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# Impact of Organic Manures and Foliar Spraying with Micronutrients on Growth, Yield and Yield Components of Barley Grown in Newly Reclaimed Sandy Soil

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Abstract: One of the major crop productivity constraints especially in new reclaimed sandy soil is the unavailability of organic matter and micronutrient, which could be provided through various nutrient management practices. To achieve the aforementioned objectives, two field experiments were carried out in the Research and Production Station of National Research Centre (NRC), Al-Nubaria Province, Beheira Governorate, Egypt during the two successive winter seasons of 2010/2011 and 2011/2012. This experiment was designed to study effect of three treatments of chicken manures (0, 5 and 10 ton/faddan, one faddan=0.42ha) and twelve foliar application treatments of some micronutrients sprayed individually or in combination on growth, yield and yield components of barely plant (Giza 123 cultivar). The results indicated that addition of 10 ton/faddan chicken manures surpass the other treatments in both seasons. Meanwhile, all foliar spraying with micronutrients treatments positively affected all growth, yield and yield components characters as compared with control treatment (tap water) with superiority to combined treatments (Zn + Fe + B + Mn) which recorded the highest values for all the previous characters in both seasons. As for the interaction effect, barley plant fertilized with 10 ton/faddan and sprayed with (Zn + Fe + B + Mn) recorded the highest values for all the studied characters in both seasons.

**Key words:** Barley · Chicken manures · Micronutrients · Growth · Yield

## INTRODUCTION

Barley (*Hordeum vulgare* L.) is considered to be one of the most important cereal crops in the world [1]. In Egypt, barley is qualified to be cultivated in wide areas, especially in the North Coast region and in the new reclaimed lands, because of its tolerance characteristics to salt and drought stresses. Organic agriculture is a system that relies on ecosystem management rather than external agricultural inputs [2]. Organic farming has emerged as an important priority area globally in view of the growing demand for safe and healthy food and long term sustainability and concerns on environmental pollution associated with indiscriminate use of agrochemicals. Though the use of chemical inputs in agriculture is inevitable to meet the growing demand for food in world, there are opportunities in selected crops and niche areas where organic production can be encouraged to tape the domestic export market [3]. The recycling and the use of nutrients from organic manure have been given more consideration for insuring sustainable land use in agricultural production development. The positive influence of organic fertilizers on soil fertility, crop yield and quality has been demonstrated in the works of many researchers [4]. Application of animal manures to agricultural fields is a widely used method of increasing soil organic matter and fertility. Most solid livestock manures can be applied directly to crop fields. Application of organic manures has various advantages like increasing soil physical properties, water holding capacity, organic carbon content apart from supplying good quality of nutrients [5]. Badr *et al.* [6] found that the differences among the four rates organic fertilizer (zero, 10, 20 and 30$m^3$/faddan were significant. They added that, addition of 30 $m^3$/faddan produced the highest values of number of spikes/$m^2$, weight of spikes (g /$m^2$), as well as grain, straw and biological yields (ton/faddan).

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Micronutrients are as important as macronutrients for adequate plant nutrition and a deficiency of just one nutrient can greatly reduce growth and yield of barley plant [7]. Micronutrients play many complex roles in plant nutrition and plant production and increase crop yield and quality. So balanced and efficient use of micronutrients fertilizers can improve agricultural production and quality [8]. Micronutrients often act as co-factors in enzyme systems and participate in redox reactions, in addition, it have several other vital functions in plants. Most importantly, micronutrients are involved in the key physiological processes of photosynthesis and respiration [9] and their deficiency can impede these vital physiological processes thus limiting yield grain [10]. The positive effects of Fe and Zn on plant may be due to their effects as a metal component of some enzymes or regulatory for the others. Moreover, they have essential roles in plant metabolism [11]. Who added, that Zn is a vital element for growth and it activates some enzymes such as carbonic anhydrase, dehydrogenase, proteins and peptidase which led to increases in leaf chlorophyll and indole acetic acid, so photosynthesis will be improved and then dry mater will be increased. Boron plays a major role in plant vital activities such as cell division, leaf and flower bud formation, glucose metabolism and hydrocarbons and their transport, root growth, cell wall formation and material transportation between cells. Boron transport and transfer in plant is relatively low and thus its concentration in lower parts of the plant is higher [12]. They added, iron (Fe) is another micronutrient that is a co-factor for approximately 140 enzymes that catalyze unique biochemical reactions. Hence, iron has many essential roles in plant growth and development including chlorophyll synthesis, thylakoid synthesis and chloroplast development. Manganese is one of the main micronutrients, which has an important role in plant as a component of enzymes involved in photosynthesis and other processes, as a structural component of the Photosystem II watersplitting protein. Manganese is part of an important antioxidant (superoxide dismutase) structure that protects plant cells by deactivating free radicals which can destroy plant tissue. It also serves as electron storage and delivery to the chlorophyll reaction centers [13]. Manganese also plays positive effect on number of fertile tillers, soluble carbohydrates especially in roots and photosynthesis of wheat plant [14]. These micronutrients help in chlorophyll formation, nucleic acid, protein synthesis and play an active role in several enzymatic activities of photosynthesis as well as respiration [15].

This study was undertaken to examine the effect of organic fertilizer and foliar application with micronutrients on barley Giza 123 cultivar grown under newly reclaimed sandy soil conditions.

## MATERIALS AND METHODS

Two field experiments were conducted at the Research and Production Station, National Research Centre, El-Nubaria Province, Beheira Governorate, Egypt, during the two successive winter seasons of 2010/2011 and 2011/2012 (latitude 30° 30\ 1.4\\ N and longitude 30°19\ 10.9\\E and mean altitude 21 m above sea level). The experimental area has an arid climate with cool winters and hot dry summers prevailing in the experimental area. The aim of the experiments was to evaluate the effect of organic manures and spraying with some micronutrients on growth, yield and its components of barley plant (Giza 123 cultivar). Soil sample was taken at depth of 30 cm for mechanical and chemical analyses as described by Chapman and Pratt [16] (Table 1). Soil was ploughed twice, ridged and divided into plots. Grains of the barley cultivar Giza-123 were obtained from Agricultural Research Centre, Giza, Egypt. The grains of barley cultivar Giza 123 were sown at a rate of 60 kg/faddan at 1st December and 25th November in the first and second seasons, respectively. During seed preparation 75 kg/faddan calcium superphosphate (15.5% $P_2O_5$), (one faddan= 0.42ha) was added as a general application. Nitrogen fertilizer was added at a rate of 40 kg/faddan ammonium sulfate (20.6 % N) in two equal doses at 15 and 45 days after sowing. After 60 days from sowing, 25 kg potassium sulphate (48% K) was added. Normal cultural practices of growing barley conducted in the usual manner followed by the farmers of this district.

