SINAI Journal of Applied Sciences 11 (4) 2022 625-642

Available online at www.sinjas.journals.ekb.eg

SCREENED BY iThenticate Professional Plagiarism Prevention

SINAI Journal of Applied Sciences

Print ISSN 2314-6079

Online ISSN 2682-3527

ARU-EGYPT SJAS Trust Science | It Creates

# EFFECT OF MINERAL AND BIO- FERTILIZATION REGIMES ON YIELD AND GRAIN VIABILITY OF SOME BARLEY CULTIVARS

**Asmaa Abdelsalam* and Salwa M.A.I. Ash-Shormillesy**

Dept. Agron., Fac. Agric., Zagazig Univ., Egypt.

ARTICLE INFO

**Article history:**

Received: 06/07/2022

Revised: 07/08/2022

Accepted: 29/08/2022

Available online: 01/09/2022

Keywords:

Barley cultivars,

Chemical,

bio-fertilization N P K,

viability.

ABSTRACT

Fertilization is one of the main factors influencing yield and grain quality of barely because it participates in numerous metabolic routes. Grain viability play important role in malting industry, field emergence, green forage (sprouted barley) and quality parameters. In this manner, this investigation was designed to study effects of three major elements (N,P,K) and bio-fertilizers on productivity and grain quality of three barley cultivars (Giza123, Giza131 and Giza136). The fertilization regimes were $F_{1,}$ control without fertilization; $F_{2,}$ supplying mineral fertilizers in levels of 45 N,30 P and24 K kg/fad as recommended regime; $F_3$, 50% of $F_2$ + biofertilizers (Azotobacter, phosphorein and potassmage); $F_{4,}$ 25% of F2 + biofertilizers and $F_{5,}$ inoculation with the bio- fertilizers (Azotobacter, phosphorein and potassmage). Results of the combined analysis indicated significant varietal differences in most yield attributes and all viability traits ( germination %, seedling dry weight and vigor index) where, Giza 136 surpassed over the other two cultivars( Giza131 and Giza123) .Withal,Giza123 outbraved significantly on Giza 136 and Giza 131 in plant height and straw yield (kg/fad). The $F_3$ fertilization regime (50% of recommended dose+ bio-fertilizers Azotobacter, phosphorein and Potassmage) gave the higher most value for each of chlorophyll content, plant height, No. of spikes/m$^2$, grain weight/spike, 1000- grain weight, grain and straw yields kg/fad, harvest index and carbohydrate content, seedling dry weight and seedling vigor index, while the highest germination (%) was achieved with both fertilization regimes $F_2$ and $F_3$ .Mean germination time was not affected by fertilization regimes.

Check for updates

## INTRODUCTION

Barley (*Hordeum vulgare* L.) is one of the main cereal crops. It grows under different environmental conditions globally. In Egypt, it grows in a lot of regions as, North Coastal, East Sinai, the newly reclaimed soils as well as a winter cereal crop for grain production, the total cultivated area of barley in 2020 season reached about 69751 fad (one faddan=4200m$^2$) and the total production exceeded 104092 ton with an average of 12.44 ardab/fad (one ardab=120kg) **(FAO, 2022).** Barley grow successfully in adverse conditions such as drought and salinity. Barley grains are used as food and malting purposes which is utilized for distillation and baby foods, cocoa malt drinks and also in medicines, while straw is used to feed animals. Also, sprouted barley is used as animal feed, where the grain can be grown immediately after harvest, thus providing forage for animals at any time of the year. The cutting at early stage at about 50-55 days after sowing provides good quality of fodder particularly in lean period for feeding animals **(Singh *et al.*, 2017)**.

Barley grain contains starch (61.8%), protein (13.1%) and insoluble fiber (10.8%)

* **Corresponding author: E-mail address:** asmaaabdelsalam2018@yahoo.com

https://doi.org/10.21608/sinjas.2022.149597.1130

**(Helam *et al.,* 1999)**. Chemical fertilization increases the plant growth, yield and vigor, but produce polluted plants with hartful, toxic chemicals, which are very dangerous. The harm effect of the chemical fertilizers starts from the industrialization of these chemicals. There are some toxic chemicals or gases like $NH_4$, $CO_2$, and $CH_4$ *etc*. which cause air pollution, the water eutrophication which used as irrigation water and cause soil pollution **(Sharma and Chetani, 2017)**.

