*International Journal of Plant & Soil Science*

***Volume 34, Issue 24, Page 614-619, 2022; Article no.IJPSS.95550***
***ISSN: 2320-7035***

# Effect of Integrated Nutrient Management on Nutritional Quality, Uptake and Yield of Wheat in Vertisol

**Hrushikesh B. Gund [a++*], R. M. Ghodpage [b#], Nishigandha R. Mairan [b†], Padmaja H. Kausadikar [b†], Nirmitha Mareddy [a++] and Sanchet Y. Gaikwad [a++]**

*[a] Soil Science and Agricultural Chemistry Section, Dr. PDKV, Akola, Maharashtra-444104, India.*
*[b] Soil Science and Agricultural Chemistry Section, College of Agriculture, Nagpur, India.*

***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

***Article Information***

DOI: 10.9734/IJPSS/2022/v34i242681

**Open Peer Review History:**
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/95550

***Original Research Article***

***Received: 25/10/2022***
***Accepted: 28/12/2022***
***Published: 29/12/2022***

## ABSTRACT

The present investigation was carried out during *rabi* season of 2021-22. at Agricultural Botany research farm, College of Agriculture, Nagpur. The treatment tested were $T_1$-GM*+100 % RDF, $T_2$-Ghanajivamrut 5 t $ha^{-1}$ at incorporation of GM* + 50 % RD of NP through inorganic fertilizers + Jivamrut + Azophos, $T_3$- Vermicompost 5 t $ha^{-1}$ at incorporation of GM* + 50 % RD of NP through inorganic fertilizers + Jivamrut + Azophos, $T_4$-Neem cake 2 t $ha^{-1}$ at incorporation of GM* + 50 % RD of NP through inorganic fertilizers + Jivamrut + Azophos, $T_5$-Ghanajivamrut 5 t $ha^{-1}$ at incorporation of GM*, $T_6$- Vermicompost 5 t $ha^{-1}$ at incorporation of GM* + Jivamrut + Azophos and $T_7$- Neem cake 2 t $ha^{-1}$ at incorporation of GM* + Jivamrut + Azophos. The result showed that the grain yield

*[++] PG student;*
*[#] Professor;*
*[†] Assistant Professor;*
**Corresponding author: E-mail: hrushikeshgund01@gmail.com;*

of wheat varied from 21.03 to 31.36 q $ha^{-1}$ and straw yield of wheat from 27.45 to 41.10 q $ha^{-1}$ It was noted the N uptake varied from 48.40 to 78.84 kg $ha^{-1}$, P from 10.38 to 20.52 kg $ha^{-1}$ and K from 48.80 to 77.82 kg $ha^{-1}$. The protein content in wheat varied from 10.93 to 11.81 per cent, carbohydrate, crude fibre and calcium in wheat grain varied from 70.82 to 71.92, 2.56 to 2.63 and 0.40 to 0.48 pe cent, respectively. The methionine, cysteine and lysine content in wheat varied from 1.36 to 1.45, 1.41 to 1.47 and 2.42 to 2.53 g / 16 g N. The application of Vermicompost @ 5 t $ha^{-1}$ at incorporation of GM* + 50 % RD of NP through inorganic fertilizers + Jivamrut + Azophos was found most suitable treatment in respect of crop yield, uptake of nutrient and quality of wheat.

*Keywords: Wheat; vermicompost; ghanajivamrut; jivamrut; GM-Green manuring.*

## 1. INTRODUCTION

"Wheat (Triticum aestivum L.) is the nation's most important crop after rice. The demand for wheat is expected to reach 950 million tonnes per year by 2020 on a global scale. Only with an annual rise in world wheat production of roughly 2.5% will this goal be met" [1]. "It covered 300 lakh hectares in India, producing 93.50 million tonnes, with a productivity of 3117 kg ha-1. India had produced 109.52 million tonnes of wheat in 2021. In Maharashtra, wheat is grown on an area of 13.52 lakh $ha^{-1}$ with total production of 20.8 lakh tons and productivity of 1708 kg $ha^{-1}$" [2]. "In India the highest productivity of wheat is recorded in Punjab, whereas Maharashtra stands 8th rank with productivity of 20.8 t $ha^{-1}$" [2]. Wheat has evolved into not just a staple food for a sizable portion of India's population but also the hope for preventing widespread hunger [3]. The majority of the soil in Maharashtra's Vidharbha region is medium black soil with poor N and S condition [4]. The yield of the wheat crop and its protein content could both rise with the application of various fertilisers. Maharashtra's relatively lower productivity is a result of a number of factors, including a lack of irrigation infrastructure, an unbalanced fertiliser use pattern, and a lack of knowledge of contemporary agronomic practises, such as the use of suitable genotypes, appropriate sowing times, seed rates, spacing, weed control, fertilisation, plant protection measures, and manures, among others [4].