The experiment was laid out in split plot design with four replications in rows 3 meter long, 15 cm apart and 20 rows with total area 10.5 $m^2$. The experiment included 36 treatments which were the combination between 3 levels of organic manures x 12 foliar spraying with micronutrients. The chemical composition of chicken manure is presented in Table 2. Organic fertilization were distributed in the main plots (without chicken manures, 5 ton/faddan chicken manures and 10 ton/faddan chicken manures),

Table 1: Physical and chemical analyses of the experimental soil (2010/2011 and 2011/2012 seasons).

| Variables | 2010/2011 | 2011/2012 |
|---|---|---|
| Physical properties | | |
| Sand % | 92.3 | 90.1 |
| Silt % | 3.1 | 4.3 |
| Clay % | 4.6 | 5.6 |
| Chemical analysis | | |
| CaCo3 % | 1.3 | 1.5 |
| Organic matter % | 0.3 | 0.3 |
| EC (mmhos/cm2) | 0.3 | 0.3 |
| pH | 7.4 | 7.2 |
| Soluble N% | 8.0 | 8.2 |
| Available P (ppm) | 3.0 | 3.4 |
| Available K (ppm) | 19.8 | 20.2 |

Table 2: Chemical composition of the chicken manure used (2010/2011 and 2011/2012 seasons).

| Characters | 2010/2011 | 2011/2012 |
|---|---|---|
| Organic matter % | 49.2 | 51.5 |
| Organic carbon % | 29.0 | 29.4 |
| C/N ratio | 14.7 | 14.1 |
| pH | 7.5 | 7.8 |
| EC (mmhos/cm2) | 2.2 | 2.2 |
| Total N % | 2.0 | 2.2 |
| Available P (ppm) | 116 | 120 |
| Available K (ppm) | 105 | 111 |

while, foliar spraying with micronutrients were allocated in sub plots (Control, 200 g zinc /faddan, 300 g boron /faddan, 200 g manganese /faddan, 250 g iron /faddan, 200 g zinc +300 g boron/faddan, 200 g zinc +200 g manganese/faddan, 200 g zinc +250 g iron/faddan, 300 g boron +200 g manganese/faddan, 300 g boron + 250 g iron/faddan, 200 g manganese +250 g iron/faddan and 200 g zinc + 200 g manganese +300 g boron + 250 g iron/faddan were dissolved in 100 liter water. All plants sprayed twice with the specific micronutrients treatment 35 days from sowing and 20 days later. Sprinkler irrigation s was applied as plants needed. Vegetative plant samples/ $m^2$ from each plot were taken at 75 days after sowing to determine plant height (cm), number of blades/$m^2$, dry weight of whole plants g/$m^2$, flag leaf area $cm^2$, leaf area index (LAI), specific leaf weight (SLW ) mg/$cm^2$.

At harvest 21st April 2011 and 2nd May 2012 in the first and second seasons, respectively, two central 1 $m^2$ from each plot were harvested to estimate yield and yield components i.e. dry weight of spikes g/$m^2$, number of grains/spike, dry weight of grains/spike (g), spike length (cm), 1000 grains weight (g), grain yield ton/faddan, straw yield ton/faddan and biological yield ton/faddan.

**Statistical Analysis:** All data were subjected to statistical analysis according to procedure outlined by Snedecor and Cochran [17]. Means of the different treatments were compared using the least significant difference (LSD) test at $P<0.05$.

## RESULTS AND DISCUSSION

**Effect of Organic Manures on Come Growth Characters:** It is clear from Table 3 that application of organic fertilizer significantly increases most growth characters i.e. plant height (cm), number of blades/$m^2$, dry weight of whole plants g/$m^2$, flag leaf area $cm^2$, leaf area index (LAI) and specific leaf weight (mg/$cm^2$) in both seasons. The highest increases in the characters mentioned before were obtained by chicken manures at 10 ton/faddan and the least values were observed in control treatment (without chicken manures). This trend could be explained on a basis that maintaining sufficient available nutrients during the growth period could be achieved through organic materials application. These results are in agreement with those obtained by Ramah *et al*. [18], who reported that application of cattle manures increased the growth of barley plants. Such pronouncing effect of organic fertilizers in increasing growth was recorded by Cerny *et al.* [19] and Kimpinski *et al.* [20]. Obtained results might be due to the stimulation effect of organic manures on improving the physical properties of the soil, increasing soil fertility and increasing the availability of many nutrients element to plant uptake, which in turn on improving the growth of barley plants. In this regards, Ahmed *et al*. [21] showed that addition of cattle manure increased yield and yield components of barley. Moreover, Hernandez *et al*. [22] stated that, annual application of 30 $m^3$ $ha^{-1}$ of pig slurry (equivalent to an average of 67 kg N $ha^{-1}$) results in barley yields similar to those obtained with the traditional mineral fertilization in the study area.

