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Research Article

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# Response of Integrated Nutrient Management (INM) on Growth, Yield, and Nutrient use Efficiency of Wheat under Irrigated Conditions

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## Abstract

To feed Pakistan's rapidly growing population, wheat productivity must be increased through balanced nutrition. Chemical fertilizer prices are rising and there is low nutrient use efficiency, as well as excessive or imbalanced use of chemical fertilizers. Integrated nutrient management treatments -the use of bio-fertilizer plus inorganic fertilizers-is a promising technology that not only increases crop yield, nutrient use efficiency. A field experiment was conducted at Naseerabad (Baluchistan) to assess the effect of (bio-fertilizer, inorganic fertilizers including Zn plus Boric Acid) on wheat crop production and nutrient use efficiency under irrigated conditions. A randomized complete block design was used to arrange the treatments (RCBD). Comprised with four treatments (INM NPK@120:90:60kg/ha$^{-1}$ Zn 5 kg, Boric acid 1 Kg/ha$^{-1}$) FP treatment NP@75:50 kg/ha$^{-1}$RDFtreatment.NPK,100.80.50 kg/ha$^{-1}$and control treatment. This bio fertilizer plus chemical fertilizer significantly improves wheat growth parameters such as plant height, number of grains spiked, straw, and grain yield. Similarly, integrated nutrient management technology significantly increased N, P, and K uptake in wheat grain content while increasing nutrient use efficiency. The highest grain yield was recorded (4.9 t/ha$^{-1}$) in integrated nutrient management treatments with 120 kg N, 90 kg P, 60 kg K, 5 kg Zn, and 1 kg B ha$^{-1}$ combined with bio-fertilizer plus farmyard manure. It resulted in a 25% increase over farmer practice (FP) and a 9% increase over the RDF treatment. The use of balance fertilizer in wheat resulted in significantly increased the wheat crop yield also improved agronomic parameters

**Keywords:** Integrated nutrient management; wheat; nutrient use efficiency (NUE)

## Introduction

Wheat (*Tritium aestivum* L.) a stable staple food that is grown extensively worldwide. It is vital to increase wheat yield in accordance with the nation's rapid population growth. In response to the issues posed by increased food consumption, In Pakistan, the average wheat output is 3.0 tons per hectare GOP (Shar, Jiskani, & Qi, 2021). Our nation's population is expanding quickly, so it is important to increase wheat productivity in line with this trend. Given that the population is growing at a rate of 1.8% annually, increasing productivity is crucial to addressing the challenges facing by increased food consumption. The goals are to increase wheat productivity from 3.0 t/ha$^{-1}$ to 3.5 t/ha$^{-1}$ by 2025 and to 3.8 t/ha$^{-1}$ with a total production of 34.3 million tons by 2030. (GOP 2020-21) Low wheat productivity is caused by a number of problems including incorrect and uneven irrigation plus fertilization, time of planting, use of low-quality seed, etc. (Aslam, 2016). The unbalanced and excessive use of chemical fertilizers may disrupt the soil biota, which ultimately hinders sustainable output. They have caused serious health and environmental risks in addition to degrading, polluting, and less productive soils. In addition to biological nitrogen fixation, bio-fertilizers are thought to act as growth regulators, which together produce a significantly stronger response on many growth and yield-attributing indices (Saiyad, 2014; Soomro *et al*, 2022). Integrated nutrient management is a technique which emphasis on balance use of fertilizer. Since integrated nutrient management (INM) has numerous positive effects on the soil ecosystem, the experiment was conducted to examine the impact of INM on the growth, yield, and nutrient use efficiency of wheat under irrigated conditions at Naseerabad. Bioorganic fertilizers are an environmentally friendly, low-cost input that improve organic matter and provide essential plant nutrients.

