# Effect of integrated nutrient management and Biofortification of Iron and Zinc on growth and yield of Wheat (*Triticum aestivum*. L.)


## Abstract

A field experiment was conducted at Students' Instructional Farm of Chandra Shekhar Azad University of Agriculture and Technology Kanpur, (U.P.) to assess the effect of organic manure and foliar application of micronutrient and their interaction effect on growth and yield of wheat for two consecutive years (2021) and (2022).The experiment comprises three treatment under main plot *viz:* $F_1$- Control (100% RDF), $F_2$- 100 % RDF + Vermicompost @ 2.5t/ha, and $F_3$- 100 % RDF + FYM @ 5t/ha, and five treatments foliar spray of micronutrient in sub plot *viz:* $M_1$- control (No spray), $M_2$- Foliar application of $ZnSO_4$ @ 0.25% at tillering and heading stage, $M_3$- Spray of Nano Zinc @ 0.5% spray at tillering and heading stage, $M_4$- Foliar application of $FeSO_4$ @ 0.25% at tillering and heading stage and $M_5$- Foliar application of $ZnSO_4$ @ 0.25% + $FeSO_4$ @ 0.25% at tillering and heading stage. Fifteen treatment combination were assigned under Split Plot Design (SPD) and replicated thrice. Wheat variety (K- 1006) was grown with the recommended agronomic practices. Results showed that maximum increase in growth parameters and yield and yield attribute of wheat *viz*: plant height (cm), number of tillers/$m^2$, leaf area index and spike length (cm), number of spikelets/spike and harvest index (%) and biological yield (ton $ha^-$) recorded maximum with $F_2$- 100 % RDF + Vermicompost @ 2.5t/ha, followed by $F_3$- 100 % RDF + FYM @ 5t/ha respectively. significantly highest harvest index (44.01 %) and biological yield (13.65 t/ha) was recorded in $F_2$- 100 % RDF + Vermicompost @ 2.5t/ha as compared to other organic manure + RDF applied. Among foliar spray of micronutrient, $M_5$- Foliar application $ZnSO_4$ @ 0.25% + $FeSO_4$ @ 0.25% at tillering and heading stage, produce significant maximum highest harvest index (42.78 %) and biological yield (13.88 ton /ha) as compared to all other treatments.



**Keywords:** *FYM, Vermicompost, Nano-Zinc, Zinc sulphate, Iron sulphate and Wheat*


## 1. Introduction

Wheat (*Triticum aestivum* L.) one of the most important cereal crops in the world of family "Poaceae" and genus "Triticum" it's grown under different agro-climaticconditions and it occupies 220.29 million ha. area with the production of 780.59 million tones and productivity of 3390 kg $ha^{-1}$. The largest producer of wheat in the world wide is the European Union followed by China and India. In India wheat cultivated in area of with the production 109.52 million tones and productivity of 3464 kg $ha^{-1}$. **(Anonymous, 2022-23a)**. Important wheat producing state are Uttar Pradesh (30 million tons), Punjab (16.4 million tons) and Haryana (11.6 million tons), with area of 9.75, 3.59, 2.52, mha, respectively. Uttar Pradesh first position in area and production of