**Effect of Foliar Spraying with Micronutrients on Some Growth Characters:** Results recorded in Table 4 revealed that all growth characters i.e. plant height (cm), number of blades/$m^2$, dry weight of whole plants g/$m^2$, flag leaf area $cm^2$, leaf area index (LAI) and specific leaf weight (mg/$cm^2$) positively affected by all foliar spraying with micronutrients with superiority to the combined treatments (Zn + Fe + B + Mn) in both seasons. These results are in agreement with those obtained by Babaeian *et al*. [23]. In this concern,

Table 3: Effect of organic manures on some growth characters.

| Organic manures (ton/faddan) | Plant height cm | | Number of blades/m² | | Dry weight of whole plants (g/m²) | | Flag leaf area (cm²) | | Leaf area index (LAI) | | Specific leaf weight (SLW) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season |
| Zero | 67.38 | 72.18 | 388.85 | 417.21 | 218.29 | 376.05 | 413.86 | 21.50 | 21.54 | 3.44 | 3.56 | 6.24 |
| 5 | 73.35 | 76.50 | 437.29 | 457.60 | 248.44 | 410.97 | 473.58 | 23.65 | 23.71 | 3.67 | 3.77 | 6.64 |
| 10 | 76.30 | 79.65 | 470.16 | 510.84 | 284.80 | 461.22 | 540.59 | 25.36 | 24.87 | 3.90 | 4.02 | 7.10 |
| LSD 5% | NS | NS | 37.61 | 27.53 | 22.06 | 51.6 | 34.62 | NS | 2.80 | 0.05 | NS | 0.83 |

Table 4: Effect of foliar spraying with micronutrients on some growth characters.

| Micronutrients treatments | Plant height cm | | Number of blades/m² | | Dry weight of whole plants (g/m²) | | Flag leaf area (cm²) | | Leaf area index (LAI) | | Specific leaf weight (SLW) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season |
| Tap water | 69.29 | 72.16 | 399.33 | 407.43 | 381.33 | 428.53 | 20.89 | 20.24 | 3.47 | 3.55 | 6.21 | 6.17 |
| Zn | 74.10 | 78.33 | 439.01 | 476.79 | 426.42 | 483.95 | 22.97 | 23.33 | 3.71 | 3.83 | 6.81 | 6.75 |
| B | 69.45 | 74.96 | 426.77 | 448.13 | 407.27 | 455.57 | 22.73 | 22.94 | 3.61 | 3.71 | 6.54 | 6.52 |
| Mn | 69.86 | 74.44 | 431.06 | 458.65 | 411.30 | 472.03 | 22.31 | 22.56 | 3.61 | 3.71 | 6.63 | 6.60 |
| Fe | 71.11 | 75.82 | 426.14 | 446.93 | 405.81 | 465.05 | 22.48 | 22.16 | 3.59 | 3.69 | 6.52 | 6.50 |
| Zn + Fe | 76.11 | 79.90 | 445.27 | 490.70 | 435.41 | 493.08 | 23.68 | 23.53 | 3.76 | 3.88 | 6.91 | 6.87 |
| Zn + Mn | 72.32 | 77.29 | 440.90 | 475.16 | 430.08 | 504.96 | 26.98 | 25.64 | 3.78 | 3.92 | 6.81 | 6.74 |
| Zn + B | 70.20 | 73.58 | 439.20 | 476.65 | 426.43 | 497.47 | 26.24 | 25.19 | 3.71 | 3.83 | 6.79 | 6.75 |
| B + Fe | 71.06 | 72.79 | 428.45 | 451.99 | 399.26 | 462.55 | 22.45 | 22.76 | 3.61 | 3.71 | 6.51 | 6.48 |
| B + Mn | 72.08 | 74.80 | 429.09 | 452.75 | 412.93 | 475.56 | 19.66 | 21.87 | 3.66 | 3.76 | 6.59 | 6.55 |
| Mn + Fe | 74.31 | 77.81 | 428.66 | 452.50 | 413.90 | 469.49 | 23.88 | 23.56 | 3.68 | 3.80 | 6.59 | 6.55 |
| All micronutrients | 78.26 | 81.48 | 451.28 | 504.92 | 442.79 | 503.87 | 27.75 | 26.67 | 3.84 | 3.99 | 7.02 | 6.96 |
| LSD 5% | NS | 11.01 | 24.3 | 28.82 | 9.02 | 28.93 | NS | NS | 0.12 | 0.23 | 0.46 | 0.34 |

Robredo *et al*. [24] reported that, the increase in growth with foliar fertilization may be due to that, foliar application of nutrients is readily absorbed by leaves and enhancing the physiological processes. Abd El-Wahab [25] stated that micronutrients such as iron, manganese and zinc have important roles in plant growth. Mona *et al*. [26] reported that foliar spraying with zinc had a significant promotion effect on the studied growth, as well as the physiological parameters of barley when compared with the control treatment. Imtiaz *et al*. [27] reported that balancing the micronutrients for barley cultivation enhanced plant growth. Each element of these micronutrients has its own function in plant growth. Potarzycki and Grzebisz [28] reported that zinc exerts a great influence on basic plant life processes, such as (I) nitrogen metabolism- uptake of nitrogen and protein quality; (ii) photosynthesis- chlorophyll synthesis, carbon anhydrase activity. Boorboori *et al*. [29] stated that, Iron (Fe) is another micronutrient that is a co-factor for approximately 140 enzymes that catalyze unique biochemical reactions. Hence, iron has many essential roles in plant growth and development including chlorophyll synthesis, thylakoid synthesis and chloroplast development. Moosavi [8] stated that, pIron (Fe) and manganese (Mn) are essential nutrients for plants. Application of high levels of either Fe or Mn is often accompanied by relatively low levels of uptake for the other nutrient. The antagonistic relationship of these nutrient elements may occur either during absorption by roots or during translocation from roots to shoot. Increase of specific leaf weight may be due to the increase in both dry matter production and leaf area/plant. These results are in agreement with those obtained by Eleiwa *et al*. [30], who revealed that foliar spraying with Zinc had a significant primitive effect on the studied growth characters (plant height, spike length, tillers and leaves numbers per plant and leaf area). In this concern, Thalooth *et al*. [31] indicated that using Zn led to increases in leaf chlorophyll, so photosynthesis will be improved and then dry mater will be increased. Moreover, Sajid *et al*. [32] stated that plants require specific amount of certain micronutrients in specific form at appropriate time, for their growth and development. The increase in plant height due to the different foliar treatments, may be attributed to that, these micronutrients stimulated stem elongation throughout the increment in the number and size of cells [23]. On the other hand, it is noteworthy to mention that, Boron influences cell development and elongation. It is involved in the transport of sugars across cell membranes and in the synthesis of cell wall material. Boron regulates the carbohydrate metabolism in plants and plays a role in amino acid formation and synthesis of proteins [12].