## Materials and Methods

To assess the balance use of nutrient in wheat crop productivity (Akbar) and Nutrient management through integrated nutrient management under irrigated condition at Baluchistan (Naseerabad). The

field experiment was conducted in rabi season 2021–2022, we have collected pre-sowing soil samples for physicochemical analysis using the ICARDA manual George Estefan *et al*. the detail of soil analysis is presented in (Table 1) (Estefan, Sommer, & Ryan, 2013). Three replications of the randomized complete block design (RCBD) were design to the various treatments. Control (no fertilizer) was the treatment, followed by Farmer Practice (FP), the Recommended Fertilizer Dose (RDF), and Integrated Nutrient Management (INM) with N, P, K, Zn, and B at 120, 90, 60, 5 and 3 kg $ha^{-1}$. Bio fertilizer @of 8 ton per acre, NM and farmer Practices were applied in this study. At maturity, agronomic parameters including No of tillers, spike length, grain per spike, 1000 grain weight, grain and straw yield, plant samples were dried to a consistent weight in an oven at 60 ºC. Samples of grain and straw remained pulverized in a Wiley mill. Nitric acid was used to degrade the ground samples: Per chloric acid (2:1 1N) mixture to estimate N, P, K and Zn (Waterlot, Pruvot, Ciesielski, & Douay, 2011). Statistics 8.1 was used to compare means by LSD at $p \leq 0.05$ (Gomez & Gomez, 1984).

**Table-1: Physico-chemical Analysis of soil at Naseerabad**

| **Parameters** | **Units** | **Values** |
|---|---|---|
| Soil pH (1:1) | - | 8.1 |
| Soil ECe (1:1) | dS $m^{-1}$ | 0.53 |
| Soil OM | % | 0.5 % |
| NO3-N (ABDTPA) | mg$kg^{-1}$ | 1.41 |
| Extractable P (ABDTPA) | | 5.0 |
| Extractable K | | 148 |
| Soil Texture | | Clay Loam |

**OM-Organic matter**

## Results and Discussion

Integrated nutrient management treatments significantly (p 0.05) increased wheat crop, growth, and yield, also presented in the (table 2). The greater wheat grain yield, 4.2 t/ $ha^{-1}$ was recorded in the treatment of (bio-fertilizer and farmyard manure, Plus Integrated nutrient management treatments). This was 23% more than farmer practice and 11% greater than the prescribed dose of fertilizer (RDF), respectively. These results were in line with those of Chesti *et al.* and Hyder *et al*. who conducted research showing that the combination use of bioorganic and chemical fertilizers considerably increased growth and production (Chesti, Kohli, & Sharma, 2013; Khan, Rahman, Haider Gh, & Ikram, 2021). The percentage of organic matter in the soil was increased by additional organic materials like humic acid and biozote, which was important for boosting soil fertility. With the addition of organic materials, the soil's physical condition improved, but the pH of the soil decreased as a result of the release of different acids and acid-forming chemicals. Since plant nutrients were more readily available as a result of the soil pH being lower, plants absorbed more of the different nutrients as a result. Greater nutrient absorption in wheat resulted in an improvement in the metabolic process. NUE thus increased significantly Khan *et al*., and agronomic parameters including grain, straw yield, no of tillers, and Grain per spike also increased significantly (Khan *et al*., 2021). INM treatments resulted in increased plant height and the No of tillers (Table 2). with Tillers and wheat yield increased because to Balance use of fertilizers as compared to farmer practice which remain low due poor nutrient supply. Under INM, the greater No of tillers (75 $m^{-2}$) was reported, whilst the fewest tillers (54 $m^{-2}$) were recorded in control. Similar finding was obtained by Nethra and Hyder *et al*. INM greatly improved the yield characteristics (Hyder *et al*., 2020; Nethra, Jayaprasad, & Kale, 1999). The highest plants, found 85.cm in height, whereas control produced the shortest plants value 55.0 cm. According to similar finding by Hyder *et al.*, INM technology boosted plant height (Hyder *et al*., 2020). Shown in (Table 2), Results are in line with Wailare *et al*. (Wailare¹ & Kesarwani, 2017). The application of 100, 150 and 200% NPK and STV based NPK levels significantly increased plant height, number of tiller plant1, length of spikelet, number of grains spikelet-1 , grain and straw yield of wheat over control In INM treatments the wheat crop significantly improved the number of grains $spike^{-1}$. The highest number of grains $spike^{-1}$ (54) and the lowest number of grains $spike^{-1}$ were found in the control group (39). Similar findings were reported by Hyder *et al.* who found that the addition of balance fertilizer in wheat crop enhanced the number of tillers, the number of grains, and the weight of 1000 grains weight which significantly increased wheat productivity (Hyder *et al*., 2020). The highest value of 1000 grain weight was reported by treatment with INM fertilizer at (45 g), while the least value was found in control (32g). Similar studies indicated that farmyard manure and phosphorus-solubilizing bacteria (PSB) with chemical phosphorus considerably boosted yield parameters (Pratibha & Aery, 2004). The Maximum straw yield (7.1 t/$ha^{1}$) was observed in balance fertilizer treatment as comparison to control treatment (3.9 t/$ha^{-1}$). Similar findings were reported by Khaliq *et al.* who found that applying balance fertilizer and efficient microbes combined with NPK led to the maximum wheat and cotton production and was more profitable economically than fertilizer application alone (Khaliq, Abbasi, & Hussain, 2006).