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wheat in India. Although productivity of wheat (2661 kg/ha) is still less than the national average **(Anonymous, 2022-23b)**. However, wheat is the stable food in many countries of the world and its zinc and iron content is very low (20-40 mg/kg **(Welch and Graham, 2004)** that further elevate the nutritional problem. Due to zinc deficiency, reported that around 800,000 deaths occur annually out of which 450, 000 deaths are of children under the age of five years. There is urgent need to increase the productivity of wheat crop with improved micronutrient content. Balanced nutrient application through organic and inorganic source play on important role in improved of micronutrient level in grain and straw as well as increase in yield of wheat crop. The organic source of nutrient is important for nutrient as well as for soil health, among organic source, FYM is a good source of nutrients and contributed towards build-up of organic matter in soil **(Das *et al.,*2008).** The improvement in grain and straw yield with the application of FYM was owing to the beneficial effect of FYM on nutrient uptake, crop growth rate and yield attributing components. **(Singh and Agarwal, 2004).** However, vermi-compost that is a bio-oxidation and stabilization of FYM involving the joint action of earthworm and microorganisms. Almost 50% of the agricultural lands around the world are Zn deficient for cereal productivity **(Cakmak, 2008).** Biofortification is the process of increasing the content and bioavailability of essential nutrients in crops during plant growth through genetic and agronomic pathways **(Bouis *et al*. 2011).** Although, nano-fertilizers Size below 100 nm nano-particles can use as fertilizer for efficient nutrient management which are eco-friendly and reduce environment pollution. may effectively tool in agriculture for better pest and nutrient management because these nano-materials having more penetration capacity, surface area and use efficiency which avoid residues in environment. Hence, these agricultural usable nano-particle develop with the help of nanotechnology can be exploited in the value chain of entire agriculture production system **(Morales-Díaz *et al.,* 2017).** Iron is most important for the respiration and photosynthesis processes. Iron plays a greatest role in many plant functions. These functions include chlorophyll development, energy transfer, ingredient of enzymes and proteins, and involved in nitrogen fixation **(Pervaiz *et al*., 2003).** In integrated nutrient management the application of FYM in the soil helps in increasing the fertility of the soil as well as physical condition of soil. Organic manures, which were perhaps the main sources of plant nutrients in traditional agriculture, receive less emphasis with the advent of high analysis chemical fertilizers **(Kumar *et al.,* 2015).** Keeping these views in mind the research was conducted to optimum use of nutrient by appropriate combination of both organic as well as inorganic source along with the foliar application of micro nutrient for improvement in Zn and Fe content in wheat grains.

## 2. Materials and Methods

### 2.1. Experimental site:

The experiment was conducted consecutive two rabi season during 2021 and 2022 at Students' Instructional Farm of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, which is situated in the alluvial tract of Indo - Gangetic plains in central plain zone of Uttar Pradesh. The soil type and fertility status were determined by the

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mechanical and chemical analysis of the soil. In order toascertain physico-chemical properties of the experimental soil, primary soil samples were drawn randomly up to 15cm depth from different spots of the entire experimental area. The Soil of the experimental field was sandy loam in texture, well drained, slightly saline in nature having initial values of pH (8.00), EC (0.29 $dsm^{-1}$), low in organic carbon (0.35%), low in available nitrogen (192.50 kg $ha^{-1}$), medium in phosphorus (15.75 kg $ha^{-1}$), Potash (173.51 kg $ha^{-1}$). Iron (1.75 mg $kg^{-1}$) and Zinc (61.15 mg $kg^{-1}$). respectively,

## 2.2. Geography and climate:

This zone has semi-arid climatic condition having alluvial fertile soil. The average relative humidity during the experimental season fluctuated between 44.4 % to 85.8 % and 47 % to 96% During 2021 to 2022 respectively. During the crop growing period, the mean weekly highest and lowest total rainfall recorded ranging from 0.0 mm to 23.5 mm and 0.0 mm to 39.2 mm and evaporation ranged from 7.6 to 26.0 mm/$day^{-1}$ and 8.8 to 25 mm/$day^{-1}$ during 2021 to 2022, respectively. The mean weekly total evaporation mm/$day^{-1}$ recorded ranging from 326.4 to 340.4 mm/$day^{-1}$ during 2021 to 2022, respectively. The weekly mean wind velocity during the experimental season fluctuated between 1.2 to 6.2 km and 1.1 to 6.0 km during 2021-22 to 2022-23, respectively.