Table 5: Interaction effect of organic manures and micronutrients on some growth characters.

| Organic manures | | Plant height cm | | Number of blades/m$^2$ | | Dry weight of whole plants (g/m$^2$) | | Flag leaf area (cm$^2$) | | Leaf area index (LAI) | | Specific leaf weight (SLW) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (ton/faddan) | Micronutrients | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season |
| Zero | Tap water | 68.34 | 73.39 | 359.61 | 362.98 | 341.20 | 382.93 | 19.12 | 19.33 | 3.26 | 3.33 | 5.80 | 5.67 |
| | Zn | 69.67 | 75.07 | 401.13 | 445.69 | 394.05 | 425.33 | 21.51 | 21.79 | 3.51 | 3.64 | 6.48 | 6.37 |
| | B | 63.48 | 67.27 | 383.71 | 403.40 | 367.76 | 409.12 | 21.33 | 21.32 | 3.42 | 3.53 | 6.12 | 6.02 |
| | Mn | 65.47 | 69.78 | 398.20 | 438.69 | 384.63 | 425.13 | 19.93 | 20.04 | 3.45 | 3.57 | 6.41 | 6.31 |
| | Fe | 66.12 | 70.60 | 387.44 | 412.49 | 371.85 | 411.12 | 20.94 | 21.01 | 3.38 | 3.47 | 6.18 | 6.09 |
| | Zn + Fe | 70.02 | 75.52 | 397.90 | 437.96 | 391.23 | 422.42 | 22.83 | 22.8 | 3.52 | 3.65 | 6.42 | 6.31 |
| | Zn + Mn | 67.03 | 71.74 | 397.56 | 434.60 | 388.53 | 435.51 | 25.23 | 24.1 | 3.55 | 3.68 | 6.4 | 6.28 |
| | Zn + B | 63.83 | 67.72 | 391.05 | 421.29 | 380.01 | 414.05 | 23.21 | 23.27 | 3.47 | 3.59 | 6.28 | 6.17 |
| | B + Fe | 66.20 | 70.70 | 383.57 | 403.02 | 363.61 | 401.65 | 18.87 | 19.10 | 3.37 | 3.47 | 6.10 | 6.02 |
| | B + Mn | 67.41 | 72.22 | 372.50 | 376.09 | 357.45 | 395.14 | 18.48 | 18.73 | 3.39 | 3.49 | 5.90 | 5.79 |
| | Mn + Fe | 70.13 | 75.64 | 385.3 | 407.28 | 369.78 | 411.44 | 21.02 | 21.35 | 3.41 | 3.51 | 6.15 | 6.05 |
| | All | 70.86 | 76.56 | 408.18 | 463.01 | 402.52 | 432.47 | 25.57 | 25.59 | 3.59 | 3.73 | 6.67 | 6.59 |
| 5 | Tap water | 69.28 | 69.82 | 404.95 | 411.31 | 380.93 | 434.38 | 20.37 | 19.41 | 3.49 | 3.56 | 6.22 | 6.20 |
| | Zn | 74.77 | 76.04 | 439.21 | 460.87 | 414.39 | 487.25 | 23.04 | 23.09 | 3.68 | 3.78 | 6.73 | 6.62 |
| | B | 69.20 | 76.82 | 434.91 | 451.21 | 409.10 | 446.32 | 23.04 | 22.98 | 3.66 | 3.76 | 6.58 | 6.54 |
| | Mn | 69.95 | 74.84 | 435.54 | 452.62 | 404.82 | 471.25 | 22.86 | 22.87 | 3.58 | 3.67 | 6.57 | 6.55 |
| | Fe | 75.76 | 81.92 | 430.1 | 440.42 | 401.17 | 461.43 | 22.74 | 22.97 | 3.59 | 3.68 | 6.47 | 6.45 |
| | Zn + Fe | 78.76 | 81.29 | 458.54 | 504.22 | 437.41 | 499.34 | 23.2 | 23.74 | 3.77 | 3.89 | 7.02 | 6.98 |
| | Zn + Mn | 73.72 | 82.04 | 445.48 | 460.24 | 421.53 | 496.06 | 27.08 | 25.89 | 3.77 | 3.89 | 6.68 | 6.62 |
| | Zn + B | 68.77 | 70.61 | 444.97 | 473.79 | 419.87 | 495.49 | 24.8 | 25.04 | 3.68 | 3.78 | 6.76 | 6.73 |
| | B + Fe | 73.51 | 74.23 | 430.44 | 441.18 | 383.40 | 451.01 | 23.72 | 24.00 | 3.60 | 3.69 | 6.48 | 6.45 |
| | B + Mn | 73.19 | 75.55 | 433.45 | 447.93 | 408.73 | 475.94 | 18.71 | 23.27 | 3.66 | 3.76 | 6.55 | 6.51 |
| | Mn + Fe | 73.46 | 71.85 | 436.14 | 453.98 | 409.98 | 461.02 | 24.69 | 24.78 | 3.67 | 3.77 | 6.60 | 6.56 |
| | All | 79.89 | 83.03 | 453.72 | 493.42 | 440.28 | 503.42 | 29.52 | 26.46 | 3.83 | 3.96 | 6.96 | 6.89 |
| 10 | Tap water | 70.27 | 73.28 | 433.44 | 448.01 | 421.87 | 468.27 | 23.17 | 22 | 3.67 | 3.75 | 6.60 | 6.65 |
| | Zn | 77.87 | 83.87 | 476.7 | 523.81 | 470.81 | 539.28 | 24.35 | 25.12 | 3.94 | 4.07 | 7.23 | 7.26 |
| | B | 75.67 | 80.81 | 461.69 | 489.78 | 444.96 | 511.26 | 23.81 | 24.52 | 3.76 | 3.86 | 6.93 | 6.99 |
| | Mn | 74.16 | 78.70 | 459.43 | 484.63 | 444.47 | 519.71 | 24.15 | 24.76 | 3.8 | 3.9 | 6.9 | 6.95 |
| | Fe | 71.46 | 74.93 | 460.89 | 487.87 | 444.42 | 522.6 | 23.77 | 22.5 | 3.81 | 3.91 | 6.92 | 6.97 |
| | Zn + Fe | 79.53 | 82.90 | 479.38 | 529.92 | 477.58 | 557.48 | 25.01 | 24.04 | 3.97 | 4.11 | 7.28 | 7.31 |
| | Zn + Mn | 76.19 | 78.09 | 479.66 | 530.64 | 480.18 | 583.3 | 28.63 | 26.92 | 4.03 | 4.18 | 7.34 | 7.31 |
| | Zn + B | 78.02 | 82.41 | 481.58 | 534.86 | 479.41 | 582.87 | 30.72 | 27.27 | 3.99 | 4.12 | 7.32 | 7.35 |
| | B + Fe | 73.46 | 73.43 | 471.34 | 511.77 | 450.77 | 535.00 | 24.77 | 25.18 | 3.85 | 3.97 | 6.95 | 6.97 |
| | B + Mn | 75.65 | 76.64 | 481.34 | 534.24 | 472.60 | 555.60 | 21.8 | 23.60 | 3.91 | 4.04 | 7.32 | 7.35 |
| | Mn + Fe | 79.35 | 85.92 | 464.53 | 496.25 | 461.93 | 536.03 | 25.93 | 24.56 | 3.97 | 4.11 | 7.02 | 7.04 |
| | All | 84.03 | 84.85 | 491.92 | 558.34 | 485.58 | 575.71 | 28.17 | 27.95 | 4.11 | 4.27 | 7.42 | 7.39 |
| LSD 5% | -- | NS | NS | NS | NS | 26.06 | NS | NS | NS | NS | 0.15 | 0.38 | NS |

