

Original Research Article

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Integration of Organic and Mineral Nutrient Sources Enhances Wheat Productivity, Soil Health and Profitability in western Uttar Pradesh

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ABSTRACT

Integrated plant nutrition management system is one of the best methods of plant nutrition, which enhances the farm productivity. To evaluate the effect of organic and mineral nutrition on wheat production, a field study was conducted at Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut. The experiment was arranged according to Randomized Block Design in three replications with fourteen treatments viz.; T₁- Control, T₂- 100 % NPK, T₃-75 % NPK + FYM, T₄- 75 % NPK + FYM + PSB+ Azotobactor, T₅- 100 % NPK + Zn, T₆- 100 % NPK + Zn+ Mn, T₇-100 % NPK + Zn + Mn + Fe, T₈-75 % NPK + FYM+ PSB+ Azotobactor + Zn + Fe + Mn, T₉-125 % NPK, T₁₀-125% NPK + Zn, T₁₁- 125 % NPK + Zn+ Mn, T₁₂-125% NPK + Zn + Mn + Fe, T₁₃-100% NPK + FYM+ PSB+ Azotobactor + Zn + Fe + Mn and T₁₄-50% N +100%PK + FYM+ PSB+ Azotobactor + Zn + Fe + Mn + LCC based N top dressing. The results revealed that the addition of 100% NPK + FYM + PSB + Azotobactor+ Zn + Fe + Mn recorded significantly higher value of growth, yield attributes and nutrient uptake in terms of plant height (cm), dry matter accumulation (g m⁻¹), number of effective tillers (m⁻²), 1000-grain weight (g), protein content (%) and grain yield (58.40 q ha⁻¹) followed by 125% NPK + Zn + Mn grain yield (57.9 q ha⁻¹). The total uptake of nitrogen, phosphorus, potassium and micro nutrients (Zn, Fe, Mn) and content of organic carbon increase with the combined application of organic and inorganic with biofertilizer. Integration of 100% NPK + FYM + Azotobactor + Zn + Mn + Fe was found more productivity and remvaerative with the higher residual soil fertility status after wheat crop. The integration of mineral fertilizers with FYM not only escalated the grain yield of wheat but also enhanced micro nutrients uptakes and their recoveries over mineral fertilizer alone.

Keywords

FYM, Biofertilizers,
Yield attributes,
Organic carbon.

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Introduction

Wheat (*Triticum aestivum* L.), the second most important food crop of the world in terms of area, production and nutrition, meets 20 per cent of the total food, 19 per cent of calories and 20 per cent of protein requirements of the global population besides being a major source of dietary fibre in human nutrition since decades. It was grown

in diverse environments across the globe over an area of 277 million hectares producing 654 million metric tons of grains with an average productivity of 3 tons ha⁻¹. In India, wheat occupied an area of 31.0 million hectare and produced of 88.9 million tons of grains with productivity of 2872 kg ha⁻¹ during 2015-16 (Anonymous, 2016). Amongst food-grains, it

shared about 21 % of area and 34 % production of the country. Use of chemical fertilizers though has increased the crop yield, it has several ill effects on soil, environment as well as human and animal health hazards besides making the crop productivity unsustainable in the long run. Indiscriminate use of high levels of N, P and K fertilizers, often leads to nutritional imbalance particularly for micronutrients which ultimately cause deterioration in physicochemical properties of soil and steadily decrease crop yield (Gupta *et al.*, 2000). Soil productivity has gone down, and now time has come to supplement these chemical fertilizers with organics to sustain the fertility and productivity of the soils Behera *et al.*, (2009).