**Table. 2 Wheat productivity-growth and yield parameters as affected by INM application**

| Treatment | Tillers ($m^{-2}$) | Plant height (cm) | Grain/spike | 1000 grain weight (g) | Straw yield (t/ha) | Grain yield (t/ha) |
|---|---|---|---|---|---|---|
| **Control** | 54d | 55.6d | 39c | 32d | 3.9c | 2.27d |
| **FP** | 64c | 65c | 46b | 38c | 5.5b | 2.9c |
| **RDF** | 69.7b | 73b | 49ab | 41b | 6.2b | 3.5b |
| **INM** | 75a | 85a | 54a | 45a | 7.1a | 4.2a |
| **LSD** | **3.98** | **4.35** | **6.6** | **0.998** | **0.71** | **0.37** |

LSD-Least significant difference, cm-centimeter, g-gram

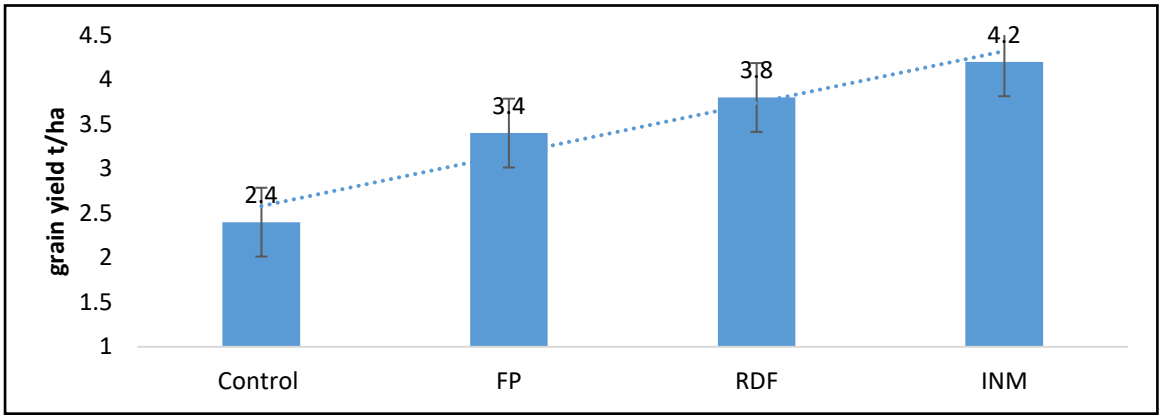


**Figure. 1 wheat grain yield as affected by INM**

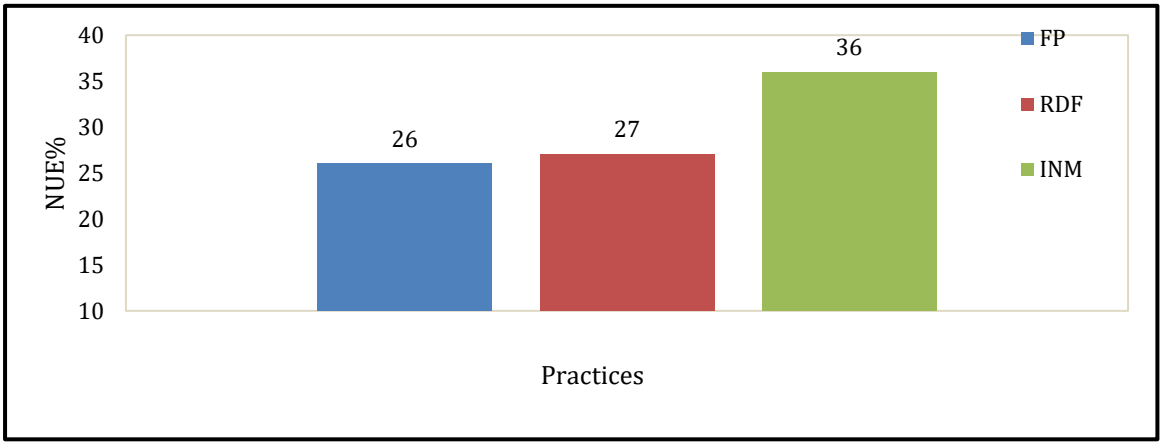


**Figure. 2 NUE% as effected by INM**

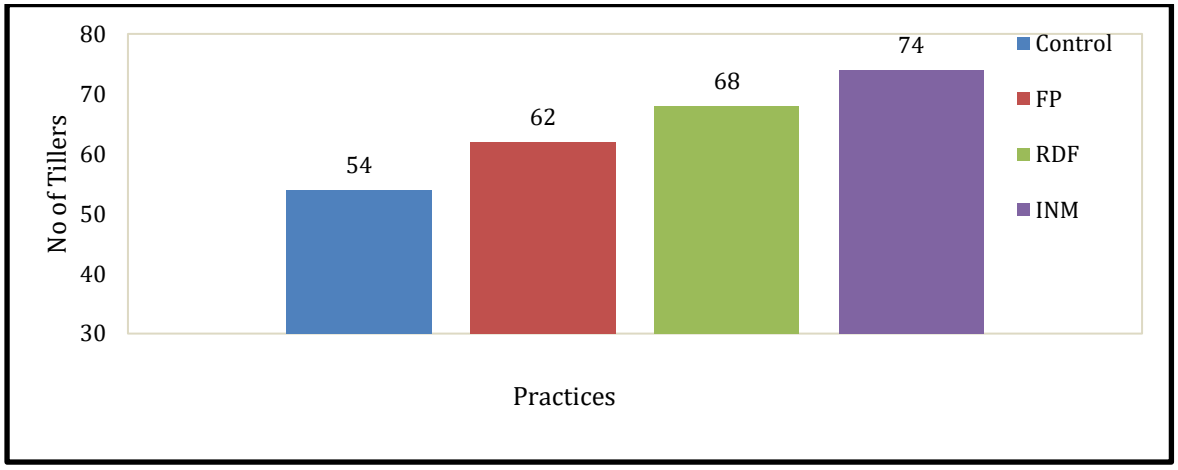


