* means green manuring of Sun hemp (*Crotolaria juncea*). Sunhemp were harvested after 30 days of sowing and incorporated into field by tractor-drawn rotavetor.

The seed of wheat was procured from Agronomy farm College of Agriculture, Nagpur. Seed were screened and used freshly for the experiment to minimize errors in seed germination. Sowing of wheat (AKW-1071) was carried out in an experimental site on 15th November 2019 by drilling. The fertilizers and Ghanjivamrut (combination of FYM and Jivamrut) were applied as per treatment details. Doses of nitrogen, phosphorous and potassium applied through urea, DAP and MOP. Nitrogen was applied in two split doses, 1st dose at the time of sowing and 2nd at 30 DAS. Jivamrut spraying @ 500 litters ha^{-1} was applied at tillering and jointing stage of wheat.

Seed treatment with biofertilizers azophos (Azotobacter + PSB) @ 25 g $kg^{-1}$of seed at the time of sowing. Wheat crop was harvested at physiological maturity and yields (Grain and Straw) were recorded. Grain and straw samples were analysed for nutrient contents using standard methodologies.

Results and Discussion

Effect of integrated plant nutrient system on yield of wheat (q ha^{-1})

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

The data pertaining to grain yield of wheat as affected by various treatments are presented in table1.The result clearly indicated that, the grain yield of wheat was significantly influenced due to incorporation of green manuring and application of 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 Ghanjivamrut 5 t ha^{-1}at incorporation of GM* + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos. and it 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 the decomposition of succulent green manure and well decomposed ghanjivamrut, vermicompost which favoured for greater release of nutrient 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. Application of Ghanjivamrut 5 t ha^{-1}at incorporation of GM* + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos (T_2) produced significantly more grain yield of wheat. which was 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. Jivamrut spraying i.e. 500 litters ha^{-1} was applied at tillering and jointing stage of wheat. Similarly 43.47, 37.97, and 44.49 per cent grain yield of wheat was reduced with the application of Ghanjivamrut 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* + 50% RD of NP through inorganic fertilizer + Jivamrut + Azophos, respectively over treatment T_2. Singh *et al.,* (2018) [11] reported that, the grain yield of wheat (48.45 q ha^{-1}) and straw yield (62.82 q ha^{-1}) was reported with the application of 100 %RDF + 2 t ha^{-1} vermicompost + PSB.

The data further revealed that among the treatment organic manure along with Vermicompost 5 t ha^{-1}at incorporation of GM* + Jivamrut + Azophos resulted the maximum grain yield of wheat (21.50 q ha^{-1}) followed by Ghanjivamrut 5 t ha^{-1}at incorporation of GM* (19.59 q ha^{-1}) and Neem cake 2 t ha^{-1}at incorporation of GM* + Jivamrut + Azophos(19.24 q ha^{-1}). The balanced amount of nutrient is required to maintain the yield of wheat. Only organic manure cannot sustained grain yield of wheat. The data further revealed that the 35.63 to 42.39 per cent grain yield of wheat was reported higher with the application of vermicompost or Ghanjivamrut or neem cake alone.

During green manuring and organic resources decomposition organic acid which not only dissolving phosphate but also reduce P fixation and increase the native element availability for crop which depends on fertility status of soil and management practices. The increase in grain yield with organic manure and organic liquid spray owing to overall development growth of plant since component involved in the activity and absorption of nutrient associated with plant growth.

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

An appraisal of data in table 1 revealed that straw yield of wheat was significantly influenced by different treatment. Among the integrated plant nutrient system application of Ghanjivamrut 5 t ha^{-1}at incorporation of GM* + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos (T_2) gave highest straw yield (43.95 q ha^{-1}) which was significantly higher over all other treatment except T_1: GM*+100%RDF (43.66 q ha^{-1}), which is at par with T_2. Addition of ghanjivamrut with different fertilizer level produced higher straw yield than the application of other treatments. The increase in grain and straw yield might be due to adequate and balanced proportion of plant nutrient supplied to the crops as per during growth period resulting in favourable increased in grain and straw yield.