This calls for development of integrated nutrient management systems (INMS) where chemical fertilizer is supplemented through organic source of plant nutrients, viz. well decomposed FYM, sugar factory press mud cake, green manures and biofertilizers for improvement and maintenance of soil fertility leading to sustained crop production. In wheat production, micronutrients play a vital role in the yield improvement Zn, Mn, Fe, B, Cu and Mo are known to be the most important micronutrients for higher plants. Micronutrients occupy a major portion as they are essential for increasing the growth and yield attributes of plant. Their importance increases due to their role in plant nutrition and increasing the soil productivity. Thus, judicious combination of organics, bio-fertilizers and chemical fertilizers helps to maintain soil productivity to alleviate the problem has become the need of the hour to address multifarious issues. Organic manures supports soil biological activities besides improving soil structure, and other physico-chemical properties of soil Devi *et al.*, (2013). An increase in availability of micronutrients like Zn, Cu, Fe and Mn and OM- bound

fractions of micronutrients with the addition of organic and mineral fertilization have been advocated by Herencia *et al.*, (2008). The present study was therefore, conducted to evaluate the efficacy of organic and inorganic nutrient sources and to sought out the suitable combination of mineral and organic fertilizers for higher wheat production, soil health and profitability.

Materials and Methods

The field experiment was conducted during the *rabi* season of 2015-16 at Crop Research Centre of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, (29^o 13' N, 77^o 68' 43 E, 237 m above mean sea level) U.P., India. Climate is semi-arid subtropical with extremes of hot weather in summer and cold in winter season. There is gradual decrease in mean daily temperature from October reaching as low as 2-4 °C in January and further a gradual increase is registered from February reaching as high as 43-45 °C in May. The rains are predominantly caused by south-west monsoon which sets in the last week of June, reaches its peak in July-August and withdraws by the end of September. The area receives 862 mm of rains annually on an average, of which 90% is confined to rainy season (July-September). Soil of experimental field was sandy loam with pH of 8.3, electric conductivity (EC) 1.7dSm⁻¹, low in organic C (0.41%), available N (174.8 kg ha⁻¹), medium in available P (13.7 kg ha⁻¹) and K (245 kg ha⁻¹). A range of mean weekly maximum temperature varied from 16.5°C to 40.2°C, and the mean weekly minimum temperature ranged from 4.6°C to 22.7°C during 2015-16. The total of 22.4 mm rainfall was received during crop season 2015-16. The experiment was laid out in RBD (Randomized Block design) with three replication. Studies were conducted with fourteen treatments viz., T₁- Control, T₂- 100 % NPK, T₃-75 % NPK + FYM, T₄- 75 %

NPK + FYM + PSB+ Azotobactor, T₅- 100 % NPK + Zn, T₆- 100 % NPK + Zn+ Mn, T₇- 100 % NPK + Zn + Mn + Fe, T₈-75 % NPK + FYM+ PSB+ Azotobactor + Zn + Fe + Mn, T₉-125 % NPK, T₁₀- 125% NPK + Zn, T₁₁- 125 % NPK + Zn+ Mn, T₁₂-125% NPK + Zn + Mn + Fe, T₁₃-100% NPK + FYM+ PSB+ Azotobactor + Zn + Fe + Mn and T₁₄-50% N +100%PK + FYM+ PSB+ Azotobactor + Zn + Fe + Mn + LCC based N top dressing. Wheat crop was sown with the row spacing of 22.5 cm. five irrigations (60 mm irrigation in each) were applied at five critical phenological stages. In regards to fertilizer application of the crop, 150 kg N, 75 kg P₂O₅ and 60 kg K₂O were applied as recommended dose. Out of which, 1/2 N and full dose of P₂O₅ and K₂O were applied as basal at the time of sowing by broadcasting method. The remaining 1/2 dose of N was applied in two equal splits at CRI and late tillering stages. Organic manure, FYM, and bio fertilizer Azotobactor and PSB were used as per treatment. Variety of wheat is DBW 17 was sown on 28 November, 2015. Five spike selected randomly were threshed manually, grains were counted and data presented as grains per spike. The sample of 1000-grains collected from each plot, weighed and presented as gram. Total bundle weight was recorded from each plot at the time of harvesting. The crop was threshed and grain were weighed and presented as quintal per hectare. A representative sample for grain and straw was taken separately to determine respective dry matter production for each treatment plot wise. The uptake of individual nutrient was calculated by multiplying dry matter yield and respective nutrient content Meteorological data, *viz.*, rainfall, relative humidity, maximum and minimum temperature, were recorded from Agro-meteorological observatory, Meerut. Data on yield attributes, grain yield, and harvest index were recorded at crop maturity. Standard procedures were used for chemical analysis of

soil and plant sample. The data were analyzed by using the 'Analysis of Variance Technique' as per the procedures described by Gomez and Gomes (1984). The treatment means were compared at 5% level of significance