**Figure. 4 No of Tiller as affected by INM**

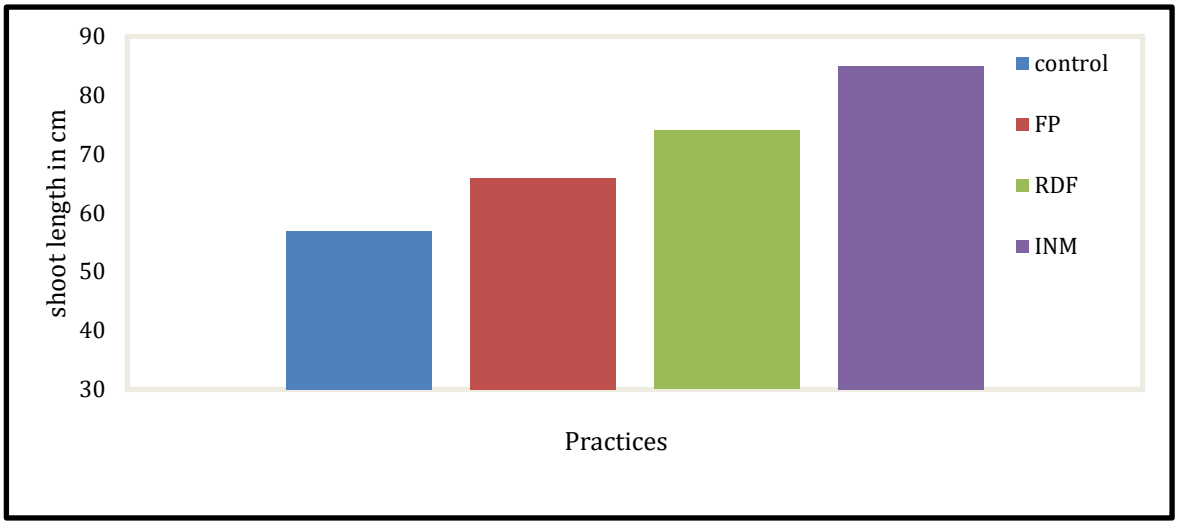


**Figure. 5 Shoot length as effected by INM**

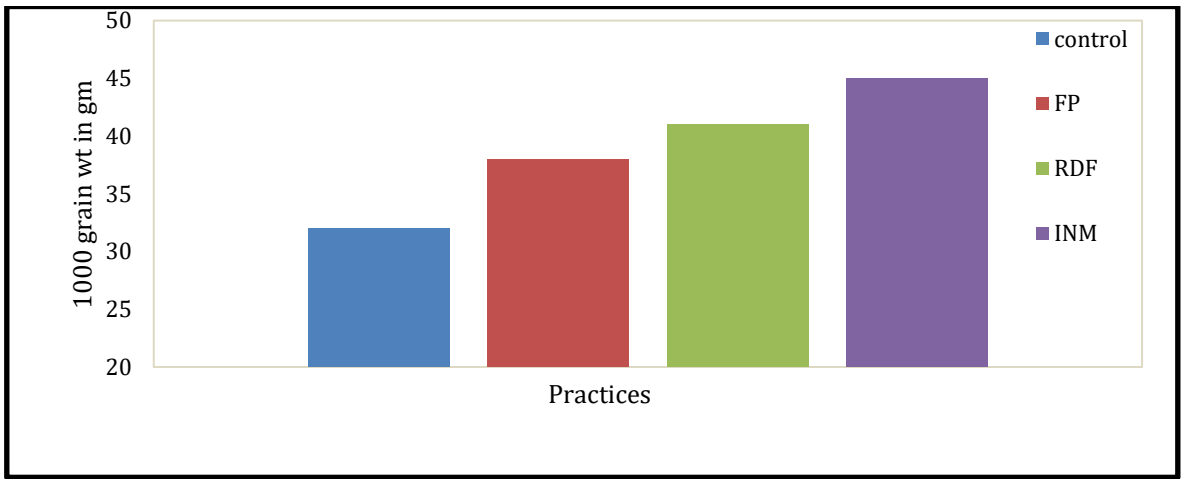


**Figure. 6 Grain weight as effected by INM**

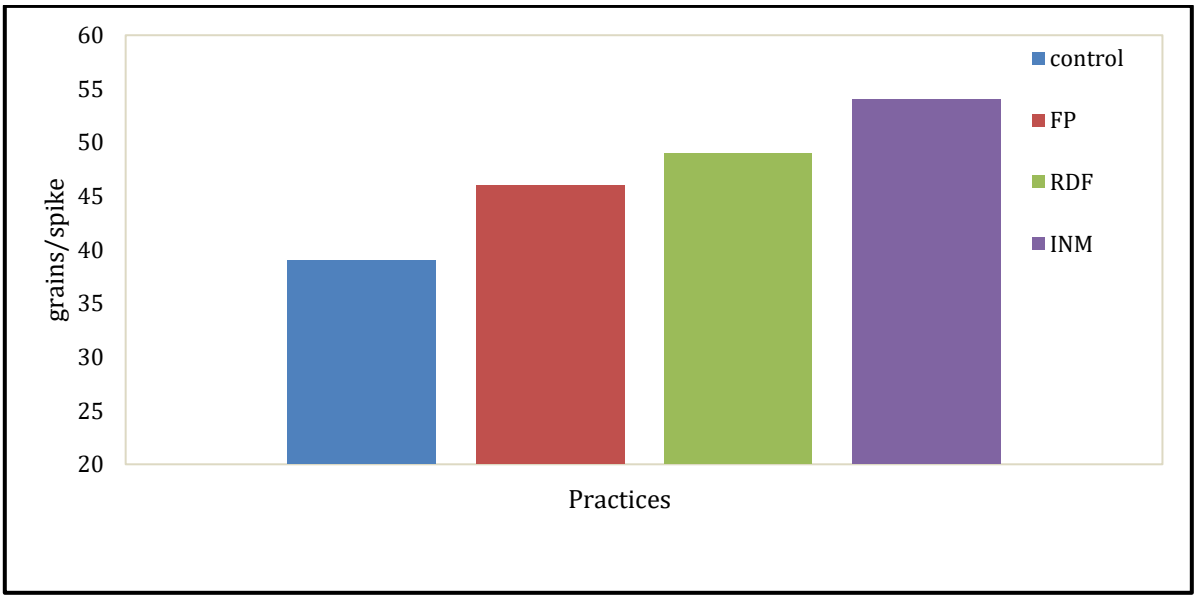


**Figure. 7 Grain per spike as effected by INM**

(INM) Integrated nutrient management: In comparison to FP, RDF, and control, INM treatments reported the highest values of N, P, K, and Zn. Similar result was reported by Nehra and Hyder *et al.* (HYDER *et al.*, 2021). The finding was consistent with the research's Dixit *et al.* (Dixit & Gupta, 2000). Similar finding reported by Shafique who observed that the balance use of NPK fertilizers combined with bio fertilizers boosted the NPK concentration in wheat grain (Shafique, 2000). This may be