**Interaction Effect of Organic Manures and Micronutrients on Some Growth Characters:** The effect of interaction between organic manures and foliar spraying with micronutrients on barley growth i.e. plant height (cm), number of blades/m$^2$, dry weight of whole plants g/m$^2$, flag leaf area cm$^2$, leaf area index (LAI) and specific leaf weight (mg/cm$^2$), are shown in Table 5. However, the highest values for all the studied growth characters were recorded in barley plants fertilized 10 ton/faddan chicken manures and sprayed with (Zn + Fe + B + Mn). On the other hand, the least values were recorded in barley plants without organic fertilizer and sprayed with tap water. However, these results were valid for both seasons. Similar results were obtained by El-Ghamry *et al.* [33], who reported that growth characters of barley plants were influenced by organics and micronutrients fertilization. This could be due to the favorable conditioned caused by organic manures and foliar spraying with micronutrients. Ramah *et al.* [18] came to the same conclusion. In this concern, Akinrinde *et al.* [34] found that use of cow manure + $ZnSO_4$ produced the highest growth criteria and plant shoot biomass. Soil organic matter enhance the availability of positively charged micronutrients through chelation (formation of bonds with of varying strength between a metallic ion and an organic molecule) which tie up the nutrients with soil minerals and keep it available for longer time [33].

**Effect of Organic Manures on Yield and Yield Components of Barley Plants:** It is clear from Fig. 1 and Table 6, that yield and yield components significantly increased by increasing rate of organic fertilizer. However, 10 ton/faddan recorded the highest values for all the previous characters in both seasons. Similar results were obtained by Ramah *et al.* [18]. In this concern, Badr *et al.* [6] found that the differences among the four rates organic fertilizer

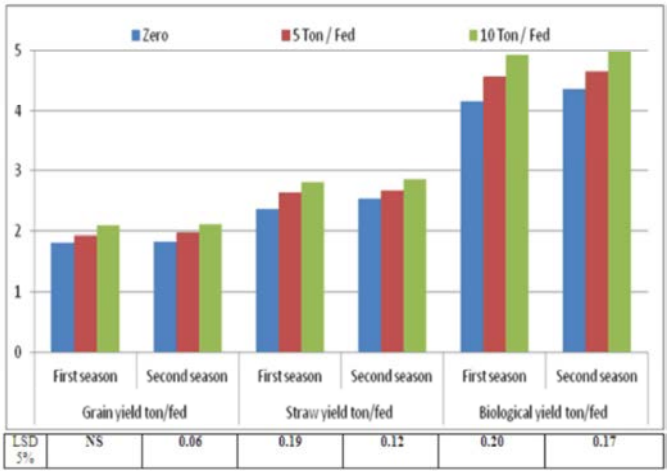


Fig. 1: Effect of organic manures rates on yield of barley.

Table 6: Effect of organic manures rates on yield components of barley plant

| Organic manures (ton/faddan) | Plant height cm | | Dry weight of spikes (g/m$^2$) | | Number of grains/spike | | Dry weight of grains/spike (g) | | Spike length (cm) | | 1000 grains weight (g) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1$^{st}$ season | 2$^{nd}$ season | 1$^{st}$ season | 2$^{nd}$ season | 1$^{st}$ season | 2$^{nd}$ season | 1$^{st}$ season | 2$^{nd}$ season | 1$^{st}$ season | 2$^{nd}$ season | 1$^{st}$ season | 2$^{nd}$ season |
| Zero | 85.51 | 87.74 | 696.07 | 710.15 | 53.30 | 55.04 | 2.43 | 2.50 | 9.24 | 9.37 | 45.53 | 45.38 |
| 5 | 92.57 | 94.89 | 763.48 | 750.35 | 56.03 | 57.75 | 2.61 | 2.74 | 9.71 | 9.94 | 46.61 | 47.25 |
| 10 | 97.14 | 99.51 | 715.01 | 770.49 | 58.01 | 59.20 | 2.73 | 2.87 | 10.07 | 10.34 | 47.15 | 48.46 |
| LSD 5% | NS | NS | 36.66 | 47.11 | NS | NS | NS | 0.33 | NS | NS | NS | 2.040 |

(zero, 10, 20, 30 m$^3$/faddan were significant. They added that, addition of 30 m$^3$/faddan produced the highest values of number of spikes/m$^2$, weight of spikes (g/m$^2$), as well as, grain, straw and biological yields (ton/faddan). Obtained results might be due to the stimulation effect of organic manures on improving the physical properties of the soil, increasing soil fertility and increasing the availability of many nutrients element to plant uptake, which in turn on improving the growth of barley plants and consequently positively affected yield and yield components. Ofosu-Anim and Leitch [35] stated that, organic manure application had the potential of increasing spring barley yield by 1.5 to 4-fold. Cerny *et al.* [19] proved that, application of sewage sludge and manure increased the yield of barley yield by 22%. El-Ghamry *et al*. [33] proved that, adding FYM at rates of 20 ton ha$^{-1}$ and some micronutrients as foliar application increased yield and yield components.