Results and Discussion

Growth and yield attributes

Applications of organic with inorganic sources of fertilizer at any level were found to improve the growth and yield attributing character (Table 1) in comparison to control. Nutrient had significant effect on plant height during the year of investigation. Application of different nutrient management practices influenced the plant height significantly over the control. The application of 125% NPK + Zn + Mn + Fe recorded the maximum plant height which was at par with 100% NPK + FYM + PSB+ Azotobactor + Zn + Fe + Mn. The control plots resulted significant reduction in plant height compared to other treatments at harvest. Such a higher plant height in 100% NPK with organic manures and bio-fertilizers can be associated with sufficient nutrient supply at the active growth stage. Similar results of increased plant height were also reported by Kumar and Ahlawat (2004), Tulsa Ram and Mir (2006), Thakral *et al.*, (2003). Dry matter production in crop is a function of current photosynthesis. Balanced nutrition helps in achieving higher dry matter accumulation through enhanced canopy cover which ultimately increased higher amount of assimilated through higher rate of current photosynthesis. Total plant stand, plant height, number of effective tillers characters will ultimately affect dry matter accumulation by crop. Nutrient management treatments had significant effect on dry matter accumulation. Further, perusal of the data revealed that dry matter accumulation (g m⁻¹) decreased significantly with nutrient doses from 100%

NPK with all other nutrient inputs (FYM + Bio fertilizers + micronutrient) to control. At harvest, 100% NPK alongwith FYM, biofertilizers, Zn, Mn and Fe with all other nutrient inputs crop accumulated more dry matter than other nutrient options. Highest dry matter accumulation was recorded in 125% NPK + Zn + Mn + Fe which was statistically at par with 100% NPK along with FYM, biofertilizers, Zn, Mn and Fe at harvest during 2015.16. Minimum dry matter accumulation was recorded in control plots. The application of organic and inorganic sources of nutrients with 100% NPK also produced better growth parameters viz., plant height, number of effective tillers and finally dry matter. Similar results were also reported by Jakhar *et al.*, (2006), Sepat *et al.*, (2010). The number of effective tillers (m^{-2}) increased up to at 60 DAS and started declining their after at 90 DAS and at harvest. The highest number effective tillers at 90 DAS were recorded in 125% NPK + Zn + Mn + Fe which was statistically at par with 100% NPK along with FYM, biofertilizers, Zn, Mn and Fe at harvest during 2015.16. Lowest numbers of tillers were recorded in control plots. Such a higher number of effective tillers in these treatments can be linked with optimum supply of essential nutrients at active tillering stage. Similar results were also reported by Singh and Agarwal (2001) and Jat *et al.*, (2013).

Yield

The yield of a crop depends upon the source sink relationship and is the cumulative expression of various growth parameters and yield attributing components viz; 1000- grain weight. Maximum of 1000- grain weight and protein content (%) was recorded in 125% NPK + Zn + Mn + Fe which was found statistically at par with 100% NPK + FYM+ PSB+ Azotobactor + Zn + Fe + Mn. The effect of 100% NPK + FYM+ PSB+ Azotobactor + Zn + Fe + Mn being

statistically at par with 125% NPK + Zn + Mn + Fe and was superior to control in respect of yield attributing characters (Table 1). More yield attributes were found in the treatment where organic and inorganic sources of plant nutrients were applied over control. Higher level of nutrients improved the fertility level of soil and creates congenial condition for better growth and development thus improved the yield attributes. These results are in conformity with those reported by Sen *et al.*, (2003), Singh *et al.*, (2007) and Barthwal *et al.*, (2013).

Application of nutrient management treatments significantly increased the grain, yield of wheat during the years of experimentation. The grain, yields were recorded significantly higher in the treatments 125% NPK + Zn + Mn + Fe which was 58.70 q ha⁻¹ which was at par with 100% NPK + FYM+ PSB+ Azotobactor + Zn + Fe + Mn. The magnitude of increase being highest of 30.4 q ha⁻¹ or 107% with 125% NPK with Zn + Mn and Fe and 20.9 q ha⁻¹ or 73.8% with 100% NPK.