## 2.3. Experiment Details

The field experiment was laid out in Split Plot Design. There were fifteen treatments combinations consisting of three organic manure as a main treatment *viz*: $F_1$- Control (100% RDF), $F_2$- 100 % RDF + Vermicompost @ 2.5t/ha, and $F_3$- 100 % RDF + FYM @ 5t/ha, and five Foliar application of micronutrient practices were applied as sub treatments *viz:* $M_1$- control (No spray), $M_2$- Foliar application of $ZnSO_4$ @ 0.25% at tillering and heading stage, $M_3$- Spray of Nano Zinc @ 0.5% spray at tillering and heading stage, $M_4$- Foliar application of $FeSO_4$ @ 0.25% at tillering and heading stage and $M_5$- Foliar application of $ZnSO_4$ @ 0.25% + $FeSO_4$ @ 0.25% at tillering and heading stage the treatments were replicated three times.

## 2.4. Agronomic practices

The pre sowing irrigation was applied 7-10 days before sowing of wheat for optimum level of moisture for field preparation for good germination, The seed of wheat variety K- 1006 was selected for these studies. The seed and sowing of clean and healthy seed were sown at shallow furrows of (5) cm deep with 20 cm row spacing were opened with the help of Desi plough and 120kg /ha Seed was sown on 21$^{th}$, Nov, 2021-22 and 22$^{th}$, November-2022-23.

## 2.5. Manure and Fertilizers application

The experimental crop was uniformly fertilized with according to treatments, Farm yard manure (FYM) 5 t $ha^{-1}$, and VC 2.5 t $ha^{-1}$ applied Before 15 days of sowing. The basal application of fertilizers (40 kg N and full does $P_2O_5$, & $K_2O$) and offer sowing Foliar application Micronutrients @ 0.25% $ZnSO_4$ at tillering and heading stage, Nano-Zinc @ 0.25% at tillering and heading stage, @ 0.25% $FeSO_4$ at tillering and heading stage and Foliar application of @

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0.25% $ZnSO_4$ + @ 0.25% $FeSO_4$ at tillering and heading stage. were also done according to treatments and remaining nitrogen was top dressed in two splits.

### 2.6. Observation Recorded:

The observations were recorded on plant height (cm), number of tillers/$m^2$ and leaf area index as well as growth characters Plant height of the longest tiller was measured from five tagged plants from the base of the plant to highest terminal point by a meter scale. Average of five plant height at harvest was taken for analysis of plant height. Number of tillers was recorded by using meter row from three places in each plot at harvest and average of three places was taken for analysis of number of tillers $m^{-2}$. and Plants from 25 cm row length removed from two places from the second row on either side in each plot were used for recording leaf area. The leaves were separated from the base of lamina. Leaf area was measured at 30 days intervals till the senescence of crop with the help of leaf area meter and the spike length of wheat was measured by using meter scale of five spikes of each plot and mean of the spike length was used for analysis of data and expressed in cm. Grain yield (t/ha) Grains were separated with the help of mini plot thresher from biological yield obtained from net area of each plot. The grain yield obtained from net plot area was converted into t/ha. After harvesting of the net plot area, the bundles of wheat crop were sun dried for two days and then weight recorded and converted into t $ha^{-1}$ for calculating biological yield. and harvest index are which is the ratio of economic yield to biological yield expressed in percent respectively.

$$\text{Leaf area index} = \frac{\text{Leaf area}}{\text{Land area}}$$

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biological Yield}} \times 100$$

### 2.7. Statistical analysis

The data collected from the experiments were subjected to statistical analysis by applying the procedure for Split Plot Design. Overall differences were tested by 'F' test at 5% level of significance as suggested by **(Gomez and Gomez, 1984).** Incase of significant result, critical difference at 5% level of probability was also calculated for testing the significance between two treatment means.