Vermicompost increases uptake of available nutrients in wheat. Azophos increases growth of grain and straw yield of wheat crop. In view of the above, the present experiment was performed with intension of investigating the benefits of integrated nutrient management in terms of yield, nutrient uptake and wheat quality.

## 2. MATERIALS AND METHODS

The experiment was conducted Agricultural Botany Research farm, College of Agriculture, Nagpur during *rabi* season 2021-22 the variety AKW -1071 was taken for study. The experiment was laid out in randomized block design with seven treatments and three replications. The initial characteristics of soil were analysed to know the nutrient status of soil. The soil in the experimental field had a clayey texture, reacted somewhat alkaline, was medium in organic carbon content, had a low availability of nitrogen, a medium availability of phosphorus, and a high availability of potassium. Sunhemp was sown as green manure on 08 Oct and crop was incorporated in soil after 30 days of sowing. Wheat was sown in third week of November using 100 kg seed $ha^{-1}$. Fertilizers used were urea, single super phosphate and muriate of potash. Six irrigations were given at critical stages of wheat. Spraying of jivamrut @500 litre $ha^{-1}$ was applied at tillering and jointing stage of wheat.

"The samples were processed and analysed in the laboratories of Soil Science and Agricultural Chemistry section, College of Agriculture, Nagpur during 2021-22. In plant and grain analysis total nitrogen was estimated by Kjeldahl's method described by" [5]. "Total phosphorus was determined by molybdate ammonium method" [6] and "total potassium content determined by flame photometer method" [6]. Carbohydrate was estimated by Phenol-sulphuric acid (Dubois,1956), protein content was determined by Kjeldahl's method [5], crude fibre was determined by Acid hydrolysis method (Anonymous,1977), methionine, cysteine and lysine estimated by spectrophotometric method (Horn,1946), Calcium content from grain estimated by EDTA method [6]. Grain and straw yield were also recorded.

**Preparation of jivamrut:** It was prepared with cow dung 10 kg plus Cow urine 10 litres plus Jaggary 2 kg plus 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 ha¹. The whole process was made and left in shade for increase the activity of microorganism.

**Preparation of Ghanajivamrut:** Pit size of 10 x 5 x 2.5 feet dimension was prepared 500 kg fresh FYM and 50 l jivamrut was taken in the pit. Mixture was covered the mixture properly with any straw material available and it was kept for one week for decomposition of material. After one week mixture of FYM was and jivamrut was mixed properly. Fallowed the similar process for 3-4 times at an interval of one week. 40-45 days were required to complete process to get Ghanajivamrut.

## 3. RESULTS AND DISCUSSION

### 3.1 Total Uptake of Nutrients of Wheat as Influenced by Integrated Nutrient Management

#### 3.1.1 Total uptake of nitrogen kg ha$^{-1}$

The results revealed that the total uptake of nitrogen was significantly increased with the incorporation of green manuring and application of inorganic fertilizers in combination with organic manure and biofertilizers. The significantly highest total uptake of nitrogen (78.84 kg ha$^{-1}$) by wheat was observed with the application of Vermicompost 5 t ha$^{-1}$ at incorporation of GM* + 50 % RD of NP through inorganic fertilizer + Jivamrut + Azophos which found at par with treatment $T_1$ GM*+100 % RDF (76.51 kg ha$^{-1}$). With the addition of organic manure and biofertilizers, total nitrogen uptake increased. The increased nutrient uptake is due to several factors, including the solubilization of native nutrients, chelation of complex intermediate organic compounds formed during the decomposition of added organic manure, and accumulation of diverse nutrients in different plant parts. Higher nutrient uptake was the outcome of the interaction of vermicompost with integrated nutrient management practises. This can be the result of improved nitrogen retention and decreased soil capacity for fixation. Kamble et al. [7] showed that the application of 100 % RDF (100:60:40 kg NPK ha$^{-1}$) + FYM @ 5 t ha$^{-1}$. to wheat resulted significantly higher poled total N, P and K uptake of 107.8, 30.2 and 69.5 kg ha$^{-1}$, respectively.