Crop grown with 25% substitution of nitrogen through FYM or FYM and biofertilizers gave 2.8 and 4.0% higher yield than that grown with 100% NPK. The crop receiving 100% NPK along with FYM, biofertilizers, Zn, Mn and Fe remaining at par with treatments having 125% NPK with micronutrients proved significantly better than 100% NPK. All the other treatments where 100% NPK was supplemented with micronutrients resulted in significant increase in grain yield over 100% NPK being 5.8% with Zn, 8.7% with Zn + Mn and 9.7% with Zn + Mn + Fe. Further enhancement of NPK to 125% alone or with micronutrients produced significant effect over respective combinations with 100% NPK. Basal application of NPK along with biofertilizers and micro-nutrients coupled with LCC based nitrogen top

dressing led to significant increase in yield being 3.8 q ha⁻¹ (7.7%) over 100 NPK but remained significantly lower than the yield obtained with 100% NPK, FYM + biofertilizers + micronutrients (58.4 q ha⁻¹). The crop receiving 100% NPK along with FYM, biofertilizers, Zn, Mn and Fe remaining at par with treatments having 125% NPK with micronutrients proved significantly better than 100% NPK.

The beneficial effect of organic manures on grain, yields and yield attributing characters might be assigned to the fact that after proper decomposition and mineralization, these manures supplemented plant nutrients to the plants and also had solubilising effect on fixed forms of nutrients in soil. Similar findings were also reported by Mubarak and Singh, (2011). The combination use of organic manures and chemical fertilizers enhanced the inherent capacity of soil as reported by Pandey *et al.*, (2009), Verma, *et al.*, (2010) and Meena *et al.*, (2012), Singh and Singh (2005).

Protein content

Application of 125% NPK + Zn + Mn + Fe has proven the best with 10.40 % Protein it was statistically at par with 100% NPK along with FYM, biofertilizers, Zn, Mn and Fe (Table 1). The results indicate that integrated nutrient application through chemical fertilizer, FYM and bio-fertilizer improve the protein content in grain over control.

Similar results have been reported by Hasan and Kamal (1998). Nitrogen is most important factor which determines protein constituent of grain. It is essential for vegetative and reproductive stages. Nitrogen not only affects wheat productivity but also has a synergistic effect on quality of grain. Nitrogen is important constituent of protein, enzyme and chlorophyll and is involved in all processes

associated with protoplasm, enzymatic reaction and photosynthesis (Tisdale *et al.*, 1995).

Nutrient uptake

Nutrient uptake, a function of dry matter yield of components (grain/straw) and respective nutrient content, behaved similar to dry matter production and nutrient content under the influence of nutrient management practices. The crop fertilized with 125% NPK + Zn + Mn + Fe highest total uptake of N (155.0 kg ha⁻¹), P (34.3 kg ha⁻¹), K (111.6kg ha⁻¹), Zn (600.8 g ha⁻¹), Mn (409.7 g ha⁻¹) and Fe (1791.5 g ha⁻¹) as against the lowest of 64.4, 10.0, 35.2, kg ha⁻¹ 193.3 g ha⁻¹, 129.4 g ha⁻¹ and 675.0 g ha⁻¹ respectively in crop receiving no fertilizer (Table 2).

Favorable effect of NPK application on nutrient uptake by wheat has also been reported by Rawat and Pareek (2003) of NPK by Pandey *et al.*, (2009) Cakmak (2012) of Zn by *Azotobacter* and PSB by Rathor and Sharma (2010). The crop having highest accumulation also had highest dry matter assimilation and nutrient content which ascertained highest uptake of most of the nutrients. The highest uptake of macro and micro nutrients with 125% NPK + Zn + Mn + Fe remained at par with 100% NPK along with FYM, biofertilizers, Zn, Mn, Fe proved significantly better than 100% NPK and lowest with no nutrient application.