**Effect of Foliar Spraying with Micronutrients on Yield and Yield Components of Barley Plants:** Data presented in Fig. 2 and Table 7 showed that, dry weight of spikes /m$^2$, number of grains/spike, dry weight of grains/spike, spike length, 1000 grains weight, grain yield ton/faddan, straw yield ton/faddan, biological yield ton/faddan and harvest index, during two growing seasons were positively affected by foliar application of micronutrients. Data also showed that the highest values for all the previous characters were recorded under treatments with (Zn + Fe + B + Mn). Similar results were obtained by Babaeian *et al*. [36], who stated that, foliar application of micronutrients resulted in better crop yield and yield components. These results reveal the importance of all of these El-Ghamry *et al*. [33] proved that, adding FYM at rates of 20 ton ha$^{-1}$ and some micronutrients as foliar application increased yield and yield components. Nutrients management practices and call for an integrated approach of crop nutrients management, which would be more economical and environmental friendly to achieve higher yields. The positive effects of Fe and Zn on plant may be due to their effects as a metal component of some enzymes or regulatory for the others. Moreover, they have essential roles in plant metabolism [11]. Abd El-Wahab [25] stated that micronutrients such as iron, manganese and zinc have important roles and enhance yield of barley plants.

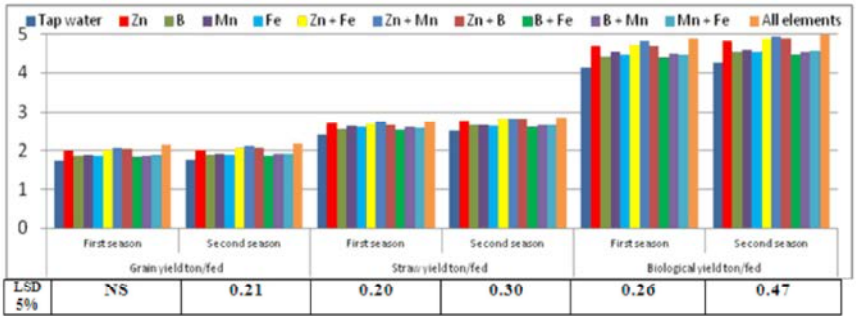


Fig. 2: Effect of foliar spraying with micronutrients on yield of barley

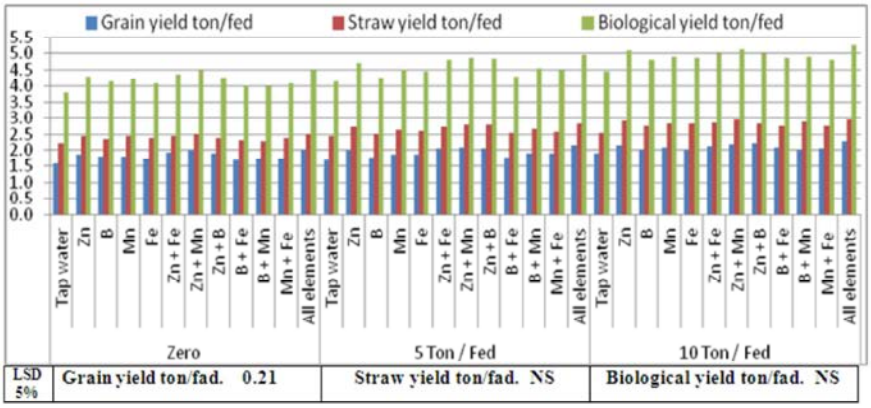


Fig. 3: Interaction effect of organic manures and micronutrients on yield (first season).

Table 7: Effect of foliar spraying with micronutrients on yield components of barley plant.

| | Dry weight of spikes (g/m$^2$) | | Number of grains/spike | | Dry weight of grains/spike (g) | | Spike length (cm) | | 1000 grains weight (g) | |
|---|---|---|---|---|---|---|---|---|---|---|
| Mocronutrients | 1$^{st}$ season | 2$^{nd}$ season | 1$^{st}$ season | 2$^{nd}$ season | 1$^{st}$ season | 2$^{nd}$ season | 1$^{st}$ season | 2$^{nd}$ season | 1$^{st}$ season | 2$^{nd}$ season |
| Tap water | 641.04 | 672.49 | 53.40 | 54.92 | 2.38 | 2.43 | 9.21 | 9.37 | 44.65 | 44.24 |
| Zn | 673.33 | 764.74 | 56.72 | 58.74 | 2.64 | 2.80 | 10.01 | 10.17 | 46.54 | 47.70 |
| B | 685.55 | 718.68 | 53.86 | 55.75 | 2.47 | 2.58 | 9.29 | 9.74 | 46.00 | 46.47 |
| Mn | 730.54 | 736.80 | 54.23 | 55.90 | 2.52 | 2.66 | 9.47 | 9.67 | 46.47 | 47.51 |
| Fe | 709.74 | 687.27 | 56.25 | 56.45 | 2.59 | 2.69 | 9.70 | 9.85 | 46.06 | 47.03 |
| Zn + Fe | 776.19 | 788.22 | 55.33 | 57.06 | 2.64 | 2.77 | 9.54 | 10.38 | 47.72 | 48.42 |
| Zn + Mn | 798.77 | 789.87 | 55.11 | 58.91 | 2.63 | 2.84 | 9.50 | 10.04 | 47.49 | 48.17 |
| Zn + B | 752.68 | 784.45 | 57.37 | 58.92 | 2.69 | 2.80 | 9.89 | 9.56 | 46.95 | 47.49 |
| B + Fe | 693.35 | 714.49 | 55.26 | 56.79 | 2.49 | 2.49 | 9.53 | 9.45 | 45.05 | 44.04 |
| B + Mn | 724.44 | 726.60 | 55.27 | 55.56 | 2.58 | 2.58 | 9.53 | 9.71 | 46.44 | 46.16 |
| Mn + Fe | 701.65 | 731.34 | 57.45 | 58.17 | 2.66 | 2.80 | 9.91 | 10.10 | 46.32 | 48.14 |
| All micronutrients | 811.00 | 808.95 | 59.10 | 60.77 | 2.81 | 2.98 | 10.51 | 10.58 | 47.46 | 49.01 |
| LSD 5% | 59.1 | 97.11 | NS | NS | NS | 0.51 | NS | NS | 1.91 | NS |