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

Treatment	Particulars	Yield (q ha^{-1})	
		Grain	Straw
T_1	GM*+100%RDF	33.40	43.66
T_2	Ghanjivamrut 5 t ha^{-1}at incorporation of GM* + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos	34.66	43.95
T_3	Vermicompost 5 t ha^{-1}at incorporation of GM* + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos	33.09	42.68
T_4	Neem cake 2 t ha^{-1}at incorporation of GM* + 50% RD of NP through inorganic fertilizer + Jivamrut + Azophos	29.67	38.42

T_5	Ghanjivamrut 5 t ha^{-1}at incorporation of GM*	19.59	26.41
T_6	Vermicompost 5 t ha^{-1}at incorporation of GM* + Jivamrut + Azophos	21.50	28.23
T_7	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%	3.58	3.90

* GM: Green manuring, RD: Recommended dose, N: Nitrogen, P: Phosphorus

Changes in available phosphorus of soil (kg ha^{-1}) during physiological growth stages of wheat influenced by integrated plant nutrient system

The changes in available phosphorus of soil at tillering and flowering stages of wheat was found significant. The significantly highest available P in soil (17.42 kg ha^{-1}) at tillering and (19.01 kg ha^{-1}) at flowering stage of wheat was recorded with application of vermicompost 5 t ha^{-1} at incorporation of green manure + 50 % RD of NP through inorganic fertilizer + jivamrut + azophos. This might be due to slowly released of phosphorus and maintained greater amount of P in soil at the latter stage of crop. The significant released of available P due to combine 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.

Table 2: Changes in available phosphorus of soil at tillering and flowering stage of wheat as influenced by integrated plant nutrient system

Treatment	Particulars	Available P (kg ha^{-1})	
		At Tillering	At Flowering
T_1	GM* + 100% RDF	16.85	17.99
T_2	Ghanjivamrut 5 t ha^{-1}at incorporation of GM* + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos	17.40	18.30
T_3	Vermicompost 5 t ha^{-1}at incorporation of GM* + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos	17.42	19.01
T_4	Neem cake 2 t ha^{-1}at incorporation of GM* + 50% RD of NP through inorganic fertilizer + Jivamrut + Azophos	16.81	17.93
T_5	Ghanjivamrut 5 t ha^{-1}at incorporation of GM*	16.15	17.53
T_6	Vermicompost 5 t ha^{-1}at incorporation of GM* + Jivamrut + Azophos	16.54	17.71
T_7	Neem cake 2 t ha^{-1}at incorporation of GM* + Jivamrut + Azophos	16.18	17.44
	SE (m) ±	0.27	0.16
	CD at 5%	0.84	0.51

* GM: Green manuring, RD: Recommended dose, N: Nitrogen, P: Phosphorus

Effect of integrated plant nutrient system on fertility status of soil after harvest of wheat

Effect of IPNS on soil pH was found to be non-significant. Soil pH was recorded in between 6.94 to 7.71. The effect of different integrated plant nutrient system found statistically non-significant on electrical conductivity after harvest of crop Electrical conductivity was resulted between 0.23 to 0.34 dSm^{-1}. The effect of integrated plant nutrient system showed that higher organic carbon found in T_2 (5.30 g kg^{-1}) with Ghanjivamrut 5 t ha^{-1}at incorporation of GM* + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos which was at par with T_1 (5.23 g kg^{-1}) and T_3 (5.27 g kg^{-1}).

Table 3: Effect of integrated plant nutrient system on fertility status of soil after harvest of wheat