Applications of Zn, Mn and Fe alone or together with 100% NPK increased uptake over 100% NPK. This is in accordance to the kind of relationship between nutrient content in plant tissues and the concentration in growing medium, the soil. Application of fertilizers readily increases the availability of nutrient concerned in the soil solution thereby enhancing its absorption by the plant roots and further translocation to the site of action.

Favorable effect of NPK on nutrient uptake of wheat has also been noted by Shivay *et al.*, (2008). The beneficial effect of Zn and B when applied in conjunction with organic/inorganic/bio-fertilizers might have helped in increasing and balancing the availability of essential plant nutrients and organic fertilizers sustained it over a long

time. Microbial decomposition of organic manure (FYM) with simultaneous release of organic acid which act as chelating agent might have facilitated the availability and absorption of micro-nutrients as indicated by plant nutrient content and residual soil fertility.

Table.1 Plant height, dry matter accumulation, effective tillers, 1000- grain weight, protein content and grain yield as influenced by different nutrient options

| Treatment | Plant height at harvest (cm) | Dry matter accumulation (g m ⁻¹ At harvest | Effective tillers m ⁻¹ 90 DAS | 1000 -grain weight (g) | Protein content (%) | Grain Yield (q ha ⁻¹) |
|---|------------------------------|---|--|------------------------|---------------------|-----------------------------------|
| T ₁ - Control | 61.5 | 678.0 | 205 | 28.7 | 9.6 | 28.3 |
| T ₂ -100 % NPK | 75.2 | 1007.4 | 267 | 36.3 | 9.7 | 49.2 |
| T ₃ -75 % NPK + FYM | 75.9 | 1010.8 | 270 | 36.6 | 9.8 | 50.6 |
| T ₄ -75 % NPK + FYM + PSB+ Azotobactor | 76.4 | 1012.1 | 273 | 36.9 | 9.8 | 51.2 |
| T ₅ -100 % NPK + Zn | 77.2 | 1014.4 | 277 | 37.2 | 9.8 | 52.1 |
| T ₆ -100 % NPK + Zn+ Mn | 78.6 | 1017.4 | 285 | 38.2 | 10.0 | 53.5 |
| T ₇ -100 % NPK + Zn + Mn + Fe | 80.2 | 1021.2 | 290 | 38.5 | 10.0 | 54.0 |
| T ₈ -75 % NPK + FYM+ PSB+ Azotobactor+ Zn + Fe + Mn | 78.3 | 1013.0 | 281 | 37.8 | 10.0 | 53.3 |
| T ₉ -125 % NPK | 84.5 | 1077.1 | 317 | 38.8 | 10.1 | 53.2 |
| T ₁₀ -125% NPK + Zn | 84.8 | 1078.4 | 320 | 39.1 | 10.1 | 56.3 |
| T ₁₁ -125 % NPK + Zn+ Mn | 85.1 | 1079.3 | 324 | 39.4 | 10.2 | 57.9 |
| T ₁₂ -125% NPK + Zn + Mn + Fe | 86.6 | 1081.5 | 330 | 40.1 | 10.4 | 58.7 |
| T ₁₃ -100% NPK + FYM+ PSB+ Azotobactor +Zn + Fe + Mn | 85.3 | 1080.2 | 327 | 39.7 | 10.2 | 58.4 |
| T ₁₄ -50% N +100%PK + FYM+PSB+ Azotobactor+Zn + Fe + Mn + LCC based N top dressing | 77.5 | 1018.7 | 280 | 37.5 | 10.0 | 53.0 |
| CD (P= 0.05) | 7.2 | 52.1 | 20.7 | 0.8 | 0.6 | 2.6 |