**Interaction Effect of Organic Manures and Micronutrients on Yield and Yield Components:** Data in Fig 3&4 and Table 8 show the effect of interaction between organic manures and foliar spraying with micronutrients on yield and yield components of barley plant. It is clear that fertilizer barley plants with 10 ton/faddan chicken manures and foliar spraying with (Zn + Fe + B + Mn) recorded the highest values for all yield and yield components characters in both seasons. In this concern, Kandel [37] showed that the dry matter yield of barley was enhanced by the addition of soil amendments and micronutrients fertilization. Moreover, Akinrinde *et al.* [34] found that use of cow manure + $ZnSO_4$ produced the highest plant shoot biomass and grain yield. Furthermore, Shelley and Kalpana [38] reported that application of zinc and organic manures significantly increased the crop yield. Soil organic matter enhance the availability of positively charged micronutrients through chelation (formation of bonds with of varying

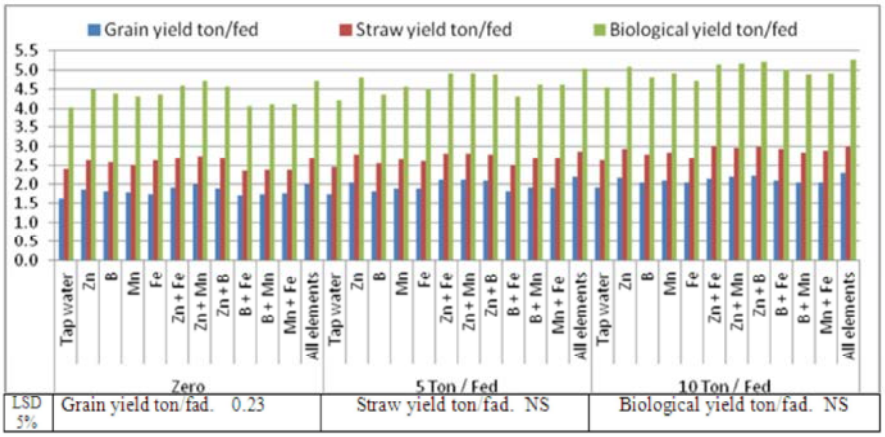


Fig. 4: Interaction effect of organic manures and micronutrients on yield (second season).

Table 8: Interaction effect of organic manures and micronutrients on yield components