Therefore, this is high time to realize that the use of the chemical fertilizer for a long time too much on the same soil may lead to soil degradation and loss of beneficial soil microorganisms (**Pandiselvi *et al.,* 2017)**. Therefore, to safeguard the environment, usage of different types of nutrient supplies such as compost, organic manures and bio-fertilizers are recommended.

Bio-fertilizers are natural inoculants containing one or more species of microorganisms. They augment the availability of nutrients to the plants with mobilizing nutritionally important elements from non-usable to usable form through biological processes as phosphate solubilization, nitrogen fixation, and excretion of plant growth promoting substances. The role of bio-fertilizers in agriculture is essentially, particularly in the present context of increased cost of chemical fertilizers and their hazardous effects on soil and health. Application of dual bio-fertilizers and chemical fertilizers, compared to the sole addition of bio-fertilizers, had a higher positive effect on productivity of yield (**Youssef, 2011)**.

Seed viability and vigor play important roles in yield potential and seedling emergence. Seed is a basic input for agricultural development since it ensures grain production (**Seboka and Deressa, 2000)** and forage production **(Massimi *et al*., 2016)**. Seven phosphorus fertilization regimes (PFR) *i.e*., control, 15 kg $P_2O_5$/fad., phosphorein, mycorrhiza, 7.5 kg $P_2O_5$/fad.+ phosphorein, 7.5 kg $P_2O_5$/fad.+ mycorrhiza and phosphorein + mycorrhiza were studied by **Khattab *et al*. (2016)**, they concluded that availability of phosphorus *via* application of any PFR surpassed the control in each of wheat number of spikes/ $m^2$, 1000 grain weight, harvest index and grain yield/fad. They also avouched that phosphorus fertilization regime included chemical and bio-fertilizer *i.e*. (7.5 kg $P_2O_5$/ fad. + phosphorein) outyielded other PFR and was excellency in each of spike No/$m^2$, grain weight/ spike, grain number/ spike and harvest index. **Mariey and Khedr (2017)** revealed that the highest grain yield was produced by each of the cultivars (Giza 131, Giza 126 and Giza 2000). The cultivars which will give high yield, good quality and adaptation to stress factors are the aim of the research. The production of barley cultivars requires quality and healthy seeds. Seed germination is a critical stage in the plant life **(Diaz-Mendoza *et al.,* 2019)**. Variation in seed germination can be related to variation genotypes, seed size and environments **(Paunović *et al*., 2010)**. This study was carried out to investigate the effect of some chemical nutrients (N, P and K) and bio- fertilizers on yield, grain viability and vigor of some barley cultivars *(Hordeum vulgare,* L.) to reduce the need for chemical fertilizer application and maximize plant yield and grain quality.

## MATERIALS AND METHODS

Two field experiments were carried out at the Experimental Farm, Fac. Agric., Zagazig Univ., Ghazala farm, Sharqia Governorate, Egypt, during the two winter seasons of 2018/2019 and 2019/2020 to study the effect of chemical nutrients and bio-fertilizers on yield, grain viability and vigor of some barley cultivars. Representative soil sample, collected from the experimental sites at the depth of 0–30 cm before applying fertilizers, were used to determine the soil's physical and chemical properties according to **Jackson (1973)** as shown in Table 1.