## 3. Result and discussions

### 3.1 Growth characters

The data plant height and number of tillers/$m^2$ during both the years of experimentation and data were pooled and data present in (Table. 1) it is clear from the data the maximum tallest plant height and number of tillers/$m^2$ was recorded with the treatments $F_2$- 100 % RDF + Vermicompost @ 2.5t/ha at harvest. followed by $F_3$- 100 % RDF + FYM @ 5t/ha both were

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significantly superior over the Control (100% RDF) during both the year as well as pooled basis data. $F_2$- 100 % RDF + Vermicompost @ 2.5t/ha, recorded significantly the highest Plant height, followed by $F_3$- 100 % RDF + FYM @ 5t/ha These results indicated that increase in growth characters resulted into more

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**Table 1. Effect of organic manure + RDF and foliar spray of micronutrients on plant height (cm), No. of tillers and LAI of wheat at successive periods of crop growth.**

| Treatments | Plant height (cm) | | | Number of tiller/m$^2$ | | | LAI | | |
|---|---|---|---|---|---|---|---|---|---|
| | At harvest | | | At harvest | | | 90 DAS | | |
| | 2021-22 | 2022-23 | Pooled | 2021-22 | 2022-23 | Pooled | 2021-22 | 2022-23 | Pooled |
| **Main plot (organic manure + RDF)** | | | | | | | | | |
| **$F_1$**- Control (100% RDF) | 70.73 | 71.72 | 71.13 | 281.60 | 285.00 | 283.30 | 2.81 | 2.90 | 2.85 |
| **$F_2$**- 100 % RDF + Vermicompost @ 2.5t/ha | 77.50 | 78.32 | 78.21 | 351.40 | 355.20 | 353.30 | 4.93 | 5.06 | 5.00 |
| **$F_3$**- 100 % RDF + FYM @ 5t/ha | 73.72 | 74.53 | 74.53 | 331.00 | 333.80 | 332.40 | 3.68 | 3.76 | 3.72 |
| **S.Em, ±** | **0.156** | **0.190** | **0.491** | **0.421** | **0.516** | **1.652** | **0.008** | **0.007** | **0.011** |
| **C.D. (P=0.05)** | **0.629** | **0.767** | **1.978** | **1.697** | **2.080** | **6.659** | **0.031** | **0.029** | **0.044** |
| **Sub plot (foliar spray of micronutrient)** | | | | | | | | | |
| **$M_1$**- Control (No spray) | 70.52 | 71.67 | 71.09 | 300.67 | 303.67 | 302.17 | 3.14 | 3.20 | 3.17 |
| **$M_2$**- Foliar application of $ZnSO_4$ @ 0.25% at tillering and heading stage. | 74.53 | 75.17 | 74.85 | 325.00 | 328.67 | 326.83 | 3.99 | 4.07 | 4.03 |
| **$M_3$**- Spray of Nano Zinc @ 0.5% spray at tillering and heading stage. | 75.13 | 75.87 | 75.50 | 329.33 | 332.67 | 331.00 | 4.02 | 4.16 | 4.09 |
| **$M_4$**- Foliar application of $FeSO_4$ @ 0.25% at tillering and heading stage. | 73.67 | 74.52 | 74.09 | 317.67 | 321.00 | 319.33 | 3.71 | 3.77 | 3.74 |
| **$M_5$**- Foliar application of $ZnSO_4$ @ 0.25% + @ 0.25% $FeSO_4$ at tillering and heading stage. | 76.07 | 77.07 | 76.57 | 334.00 | 337.33 | 335.67 | 4.18 | 4.32 | 4.25 |
| **S.Em, ±** | **0.423** | **0.723** | **0.641** | **1.792** | **1.895** | **2.398** | **0.023** | **0.036** | **0.030** |
| **C.D. (P=0.05)** | **1.243** | **2.123** | **1.882** | **5.262** | **5.565** | **7.040** | **0.066** | **0.106** | **0.089** |
| **Interactions** | | | | | | | | | |
| **S.Em, ±** | **0.674** | **1.136** | **1.011** | **2.808** | **2.981** | **4.065** | **0.036** | **0.057** | **0.048** |
| **C.D. (P=0.05)** | **NS** | **NS** | **NS** | **8.315** | **8.851** | **12.672** | **0.107** | **0.167** | **0.144** |