#### 3.1.2 Total uptake of phosphorus kg ha$^{-1}$

Results showed that adding green manuring and applying inorganic fertilisers along with organic manure and biofertilizers considerably boosted the amount of phosphorus that was absorbed overall. Total uptake of P (21.53 kg ha$^{-1}$) was obtained with treatment receiving Vermicompost 5 t ha$^{-1}$ at incorporation of GM* + 50 % RD of NP through inorganic fertilizer + Jivamrut + Azophos and found at par with treatment $T_1$ GM*+100 % RDF (20.52 kg ha$^{-1}$). The release of native P may have been augmented by the solubilizing effect of organic acids created during the breakdown of organic manure, which also encouraged microbial activity in the soil and favoured root growth, both of which ultimately increased P uptake by wheat. The beneficial effect of organic sources on nutrient available it may be ascribed to release of nutrient due to decomposition of organic sources. The addition of biofertilizer and green manuring to inorganic fertiliser increased the amount of phosphorus that crops could access, caused organic phosphorus to mineralize as a result of microbial action, and improved nutrient mobility. P. Singh et al. [8] reported increase in available P through manure and fertilizer in excess of removal by the crop.

#### 3.1.3 Total uptake of potassium kg ha$^{-1}$

It was observed that the potassium uptake was significantly influenced by different treatments. Maximum being 77.82 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 which was significantly at par with treatment $T_1$ (GM* + 100 % RDF). The enhanced uptake of K by wheat may be attributed to the complexing agent's and organic acids' release of K from the K-bearing mineral during the breakdown of organic resources. Singh et al. [9] demonstrated that 50% NPK above the other treatments and 100% NPK + residual impact of FYM @ 10 t ha considerably increased the nitrogen, phosphorus, and potassium uptake of wheat by 121.15, 20.15, and 82.80 kg ha$^{-1}$, respectively.

It could be attributed to the balanced application of NPK in wheat in the form that is now available, along with residual responses from organic manures and inorganic N and P that drive microbial activity when organic sources are present.

## 3.2 Effect of Integrated Nutrient Management on Yield of Wheat

### 3.2.1 Grain yield

The grain yield varied from 21.03 to 31.36 q $ha^{-1}$. Vermicompost @ 5 t $ha^{-1}$ at incorporation of GM* + 50 % RD of NP through inorganic fertilizers + Jivamrut + Azophos gave the highest grain yield followed by treatment $T_1$ GM*+100 % RDF. About 6.86 per cent yield increased with the application of balanced use of organic and inorganic fertilizers in comparison to control. Vyas et al. [10] reported that, the application of NP 120:60 kg $ha^{-1}$ + 10 t FYM $ha^{-1}$ + PSB to wheat resulted good nutrient management practice for getting higher yield of wheat (46.38 q $ha^{-1}$) Singh et al. [11] reported (48.45 q $ha^{-1}$) grain of wheat with the application of 100 % RDF + 2 t $ha^{-1}$ Vermicompost + PSB.

### 3.2.2 Straw yield

"Among the integrated nutrient management treatment, application of Vermicompost 5 t $ha^{-1}$ at incorporation of GM* + 50 % RD of NP through inorganic fertilizers + Jivamrut + Azophos ($T_3$) gave highest straw yield (41.10 q $ha^{-1}$) which was significantly increased over other treatments and it found at par with $T_1$ (GM*+100 % RDF) and $T_2$(Vermicompost 5 t $ha^{-1}$ at incorporation of GM* + 50 % RD of NP through inorganic fertilizer + Jivamrut + Azophos). Addition of Vermicompost with inorganic fertilizers 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 during growth period resulting in favourable increase in grain and straw yield" [12]. Singh et al. [11] found that, 100 % NPK + 10 t FYM $ha^{-1}$ recorded highest straw (5.71 $tha^{-1}$) yield of wheat. Kamble et al. [7] also revealed that straw yield of wheat (4.68 t $ha^{-1}$) was obtained with application of 120:60:40 kg NPK + FYM 5 t $ha^{-1}$ in wheat.