Table.2 Total nitrogen, phosphorus, potassium, zinc, manganese and iron uptake in wheat as influenced by different nutrient options

| Treatment | Total nitrogen uptake (kg ha ⁻¹) | Total phosphorus uptake (kg ha ⁻¹) | Total potassium uptake (kg ha ⁻¹) | Total zinc uptake (g ha ⁻¹) | Total manganese uptake (g ha ⁻¹) | Total iron uptake (g ha ⁻¹) |
|---|--|--|---|---|--|---|
| T ₁ - Control | 64.4 | 10.0 | 35.2 | 193.3 | 129.4 | 675.0 |
| T ₂ -100 % NPK | 111.1 | 19.3 | 73.0 | 449.7 | 322.3 | 1498.9 |
| T ₃ -75 % NPK + FYM | 115.3 | 21.1 | 76.8 | 466.1 | 333.5 | 1536.0 |
| T ₄ -75 % NPK + FYM + PSB+ Azotobactor | 117.5 | 22.0 | 79.1 | 478.5 | 340.0 | 1557.2 |
| T ₅ -100 % NPK + Zn | 121.2 | 22.9 | 81.8 | 491.5 | 350.2 | 1572.4 |
| T ₆ -100 % NPK + Zn+ Mn | 128.5 | 24.8 | 91.7 | 515.2 | 365.2 | 1621.9 |
| T ₇ -100 % NPK + Zn + Mn + Fe | 131.6 | 26.5 | 94.9 | 524.7 | 374.5 | 1664.6 |
| T ₈ -75 % NPK + FYM+ PSB+ Azotobactor+Zn + Fe + Mn | 126.7 | 24.8 | 87.8 | 511.5 | 361.4 | 1628.0 |
| T ₉ -125 % NPK | 131.6 | 27.1 | 98.6 | 516.2 | 360.2 | 1650.9 |
| T ₁₀ -125% NPK + Zn | 140.5 | 28.9 | 102.7 | 557.8 | 379.8 | 1711.7 |
| T ₁₁ -125 % NPK + Zn+ Mn | 143.9 | 30.7 | 106.3 | 576.6 | 394.1 | 1749.4 |
| T ₁₂ -125% NPK + Zn + Mn + Fe | 155.0 | 34.3 | 111.6 | 600.8 | 409.7 | 1791.5 |
| T ₁₃ -100% NPK + FYM+ PSB+ Azotobactor+Zn +Fe +Mn | 149.0 | 31.1 | 108.9 | 592.2 | 401.1 | 1749.0 |
| T ₁₄ -50% N +100%PK + FYM+ PSB+ Azotobactor +Zn + Fe + Mn + LCC based N top dressing | 124.7 | 24.0 | 93.1 | 504.3 | 357.4 | 1614.9 |
| CD (P= 0.05) | 12.1 | 4.3 | 10.7 | 31.5 | 20.7 | 35.6 |

Table.3 Organic carbon, Soil pH, EC, Bulk density, Particle density and Net return as influenced by different nutrient options

| Treatment | Organic carbon (%) | Soil pH | EC (dSm ⁻¹) | Bulk density (g/cc) | Particle density (g/cc) | Net returns (Rs ha ⁻¹) |
|---|--------------------|---------|-------------------------|---------------------|-------------------------|------------------------------------|
| T ₁ - Control | 0.39 | 8.19 | 0.47 | 1.53 | 2.66 | 24740 |
| T ₂ -100 % NPK | 0.41 | 8.10 | 0.49 | 1.55 | 2.64 | 66385 |
| T ₃ -75 % NPK + FYM | 0.45 | 7.74 | 0.50 | 1.48 | 2.63 | 69143 |
| T ₄ -75 % NPK + FYM + PSB+ Azotobactor | 0.48 | 7.71 | 0.51 | 1.47 | 2.62 | 70123 |
| T ₅ -100 % NPK + Zn | 0.40 | 7.90 | 0.52 | 1.50 | 2.65 | 71080 |
| T ₆ -100 % NPK + Zn+ Mn | 0.42 | 7.81 | 0.51 | 1.50 | 2.64 | 72900 |
| T ₇ -100 % NPK + Zn + Mn + Fe | 0.44 | 7.77 | 0.52 | 1.49 | 2.64 | 73175 |
| T ₈ -75 % NPK + FYM+ PSB+ Azotobactor +Zn+ Fe +Mn | 0.49 | 7.70 | 0.54 | 1.45 | 2.63 | 70628 |
| T ₉ -125 % NPK | 0.46 | 7.75 | 0.53 | 1.48 | 2.65 | 74374 |
| T ₁₀ -125% NPK + Zn | 0.47 | 7.74 | 0.55 | 1.47 | 2.64 | 79079 |
| T ₁₁ -125 % NPK + Zn+ Mn | 0.48 | 7.73 | 0.57 | 1.46 | 2.64 | 80168 |
| T ₁₂ -125% NPK + Zn + Mn + Fe | 0.50 | 7.72 | 0.59 | 1.46 | 2.65 | 81349 |
| T ₁₃ -100% NPK + FYM+ PSB+ Azotobactor+Zn +Fe+Mn | 0.53 | 7.68 | 0.62 | 1.43 | 2.63 | 80170 |
| T ₁₄ -50% N +100%PK + FYM+ PSB+ Azotobactor +Zn + Fe + Mn + LCC based N top dressing | 0.48 | 7.71 | 0.53 | 1.45 | 2.63 | 71260 |
| CD (P= 0.05) | 0.05 | NS | 0.03 | NS | NS | - |