the resulted of balance use of fertilizer which improve the nutrient availability to crops directly from organic and inorganic sources, and to improved nutrient usage efficiency. With the use of INM, the greatest NPK% values were 3.47, 0.59, and 1.71%, respectively.

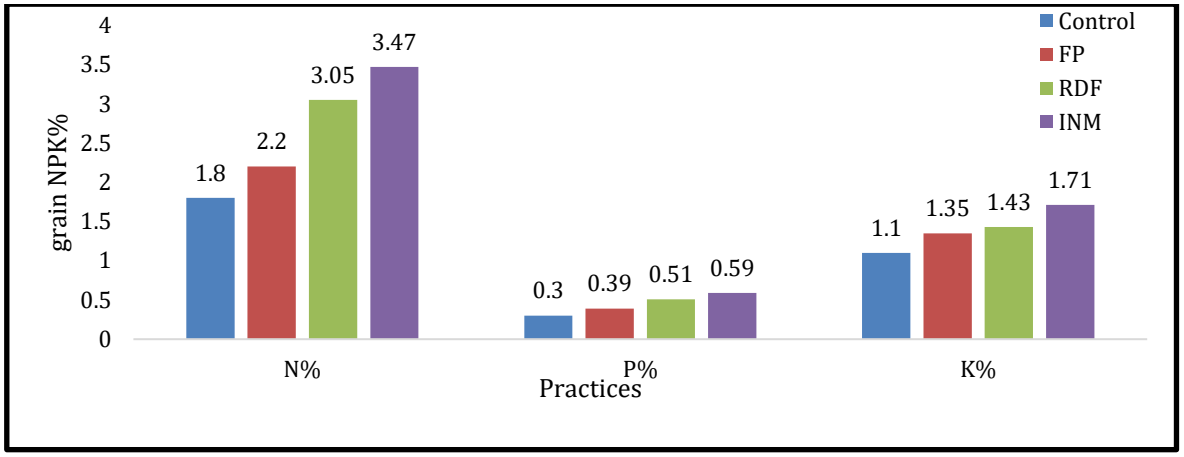


**Figure. 8 Grain NPK% as improved by INM**

Where INM treatments were used, the highest Soil NO3, P, and Soil K (ppm) values (2.43, 3.7, and 185) were noted (Fig 4, 5, 6 and 7). These results are consistent with Cheshti *et al.* (Chesti *et al.*, 2013). When nitrogen, phosphorous, and potassium fertilizers are applied along with bio-organic fertilizers, there is a noticeable improvement in the soil's residual status in $NO_3$, P, K, and Zn. In comparison to FP, RDF, and control, INM reported the highest values of N, P, K, and Zn. comparable outcomes reported by Nethra and Hyder *et al.* (HYDER *et al.*, 2021; Nethra *et al.*, 1999; Abro *et al.*, 2022). Humic acid and bio-fertilizer applications improved the availability of NO3, P, and K as well as micronutrients like Zn among organic compounds. A lower pH may have enhanced the availability of Zn, whereas bio fertilizer may have fixed soil NO3 and increased soil organic matter's ability to fix P. Thus the use of chemical plus bio-fertilizers will not only gave maximum crop yield but also improved the efficiency of nutrient uptake (Verma, Nepalia, & Kanthaliya, 2006). Multiple nutrient shortages in soil can be mitigated through the use of bio-fertilizers in combination with important macro- and micronutrients (Satyanarayana, Vara Prasad, Murthy, & Boote, 2002).