## 3.3 Nutritional Quality of Wheat as Influenced by Integrated Nutrient Management

Data in respect of nutritional quality of wheat affected by integrated nutrient management practices are summarized in Table 1. The highest protein (11.81 %) of wheat grain was recorded with the application of Vermicompost at 5 t $ha^{-1}$ at incorporation of GM* + 50 % RD of NP through inorganic fertilizer + Jivamrut + Azophos. Singh et al. [11] revealed that, the range of protein in wheat grain was from 6.75% at control to 11.75% with 100 % NPK + 10 t FYM $ha^{-1}$. Maximum value of crude fibre (2.63%) was higher in treatment receiving GM*+100 % RDF. Carbohydrate content in wheat (71.92 %) was highest with the application of Ghanajivamrut 5 t $ha^{-1}$ at incorporation of GM*. Singh and Pathak [13] resulted that the starch content in wheat grain was noticed between 2.65 to 2.89 %. The maximum calcium content in wheat grain was observed 0.48 per cent with the application of GM* + 100 %RDF but found statistically non-significant over all other treatments.

The methionine and cysteine content in wheat grain was highest i.e., 1.45 g 16 $g^{-1}$ N and 1.47 g 16 $g^{-1}$ N respectively, with the application of Vermicompost at 5 t $ha^{-1}$ at incorporation of GM* + 50 % RD of NP through inorganic fertilizer + Jivamrut + Azophos. However, lysine content in grain was observed maximum (2.53 g 16 $g^{-1}$ N) in treatment receiving GM*+100% RDF.

**Table 1. Total uptake of nutrients of wheat as influenced by integrated nutrient management**

| Treatments | Total uptake (kg $ha^{-1}$) | | |
|---|---|---|---|
| | N | P | K |
| **$T_1$**- GM + 100%RDF | 76.13 | 20.52 | 75.73 |
| **$T_2$**-Ghanajivamrut 5 t $ha^{-1}$ at incorporation of GM* + 50% RD of NP through inorganic fertilizer + Jivamrut + Azophos | 72.18 | 18.36 | 69.58 |
| **$T_3$**-Vermicompost 5 t $ha^{-1}$ at incorporation of GM* + 50% RD of NP through inorganic fertilizer + Jivamrut + Azophos | 78.84 | 21.53 | 77.82 |
| **$T_4$**-Neem cake 2 t $ha^{-1}$ at incorporation of GM* + 50% RD of NP through inorganic fertilizer + Jivamrut + Azophos | 62.70 | 15.90 | 61.04 |
| **$T_5$**-Ghanajivamrut 5 t $ha^{-1}$ at incorporation of GM*+ Jivamrut + Azophos | 53.18 | 12.37 | 52.94 |
| **$T_6$**-Vermicompost 5 t $ha^{-1}$ at incorporation of GM* + Jivamrut + Azophos | 51.04 | 12.65 | 52.34 |
| **$T_7$**-Neem cake 2 t $ha^{-1}$ at incorporation of GM* + Jivamrut + Azophos | 48.40 | 10.38 | 48.80 |
| SE (m) ± | 1.55 | 0.88 | 2.63 |
| CD at 5 % | 4.38 | 2.62 | 7.87 |

**Table 2. Effect of integrated nutrient management on yield of wheat**

| Treatments | Yield (q ha$^{-1}$) | |
|---|---|---|
| | Grain | Straw |
| $T_1$-GM*+100%RDF | 29.21 | 38.87 |
| $T_2$-Ghanajivamrut 5 t ha$^{-1}$ at incorporation of GM* + 50% RD of NP through inorganic fertilizer + Jivamrut + Azophos | 28.58 | 37.30 |
| $T_3$-Vermicompost 5 t ha$^{-1}$ at incorporation of GM* + 50% RD of NP through inorganic fertilizer + Jivamrut + Azophos | 31.36 | 41.10 |
| $T_4$- Neem cake 2 t ha$^{-1}$ at incorporation of GM* + 50% RD of NP through inorganic fertilizer + Jivamrut + Azophos | 25.58 | 33.13 |
| $T_5$- Ghanajivamrut 5 t ha$^{-1}$ at incorporation of GM*+ Jivamrut + Azophos | 22.54 | 29.35 |
| $T_6$- Vermicompost 5 t ha$^{-1}$ at incorporation of GM* + Jivamrut + Azophos | 21.62 | 28.37 |
| $T_7$- Neem cake 2 t ha$^{-1}$ at incorporation of GM* + Jivamrut + Azophos | 21.03 | 27.45 |
| SE(m) ± | 1.23 | 1.59 |
| CD at 5% | 3.67 | 4.70 |