**Note: -** RDF- (Recommended dose of fertilizers), FYM- (Farm yard manure), $ZnSO_4$ – (Zinc Sulphate) and $FeSO_4$ – (Ferrous Sulphate) and DAS (day after sowing)

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**Table 2. Effect of organic manure + RDF and foliar spray of micronutrient on Spike length, no of spikelet/spike, harvest index and biological yield in wheat.**

| Treatments | Spike length (cm) | | | No of spikelet/spike | | | Harvest Index | | | Biological yield (t/ha) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2021-22 | 2022-23 | Pooled | 2021-22 | 2022-23 | Pooled | 2021-22 | 2022-23 | Pooled | 2021-22 | 2022-23 | Pooled |
| **Main plot (Organic manure +RDF)** | | | | | | | | | | | | |
| **$F_1$**- Control (100% RDF) | 8.87 | 9.16 | 9.01 | 17.83 | 18.68 | 18.25 | 40.99 | 41.65 | 41.32 | 10.83 | 11.16 | 11.00 |
| **$F_2$**- 100 % RDF + Vermicompost @ 2.5t/ha. | 11.99 | 12.81 | 12.40 | 20.90 | 21.83 | 21.37 | 43.50 | 44.49 | 44.00 | 13.34 | 13.97 | 13.65 |
| **$F_3$**- 100 % RDF + FYM @ 5t/ha. | 10.38 | 11.25 | 10.82 | 19.23 | 20.09 | 19.66 | 41.96 | 42.77 | 42.37 | 11.94 | 12.66 | 12.30 |
| **S.Em, ±** | **0.054** | **0.039** | **0.044** | **0.035** | **0.055** | **0.088** | **0.140** | **0.087** | **0.173** | **0.029** | **0.048** | **0.046** |
| **C.D. (P=0.05)** | **0.219** | **0.159** | **0.179** | **0.141** | **0.220** | **0.355** | **0.564** | **0.349** | **0.697** | **0.118** | **0.195** | **0.185** |
| **Sub plot (Foliar spray of micronutrient)** | | | | | | | | | | | | |
| **$M_1$**- Control (No spray) | 9.54 | 9.71 | 9.63 | 18.56 | 18.70 | 18.63 | 41.90 | 42.55 | 42.22 | 10.08 | 10.47 | 10.28 |
| **$M_2$**- Foliar application of $ZnSO_4$ @ 0.25% at tillering and heading stage. | 10.49 | 10.83 | 10.66 | 19.38 | 20.43 | 19.91 | 42.07 | 43.37 | 42.72 | 12.19 | 12.76 | 12.48 |
| **$M_3$**- Spray of Nano Zinc @ 0.5% spray at tillering and heading stage. | 10.71 | 11.73 | 11.22 | 19.61 | 20.67 | 20.14 | 42.15 | 43.02 | 42.58 | 12.72 | 13.30 | 13.01 |
| **$M_4$**- Foliar application of $FeSO_4$ @ 0.25% at tillering and heading stage. | 10.21 | 11.63 | 10.92 | 18.94 | 19.92 | 19.43 | 42.07 | 42.94 | 42.51 | 11.62 | 12.26 | 11.94 |
| **$M_5$**- Foliar application of $ZnSO_4$ @ 0.25% + @ 0.25% $FeSO_4$ at tillering and heading stage. | 11.10 | 11.45 | 11.28 | 20.11 | 21.28 | 20.70 | 42.56 | 42.99 | 42.77 | 13.57 | 14.20 | 13.88 |
| **S.Em, ±** | **0.102** | **0.100** | **0.095** | **0.157** | **0.174** | **0.120** | **0.213** | **0.220** | **0.334** | **0.113** | **0.124** | **0.095** |
| **C.D. (P=0.05)** | **0.300** | **0.293** | **0.278** | **0.461** | **0.510** | **0.353** | **NS** | **NS** | **NS** | **0.333** | **0.364** | **0.280** |
| **Interactions** | | | | | | | | | | | | |
| **S.Em, ±** | **0.157** | **0.159** | **0.153** | **0.246** | **0.275** | **0.206** | **0.358** | **0.352** | **0.546** | **0.178** | **0.198** | **0.155** |
| **C.D. (P=0.05)** | **0.469** | **0.479** | **0.464** | **NS** | **NS** | **NS** | **NS** | **NS** | **NS** | **0.562** | **0.626** | **0.490** |