| Organic manures | | Plant height cm | | Number of blades/m$^2$ | | Dry weight of whole plants (g/m$^2$) | | Flag leaf area (cm$^2$) | | Leaf area index (LAI) | | Specific leaf weight (SLW) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (ton/faddan) | Micronutrients | 1$^{st}$ season | 2$^{nd}$ season | 1$^{st}$ season | 2$^{nd}$ season | 1$^{st}$ season | 2$^{nd}$ season | 1$^{st}$ season | 2$^{nd}$ season | 1$^{st}$ season | 2$^{nd}$ season | 1$^{st}$ season | 2$^{nd}$ season |
| Zero | Tap water | 81.77 | 83.71 | 560.51 | 641.95 | 50.76 | 52.27 | 81.77 | 83.71 | 560.51 | 641.95 | 50.76 | 52.27 |
| | Zn | 89.82 | 92.14 | 677.84 | 728.93 | 55.02 | 56.55 | 89.82 | 92.14 | 677.84 | 728.93 | 55.02 | 56.55 |
| | B | 80.68 | 82.88 | 607.10 | 698.39 | 52.09 | 53.61 | 80.68 | 82.88 | 607.10 | 698.39 | 52.09 | 53.61 |
| | Mn | 84.07 | 86.31 | 738.09 | 692.13 | 50.76 | 52.70 | 84.07 | 86.31 | 738.09 | 692.13 | 50.76 | 52.70 |
| | Fe | 85.49 | 87.75 | 650.11 | 692.27 | 52.48 | 53.99 | 85.49 | 87.75 | 650.11 | 692.27 | 52.48 | 53.99 |
| | Zn + Fe | 85.81 | 88.07 | 749.77 | 759.36 | 53.43 | 54.95 | 85.81 | 88.07 | 749.77 | 759.36 | 53.43 | 54.95 |
| | Zn + Mn | 86.17 | 88.44 | 782.59 | 743.70 | 51.90 | 55.73 | 86.17 | 88.44 | 782.59 | 743.70 | 51.90 | 55.73 |
| | Zn + B | 81.85 | 84.06 | 801.94 | 740.00 | 55.57 | 57.10 | 81.85 | 84.06 | 801.94 | 740.00 | 55.57 | 57.10 |
| | B + Fe | 84.49 | 86.73 | 642.94 | 677.78 | 52.82 | 54.34 | 84.49 | 86.73 | 642.94 | 677.78 | 52.82 | 54.34 |
| | B + Mn | 86.81 | 89.08 | 689.37 | 684.72 | 52.38 | 55.21 | 86.81 | 89.08 | 689.37 | 684.72 | 52.38 | 55.21 |
| | Mn + Fe | 88.71 | 91.01 | 656.13 | 691.54 | 54.57 | 56.10 | 88.71 | 91.01 | 656.13 | 691.54 | 54.57 | 56.10 |
| | All | 90.41 | 92.74 | 796.48 | 770.98 | 57.86 | 57.91 | 90.41 | 92.74 | 796.48 | 770.98 | 57.86 | 57.91 |
| 5 | Tap water | 88.63 | 90.93 | 701.26 | 662.88 | 53.95 | 55.48 | 88.63 | 90.93 | 701.26 | 662.88 | 53.95 | 55.48 |
| | Zn | 94.18 | 96.22 | 600.04 | 765.61 | 56.24 | 58.28 | 94.18 | 96.22 | 600.04 | 765.61 | 56.24 | 58.28 |
| | B | 88.85 | 91.15 | 739.13 | 692.14 | 52.97 | 55.59 | 88.85 | 91.15 | 739.13 | 692.14 | 52.97 | 55.59 |
| | Mn | 88.12 | 90.41 | 723.98 | 732.14 | 54.73 | 56.26 | 88.12 | 90.41 | 723.98 | 732.14 | 54.73 | 56.26 |
| | Fe | 96.05 | 98.45 | 896.81 | 742.06 | 57.67 | 59.21 | 96.05 | 98.45 | 896.81 | 742.06 | 57.67 | 59.21 |
| | Zn + Fe | 94.29 | 96.66 | 832.97 | 801.62 | 55.91 | 57.44 | 94.29 | 96.66 | 832.97 | 801.62 | 55.91 | 57.44 |
| | Zn + Mn | 95.80 | 98.19 | 854.38 | 807.66 | 59.10 | 60.66 | 95.80 | 98.19 | 854.38 | 807.66 | 59.10 | 60.66 |
| | Zn + B | 87.69 | 89.98 | 699.79 | 798.37 | 57.14 | 58.68 | 87.69 | 89.98 | 699.79 | 798.37 | 57.14 | 58.68 |
| | B + Fe | 93.83 | 96.20 | 719.39 | 692.30 | 53.91 | 55.44 | 93.83 | 96.20 | 719.39 | 692.30 | 53.91 | 55.44 |
| | B + Mn | 92.85 | 95.20 | 784.61 | 741.50 | 54.73 | 56.26 | 92.85 | 95.20 | 784.61 | 741.50 | 54.73 | 56.26 |
| | Mn + Fe | 92.51 | 94.86 | 742.77 | 741.68 | 57.28 | 58.82 | 92.51 | 94.86 | 742.77 | 741.68 | 57.28 | 58.82 |
| | All | 97.99 | 100.41 | 866.59 | 826.19 | 58.66 | 60.86 | 97.99 | 100.41 | 866.59 | 826.19 | 58.66 | 60.86 |
| 10 | Tap water | 90.33 | 92.32 | 661.34 | 712.65 | 55.49 | 57.02 | 90.33 | 92.32 | 661.34 | 712.65 | 55.49 | 57.02 |
| | Zn | 100.04 | 102.48 | 742.09 | 799.67 | 58.91 | 61.39 | 100.04 | 102.48 | 742.09 | 799.67 | 58.91 | 61.39 |
| | B | 97.89 | 100.31 | 710.41 | 765.52 | 56.51 | 58.05 | 97.89 | 100.31 | 710.41 | 765.52 | 56.51 | 58.05 |
| | Mn | 96.41 | 98.81 | 729.53 | 786.14 | 57.21 | 58.75 | 96.41 | 98.81 | 729.53 | 786.14 | 57.21 | 58.75 |
| | Fe | 93.78 | 96.14 | 582.31 | 627.49 | 58.62 | 56.15 | 93.78 | 96.14 | 582.31 | 627.49 | 58.62 | 56.15 |
| | Zn + Fe | 99.36 | 101.79 | 745.83 | 803.69 | 56.65 | 58.80 | 99.36 | 101.79 | 745.83 | 803.69 | 56.65 | 58.80 |
| | Zn + Mn | 95.99 | 98.38 | 759.35 | 818.26 | 54.33 | 60.32 | 95.99 | 98.38 | 759.35 | 818.26 | 54.33 | 60.32 |
| | Zn + B | 100.18 | 102.62 | 756.30 | 814.98 | 59.41 | 60.97 | 100.18 | 102.62 | 756.30 | 814.98 | 59.41 | 60.97 |
| | B + Fe | 92.72 | 95.07 | 717.71 | 773.39 | 59.04 | 60.60 | 92.72 | 95.07 | 717.71 | 773.39 | 59.04 | 60.60 |
| | B + Mn | 94.97 | 97.35 | 699.33 | 753.59 | 58.70 | 55.19 | 94.97 | 97.35 | 699.33 | 753.59 | 58.70 | 55.19 |
| | Mn + Fe | 101.48 | 103.94 | 706.04 | 760.81 | 60.51 | 59.59 | 101.48 | 103.94 | 706.04 | 760.81 | 60.51 | 59.59 |
| | All | 102.47 | 104.95 | 769.94 | 829.68 | 60.78 | 63.53 | 102.47 | 104.95 | 769.94 | 829.68 | 60.78 | 63.53 |
| LSD 5% | -- | 6.92 | NS | 7.98 | 198.23 | 87.03 | NS | 3.93 | NS | NS | NS | NS | 4.41 |

strength between a metallic ion and an organic molecule) which tie up the nutrients with soil minerals and keep it available for longer time El-Ghamry *et al.* [33]. They added that, FYM at rates of 20 ton ha$^{-1}$ and micronutrients as foliar application increased yield and yield components.

## CONCLOSION AND RECOMENDATION

From the previous results, it could be concluded that, all chicken manures treatments (5 and 10 ton/faddan), positively affected the studied growth, yield and yield components characters of barley plants. Moreover, use of micronutrients especially Zinc, Mn, Boron and Fe had positive effect on growth and yield of barley plants under the circumstance of new reclaimed sandy soil with superiority to Zn element over all the other elements. However, the combined treatments with (Zn + Fe + B + Mn) recorded the highest values for all the previous characters. As for interaction treatments, plant fertilized with 10 ton/faddan organic manures and sprayed with (Zn + Fe + B + Mn) recorded the highest values for all the previous characters More attention to organic and micronutrients fertilization to assess the economic impact of nutrient management practices in an integrated manner. For achieving overview results recommend, that replicate experiments on these elements in other locations and regions and evaluation combined methods for elements application to pay more attention to the adequacy of micronutrients in barley production.

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