Soil properties

Soil pH did not differ significantly by the nutrient management practices. Numerically the maximum soil pH value (8.19) was observed in the control plot. Lowest soil pH (7.68) was recorded with 100% NPK + FYM+ PSB+ Azotobactor + Zn + Fe + Mn. The maximum soil EC value (0.62) was observed in 100% NPK + FYM+ PSB+ Azotobactor + Zn + Fe + Mn. Lowest soil EC (0.47) was recorded in Control plot. Numerically the maximum Bulk density value (1.55) was observed in 100% NPK plot. Lowest Bulk density (1.43) was recorded 100% NPK + FYM+ PSB+ Azotobactor + Zn + Fe + Mn (Table 3). Numerically the maximum Particle density value (2.66) was observed in Control plot. Lowest Particle density (2.62) was recorded 75 % NPK + FYM + PSB+ Azotobactor. Studies conducted by various workers have established the fact of maintenance of soil physical and chemical properties in terms of improved organic content, soil pH, EC, Bulk density and particle density in soil by application of organic manures in combination with chemical fertilizers in different ratio Singh *et al.*, (2008) and Verma *et al.*, (2009).

Soil organic carbon

Organic carbon in soil varied significantly among different nutrient treatment. Maximum carbon content was recorded in 100% NPK along with FYM, biofertilizers, Zn, Mn and Fe (0.53) was statistically at par with 125% NPK + Zn + Mn + Fe and 50% N +100%PK + FYM+ PSB+ Azotobactor + Zn + Fe + Mn + LCC based N top dressing (0.50 and 0.48) and significantly higher to control (Table 3). Studies conducted by various workers have established the fact of maintenance of soil fertility in terms of improved organic content and available nutrients in soil by application of organic manures in combination with chemical fertilizers in different ratio Singh *et al.*, (2008) and Verma *et al.*, (2009).

Profitability

Net return was observed highest in treatment 125% NPK + Zn + Mn + Fe Rs. 81349 closely followed by 100% NPK along with FYM, biofertilizers, Zn, Mn and Fe of Rs. 80170. The lowest net return was observed in control plots (Table 3). The result on current studies showed that cost of cultivation was marginally higher when the nutrients were

applied in combination. Due to higher grain yield, the net income was also higher with use of organic and inorganic fertilizers over 100% NPK. Similar result was also reported by Bhaduri & Gautam (2012) and Lone *et al.*, (2011)

The highest growth characters recorded with 125% NPK + Zn + Mn + Fe of was similar to the treatment of 100% NPK along with FYM, biofertilizers, Zn, Mn and Fe and higher than 100% NPK and control. Although application of 125% NPK + Zn + Mn + Fe yielded more among all the nutrient management options but it was found at par with 100% NPK along with FYM, biofertilizers, Zn, Mn and Fe in grain yield, protein content and net return. In view the buildup of Soil organic carbon in soil, and uptake of macro and micro nutrients, application of 100% NPK along with FYM, biofertilizers, Zn, Mn and Fe was found best among all nutrient management options. Keeping in view the sustainability of soil health 100% NPK along with FYM, biofertilizers, Zn, Mn and Fe proved better. Thus 100% NPK along with FYM, biofertilizers, Zn, Mn and Fe may be suggested for good performance of wheat crop and sustainability of soil health and crop yield in future.

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