Treatment	Particulars	pH	EC (dS m^{-1})	OC (g kg^{-1})	Available N (kg ha^{-1})	Available P_2O_5 (kg ha^{-1})	Available K_2O (kg ha^{-1})	Available S (mg kg^{-1})
T_1	GM*+100%RDF	7.55	0.24	5.24	200.7	16.60	478	15.09
T_2	Ghanjivamrut 5 t ha^{-1}at incorporation of GM* + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos	7.63	0.23	5.30	217.4	19.80	474	17.65
T_3	Vermicompost 5 t ha^{-1}at incorporation of GM* + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos	7.71	0.22	5.27	213.2	21.07	482	17.64
T_4	Neem cake 2 t ha^{-1}at incorporation of GM* + 50% RD of NP through inorganic fertilizer + Jivamrut + Azophos	7.50	0.25	5.12	209.0	18.70	470	16.43
T_5	Ghanjivamrut 5 t ha^{-1}at incorporation of GM*	7.68	0.24	5.08	204.8	18.93	456	12.73
T_6	Vermicompost 5 t ha^{-1}at incorporation of GM* + Jivamrut + Azophos	7.36	0.23	5.09	200.6	19.01	462	13.19
T_7	Neem cake 2 t ha^{-1}at incorporation of GM* + Jivamrut + Azophos	6.94	0.23	4.35	204.8	18.40	453	13.86
	SEm ±	0.31	0.04	0.03	11.21	0.20	5.13	0.29
	CD at 5%	NS	NS	0.11	34.44	0.64	15.76	0.89

* GM: Green manuring, RD: Recommended dose, N: Nitrogen, P: Phosphorus

Effect of integrated plant nutrient system on available nutrients in soil (kg ha^{-1}) after harvest of wheat

The result pertaining to fertility status of soil after harvest of crop is presented in table 3. In the present study available nitrogen of soil was observed between 200.7 to 217.4 kg ha^{-1}. The maximum available nitrogen was observed 217.4 kg ha^{-1} (T_2) with the application of Ghanjivamrut 5 t ha^{-1}at incorporation of GM* + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos which remained at par with T_1 (200.7 kg ha^{-1}) with GM*+ 100 % RDF and T_3 (213.2 kg ha^{-1}) with vermicompost 5 t ha^{-1} at incorporation of green manure + 50 % RD of NP through inorganic fertilizer + jivamrut + azophos**.** Available phosphorus of soil was observed between 16.60 to 21.07 kg ha^{-1} the maximum available P was observed 21.07 kg ha^{-1} with the application of Vermicompost 5 t ha^{-1}at incorporation of GM* + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos was found significantly superior over all other treatment. At harvest stage the available P had slightly increased in all the treatment. Moharana *et al.*, (2015) [6] found that, the plot receiving 50% NPK + RP enriched compost resulted in 100.8, 95.2 and 100 per cent greater build in available phosphorus over unfertilized control in CRI, flowering and maturity stage of wheat, respectively.

In the present study available potassium of soil was observed between 453 to 482 kg ha^{-1} the maximum available potassium was found 482 kg ha^{-1} with the application of T_3: Vermicompost 5 t ha^{-1}at incorporation of GM* + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos was significantly higher over other treatment and found at par with T_1: GM*+100%RDF, T_2: Ghanjivamrut 5 t ha^{-1}at incorporation of GM* + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos and T_4: Neem cake 2 t ha^{-1}at incorporation of GM* + 50% RD of NP through inorganic fertilizer + Jivamrut + Azophos. The available potassium in the soil registers the higher value in all the replication. Available K in soil increase due to addition of organic sources and chemical fertilizer may be ascribed to the reduction of K fixation and release of K due to interaction of organic material with clay. The sufficient range of available sulphur in the soil is found in the experimental area.

Total uptake of nutrient (kg ha^{-1}) of wheat as influenced by integrated plant nutrient system

Total uptake of nitrogen, phosphorus and potassium by wheat grain and straw recorded high with the application of Ghanjivamrut 5 t ha^{-1}at incorporation of GM* + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos. Highest total uptake of nitrogen (100.6 kg ha^{-1}), phosphorus found (25.73 kg ha^{-1}) and potassium found (85.58 kg ha^{-1}), respectively. Total uptake of nutrient increased with integration of organic manure and bio-fertilizer the higher nutrient uptake attributed to solubilization of native nutrients chelation of complex intermediate organic molecules produced during decomposition of added organic manure their mobilization and accumulation of different nutrient in different plant parts. Interaction of vermicompost in integrated plant nutrient system resulted higher uptake of nutrient. This may be due to enhanced retention of nutrient and reduced fixation capacity of soil.