**Table 3. Nutritional quality of wheat as influenced by integrated nutrient management**

| Treatments | Carbohydrate (%) | Protein (%) | Crude fibre (%) | Calcium (%) |
|---|---|---|---|---|
| $T_1$- GM* + 100%RDF | 70.90 | 11.75 | 2.63 | 0.48 |
| $T_2$- Ghanajivamrut 5 t ha$^{-1}$at incorporation of GM* + 50% RD of NP through inorganic fertilizer + Jivamrut + Azophos | 70.96 | 11.56 | 2.62 | 0.43 |
| $T_3$-Vermicompost 5 t ha$^{-1}$at incorporation of GM* + 50% RD of NP through inorganic fertilizer + Jivamrut + Azophos | 70.82 | 11.81 | 2.60 | 0.47 |
| $T_4$-Neem cake 2 t ha$^{-1}$ at incorporation of GM* + 50% RD of NP through inorganic fertilizer + Jivamrut + Azophos | 71.37 | 11.50 | 2.59 | 0.42 |
| $T_5$-Ghanajivamrut 5 t ha$^{-1}$ at incorporation of GM*+ Jivamrut + Azophos | 71.89 | 11.00 | 2.57 | 0.41 |
| $T_6$-Vermicompost 5 t ha$^{-1}$ at incorporation of GM* + Jivamrut + Azophos | 71.61 | 11.13 | 2.60 | 0.41 |
| $T_7$-Neem cake 2 t ha$^{-1}$ at incorporation of GM* + Jivamrut + Azophos | 71.92 | 10.93 | 2.56 | 0.40 |
| SE (m) ± | 0.31 | 0.08 | 0.04 | 0.02 |
| CD at 5% | NS | 0.24 | NS | NS |

*NS- Non-Significant*

**Table 4. Effect of integrated nutrient management on amino acids in wheat grain**

| Treatments | Sulphur containing amino acid | | Lysine (g16 g$^{-1}$ N) |
|---|---|---|---|
| | Methionine (g 16 g$^{-1}$ N) | Cysteine (g 16 g$^{-1}$ N) | |
| $T_1$-GM + 100%RDF | 1.39 | 1.43 | 2.53 |
| $T_2$-Ghanajivamrut 5 t ha$^{-1}$at incorporation of GM* + 50% RD of NP through inorganic fertilizer + Jivamrut + Azophos | 1.42 | 1.47 | 2.48 |
| $T_3$-Vermicompost 5 t ha$^{-1}$at incorporation of GM* + 50% RD of NP through inorganic fertilizer + Jivamrut + Azophos | 1.45 | 1.47 | 2.52 |
| $T_4$-Neem cake 2 t ha$^{-1}$ at incorporation of GM* + 50% RD of NP through inorganic fertilizer + Jivamrut + Azophos | 1.40 | 1.45 | 2.47 |
| $T_5$-Ghanajivamrut 5 t ha$^{-1}$ at incorporation of GM*+ Jivamrut + Azophos | 1.40 | 1.44 | 2.44 |
| $T_6$-Vermicompost 5 t ha$^{-1}$ at incorporation of GM* + Jivamrut + Azophos | 1.36 | 1.41 | 2.42 |
| $T_7$-Neem cake 2 t ha$^{-1}$ at incorporation of GM* + Jivamrut + Azophos | 1.41 | 1.43 | 2.43 |
| SE (m) ± | 0.02 | 0.02 | 0.04 |
| CD at 5% | NS | NS | NS |

*NS- Non-Significant*

## 4. CONCLUSION

It can be concluded from present study that, the use of Vermicompost @ 5 t $ha^{-1}$ at incorporation of green manuring with addition of 50 % RD of chemical fertilizers + biofertilizers + two spraying of Jivamrut at tillering and jointing stage leads the suitable nutrient source for maintaining the fertility status, uptake of nutrients, quality and yield of wheat in Vertisol.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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