**Note: -** RDF- (Recommended dose of fertilizers), FYM- (Farm yard manure), $ZnSO_4$ – (Zinc Sulphate) and $FeSO_4$ – (Ferrous Sulphate) and DAS (day after sowing`

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vigorous crop growth due to favorable growing environment. The development of growth characters is a numerically maximum value of plant height, number of tillers and leaf area index was recorded under the $F_2$- 100 % RDF + Vermicompost @ 2.5t/ha an over $F_3$- 100 % RDF + FYM @ 5t/ha Similar, results reported by **Chaudhary *et al.,* (2022), and Kumawat *et al.,* (2022).**

the result of number of tillers in organic manure showed significant influence on growth of crop. $F_2$- 100 % RDF + Vermicompost @ 2.5t/ha recorded the highest number of tillers than other organic manure applied. That is to higher growth characters than, $F_2$- 100 % RDF + Vermicompost @ 2.5t/ha and $F_3$- 100 % RDF + FYM @ 5t/ha respectively. These results further indicated that increased in growth characters and number of tillers $F_2$- 100 % RDF + Vermicompost @ 2.5t/ha was due to better growing environment than other organic manure These results are corroborated by the findings of **Singh and Patra (2017) and Singh *et al.,* (2018).** Among micronutrient foliar application of $M_5$- Foliar application of $ZnSO_4$ @ 0.25% + $FeSO_4$ @ 0.25% at tillering and heading stage recorded tallest plant height which was at par with $F_3$**-** Spray of Nano Zinc @ 0.5% spray at tillering and heading stage followed by, $M_2$**-** foliar application of $ZnSO_4$ @ 0.25% at tillering and heading stage which was at par with $M_4$- foliar application of $FeSO_4$ @ 0.25% at tillering and heading stage at harvest stages of growth during whereas minimum plant height recorded in treatment control (No spray) both the years as well as pooled basis. Among the foliar spray of micronutrient treatment, the maximum tallest plant height, recorded with the application of $M_5$- Foliar application of $ZnSO_4$ @ 0.25% + $FeSO_4$ @ 0.25% at tillering and heading stage. Highest growth characters under these treatments may be due to micronutrient spray which gave better environment for crop growth and development. Because in these treatments It confirms the conclusion drawn by **Fatima *et al.,* (2021) and Noreen *et al.,* (2023).** However, the maximum number of tillers/$m^2$ recorded in $M_5$- Foliar application of $ZnSO_4$ @ 0.25% + $FeSO_4$ @ 0.25% at tillering and heading stage which significantly at par with the treatment $M_3$- Spray of Nano Zinc @ 0.5% spray at tillering and heading stage, $M_2$- Foliar application of $ZnSO_4$ @ 0.25% at tillering and heading stage. The minimum number of tiller/$m^2$ recorded in control (No spray) at 30 DAS, 60 DAS, 90 DAS and at harvest stage of growth during both the years as well as pooled basis. These results are corroborated with the research results **Meena *et al.,* (2020) and Ramzen *et al.,* (2020).** Similarly, leaf area index at 90 DAS highest LAI (Table. 1) at polled basis revealed that in organic manure $F_2$- 100 % RDF + Vermicompost @ 2.5t/ha at harvest. followed by $F_3$- 100 % RDF + FYM @ 5t/ha both were significantly superior over the Control (100% RDF) during both the year as well as pooled basis data. The result is close conformity with the finding of the result is close conformity with the finding of **Tiwari *et al.,* (2022).** In micronutrient foliar spray highest LAI was recorded under the $M_5$- Foliar application of $ZnSO_4$ @ 0.25% + $FeSO_4$ @ 0.25% at tillering and heading stage followed by $M_3$- Spray of Nano Zinc @ 0.5% spray at tillering and heading stage which was statistically at par with $M_2$- Foliar application of $ZnSO_4$ @ 0.25% at tillering and heading stage followed by $M_4$- foliar application of $FeSO_4$ @ 0.25% at tillering and heading stage at harvest stages. Whereas, lowest LAI was