Table 4: Effect of integrated plant nutrient system on total uptake of NPK by grain and straw (kg ha^{-1}) after harvest of wheat

Treatment N.	Treatments	Total uptake of NPK (kg ha^{-1})		
		N	P	K
1	GM* + 100% RDF	95.33	21.82	77.71
2	Ghanjivamrut 5 t ha^{-1}at incorporation of GM* + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos	100.6	25.73	85.58
3	Vermicompost 5 t ha^{-1}at incorporation of GM* + 50% RD of NP through inorganic fertilizer + jivamrut + Azophos	99.17	25.41	83.99
4	Neem cake 2 t ha^{-1}at incorporation of GM* + 50% RD of NP through inorganic fertilizer + Jivamrut + Azophos	83.68	19.88	68.88
5	Ghanjivamrut 5 t ha^{-1}at incorporation of GM*	53.26	12.15	41.85
6	Vermicompost 5 t ha^{-1}at incorporation of GM* + Jivamrut + Azophos	57.28	13.73	48.60
7	Neem cake 2 t ha^{-1}at incorporation of GM* + Jivamrut + Azophos	49.23	12.68	42.66
	SE(m) ±	2.26	0.74	1.86
	CD at 5%	6.94	2.27	5.71

* GM: Green manuring, RD: Recommended dose, N: Nitrogen, P: Phosphorus

Conclusion

The result of present investigation leads to draw the following conclusions:

It can be concluded from present study that, the use of Ghanjivamrut @ 5 t ha^{-1} at incorporation of green manuring in combination with 50 % RD of chemical fertilizers + biofertilizers is the suitable nutrient source for maintaining soil available phosphorus nutrient at physiological growth stage and fertility status. It also improves the uptake of nutrient and yield of wheat with the IPNS practice, there by 50 % chemical fertilizers can be saved and increase solubility.

References

1. Anonymous. Agricultural stat at glance. Government of India 2019.
2. Bertrand I, Holloway RE, Amostrong RD, McLaughlin MJ. Chemical characteristics of phosphorus in alkaline soils from southern Australia. Aust J Agric Res 2003;41:16-76.
3. Chesnin L, Yien CH. Turbidimetric determination of available Sulphates. Soil Sci Soc America proceedings 1951;15:149-151.
4. Jackson ML. Soil Chemical Analysis prentice hall of India. Private Limited New Delhi 1973, P151-153.
5. Memon KS, Rashid A. Phosphorus plays vital role in several physiological processes In soil science. National Book Foundation, Islamabad 2001, P291-294.
6. Moharana PC, Biswas DR, Datta SC. Mineralization of Nitogen, Phosphorous and Sulphur in soil influenced by rock phosphate enriched compost and chemical fertilizers. J of Indian Soc S Sci 2015;63:283-293.

7. Panhwar QA, Shamshuddin J, Naher UA, Radziah O, MohdRazi I. Biochemical and molecular characterization of potential phos-phate solubilizing bacteria in acid sulfate soils and their beneficial effects on rice production. PLOS ONE 2013;9(10):9724.
8. Pattnyak SK, Sureshkumar P, Tarafdar JC. New vista in phosphorous research. J Indian Soc Soil Sci 2009;57(4):536-545.
9. Piper CS. Soil and plant analysis. Hans Publisher, Bombay 1966, P368.
10. Shahzado N, Kalhoro SA, Amjad A, Ama-nullah M, Sajjad R, Muneer A, Shah SFA, Baloch S. Effect of different levels of phosphorus and method of application on the growth and yield of wheat. Nat Sci 2016;8(7):305-314.
11. Singh G, Kumar S, Sindhu GS, Kaur R. Effect of nutrient management on yield of wheat under irrigated conditions. Int J Chem Studies 2018;6:904-907.
12. Subbaiah BV, Assija GL. A rapid procedure for the estimation of available nitrogen in soils. Current Sci 1956;25:259-260.
13. Walkley NM, Black AI. Estimation of organic carbon by chromic acid titration method Soil Science 1934;25:259-263.