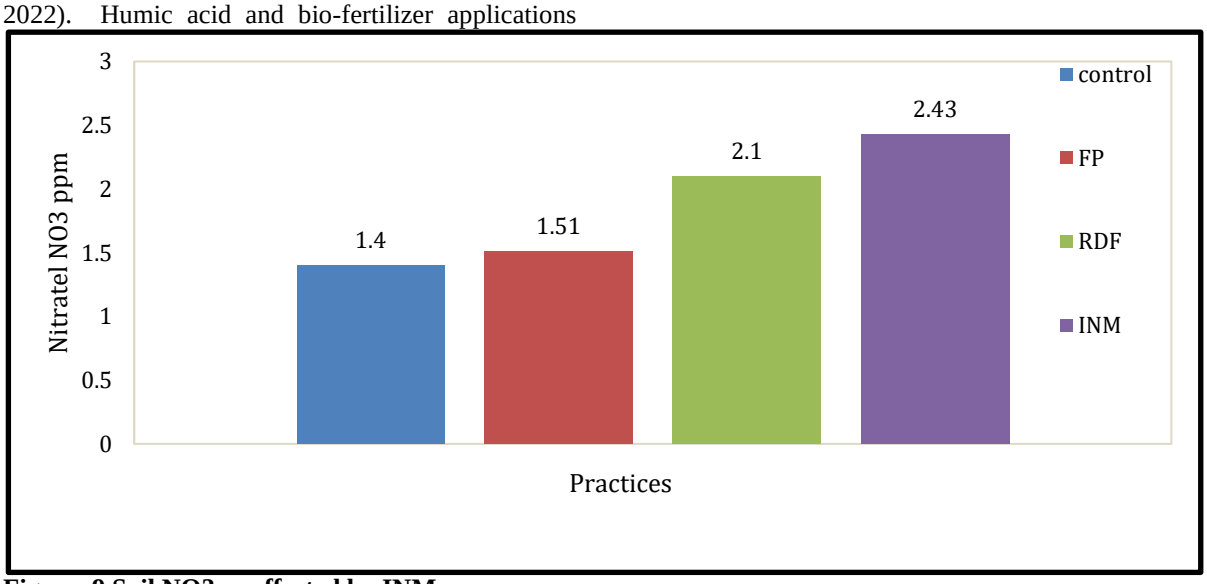


**Figure. 9 Soil NO3 as effected by INM**

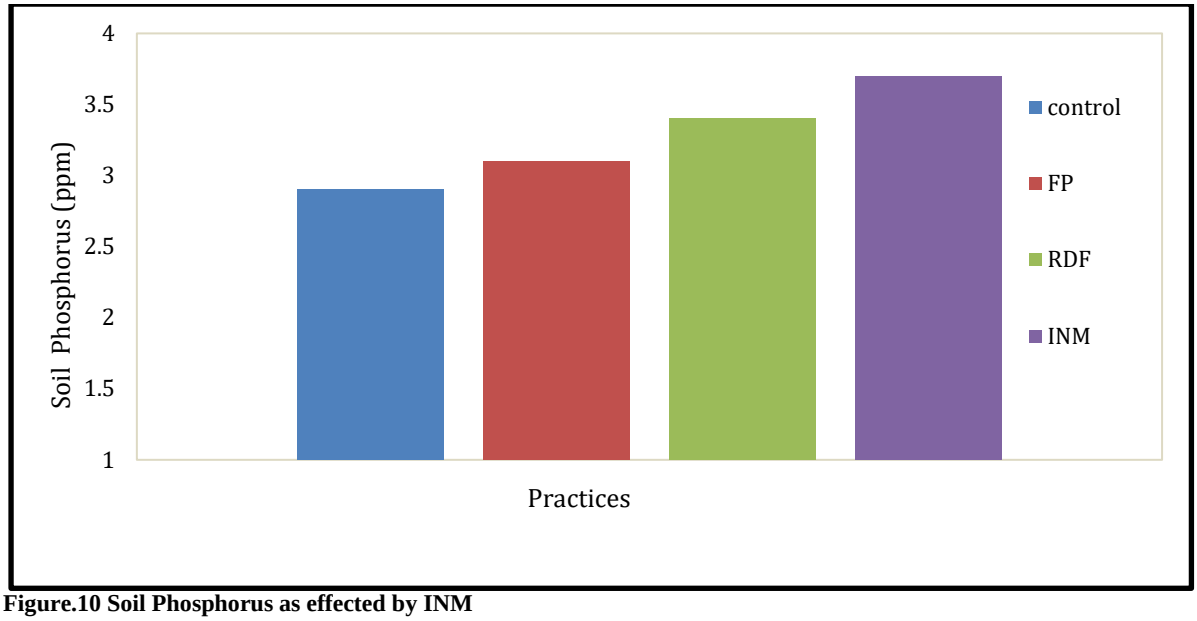


**Figure.10 Soil Phosphorus as effected by INM**

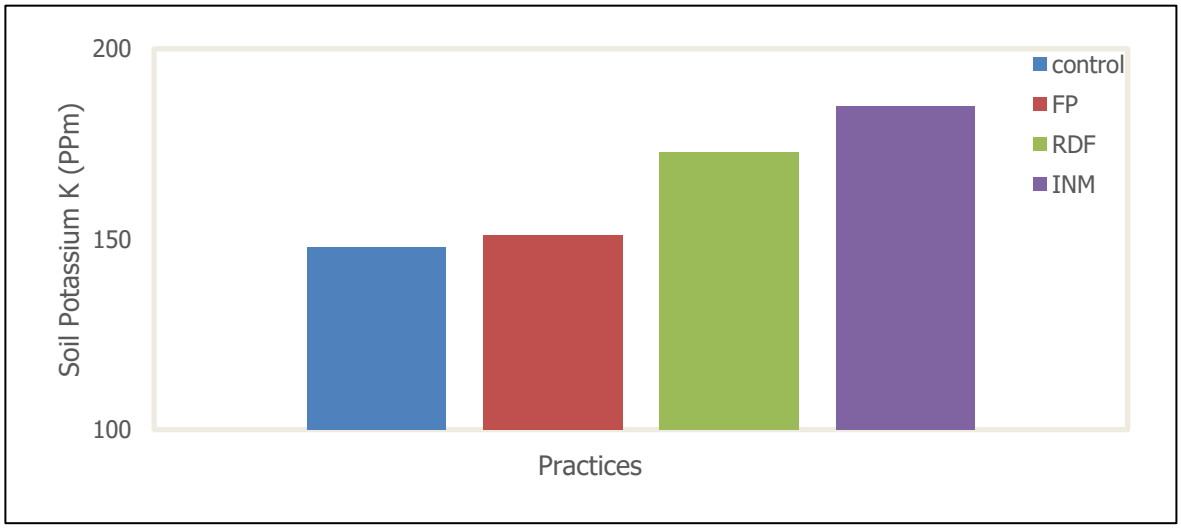


**Figure. 11 Soil Potassium as effected by INM**

## Conclusion

It is may be concluded from the study that the INM treatments had a significant impact on wheat yield and nitrogen utilization efficiency. Wheat grain yield recorded the maximum value (4.2 tone $ha^{-1}$) in the treatment, which included the application of bio fertilizer, humic acid, and 120 kg N, 90 kg P, 60 kg K, 5 kg Zn, and 1 kg B per hectare. This treatment increased wheat grain yield by 23% over farmer practice and by 11% over the recommended dose of fertilizer (RDF), respectively. Comparing farmer field treatments, the increase was 33%. INM treatments showed greater supplying of nutrient which also increased productivity of wheat upto 33% as compared with control.it is important to use balance fertilizer for better crop yield.

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