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recorded under the control (No spray) both the years as well as pooled basis. Similar type of result found by **Nadim *et al*., (2011) and Dimkpa *et al.,* (2020).**

## 3.2 Yield attributes and yield

Data on spike length (cm), No of spikelet/spike, harvest index and biological yield (ton/ha) given in (Table. 2). Revealed that all the parameters followed the same sequence which was highest spike length (cm), No of spikelet/spike, harvest index and biological yield (t/ha) recorded under $F_2$- 100 % RDF + Vermicompost @ 2.5t/ha at harvest. followed by $F_3$- 100 % RDF + FYM @ 5t/ha both were significantly superior over the Control (100% RDF) during both the year as well as pooled basis data. These results are corroborated with the research results **Davi *er al.,* (2011), Verma *et al*., (2016) Bairagya *et al*., (2019) and Kumari *et al*., (2022).** Whereas, among foliar application of micro nutrient highest spike length (cm) foliar application of $M_5$- Foliar application of $ZnSO_4$ @ 0.25% + $FeSO_4$ @ 0.25% at tillering and heading stage recorded highest spike length (cm) which was at par with $M_3$- Spray of Nano Zinc @ 0.5% spray at tillering and heading stage followed by, $M_2$- Foliar application of $ZnSO_4$ @ 0.25% at tillering and heading stage followed with $M_4$- foliar application of @ 0.25% $FeSO_4$ followed by control (No spray) harvest stages of growth during both the year as well as pooled basis data. It confirms the conclusion drawn by **Yadav *et al.,* (2023).** However, during both the growing season as well as polled basis number of spikelet/spike recorded highest under foliar application of $ZnSO_4$ @ 0.25% + $FeSO_4$ @ 0.25% at tillering and heading stage followed by $F_3$**-** Nano Zinc @ 0.5% spray at tillering and heading stage, $M_2$- Foliar application of $ZnSO_4$ @ 0.25% at tillering and heading stage, followed by $M_4$- foliar application of $FeSO_4$ @ 0.25% followed by control (No spray). These results are corroborated with the research results **Noreen *et al.*, (2023).** Data pertaining to biological yield indicate that the highest biological yield was recorded under the $M_5$- Foliar application of $ZnSO_4$ @ 0.25% + $FeSO_4$ @ 0.25% at tillering and heading stage (13.88 t/ha) followed by $F_3$**-** Nano Zinc @ 0.5% spray at tillering and heading stage (13.01 ton/ha), $M_2$- Foliar application of $ZnSO_4$ @ 0.25% at tillering and heading stage (12.48 t/ha) followed by $M_4$- foliar application of $FeSO_4$ @ 0.25% (11.93 t/ha) followed by control (No spray). **Sattar *et al*., (2022), Kandil and Marie (2017**). However, there is non-significant difference found between harvest index in foliar spray of micronutrients.

## CONCLUSION

Based on the foregoing discussion it can concluded that the combined application of 100 % RDF + Vermicompost @ 2.5t/ha are found to be superior with respect of growth, yield as well as yield attribute of wheat crop. Moreover, the combined foliar application of $ZnSO_4$ @ 0.25% + $FeSO_4$ @ 0.25% at tillering and heading stage proved to be best for growth parameters, yield attribute as well as yield of wheat crop as compared to others treatment combinations.

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