## Experimental Design and Treatments

The experimental design was split plot design with three replicates, the main plots were devoted to barley cultivars (Giza 123, Giza 131 and Giza136). While, the five fertilization regimes occupied the sub-plots, they were as follows $F_{1,}$ control without fertilization, $F_{2,}$ supplying mineral fertilizers in levels of 45 N, 30 P and 24 K kg/fad., as recommended regime, $F_3$, 50% of $F_2$+ biofertilizers (Azotobacter, phosphorein and potassmage), $F_4$ 25% of $F_2$ + biofertilizers and $F_5$, inoculation with the bio-fertilizers (Azotobacter, phosphorein and potassmage). N as a urea (46% N), 30 kg $P_2O_5$ $fad^{-1}$ as superphosphate (15.5% $P_2O_5$) was applied before planting and 24 kg $K_2O$ $fad^{-1}$ as potassium sulphate (48% $K_2O$) was applied at 25 days after sowing (DAS). Nitrogen fertilizer was splited into three doses, 20% was added at sowing, 40% was added 25 DAS and the last dose (40%) was applied 50 DAS. The area of each sub-plot was (4 $m^2$), 2 x 2m. The space between plots was 1 m. planting rate of 50 kg grain/fad., was used.

## Crop Management

Barley grains were sown in rows, 15 cm apart on $20^{th}$ and $25^{th}$ of November in the first and second seasons, respectively. The preceding crop was maize in both seasons. Barley grains were mixed with bacterial bio-fertilizers containing (NFB, *Bacillus polymxa* and *Azotobacte*r *chroococcum*), phosphate dissolving bacteria (PDB, *Paenibacillus polymyxa*) and potassium dissolving bacteria (KDB, *Bacillus cereus*). Arabic gum 5% as adhesive was used. Then after, grains were spread on a plastic sheet in shaded place. The bio-fertilizer was obtained from Agricultural Research Centre Giza, Egypt. Cultural practices were applied in both seasons as recommended.

## Field Measurements

Total chlorophyll content (SPAD value) was measured using Minolta SPAD-502 chlorophyll meter as quantitatively in five developed flag leaves at 50% heading stag according to **Peng *et al.* (1993**). Harvesting was carried out at maturity of each cultivar in both seasons. The following traits were recorded: plant height (cm), spike length (cm), number of spikes/$m^2$, number of grains spike, grain weight/spike (g), 1000-grain weight (g) and number of spikes/$m^2$. Grain and straw yields were determined from 1 $m^2$. Withal, harvest index was calculated as follows = (economic yield/ biological yield) x 100.

## Chemical Analysis of Grains

Sample of grains (10g) was milled into a powder which was used to analysis crude protein and carbohydrate .protein percentage was determined with estimating the total nitrogen in the grains and calculated by multiplying total N% × 6.25 as **AOAC (2007)**, Total carbohydrates (%)was analyzed by using method described by **AOAC (2000)**.

## Viability Measurements

After harvest, grains were taken to the Laboratory of Seed Analysis, Agron. Dept., Fac. Agric., Zagazig Univ., Egypt. Grains moisture content was about 13%. Barley seed dormancy breaking with 10 ºC during seven days, as described by the Seeds Analysis Rules **(MARA, 2009)**. Standard germination test was conducted according to International Seed Testing Association roles **(ISTA, 2003)**. Four replicates of 100 seeds per each treatment were placed in germination papers, and then incubated in a seed germinator at 20°C for 7 days. The seeds were evaluated on the $7^{th}$ day and normal seedlings were counted for calculation germination percentage (%). Speed of germination or mean germination time (MGT), was calculated using the following formula: (MGT)= $\Sigma nd/\Sigma n$ Where,

**Table 1. Physical and chemical soil properties (averaged the two growing seasons 2018/ 2019 and 2019/2020)**

| Soil property | Value |
|---|---|
| **Mechanical analysis** | |
| Sand (%) | 23.67 |
| Clay (%) | 46.70 |
| Silt (%) | 29.63 |
| Soil texture | Clay |
| **Chemical analysis** | 1.04 |
| Organic matter (%) | 1.88 |
| Soil EC ds/m | |
| pH | 7.99 |
| Available N (ppm) | 58.91 |
| Available P (ppm) | 8.95 |
| Available K (ppm) | 148.10 |

*Central Laboratory of Fac. Agric., Zagazig Univ., Zagazig, Egypt.

n= number of seeds which were germinated on day, d= number of days counted from the beginning of germination test. First count of the percentage of germination was after four days and the final score was obtained on the seventh day of the test. Seedling dry weight (g), was evaluated from five seedlings which were oven–dried at 70ºC until constant drying weight and seedling vigor index (SVI) was calculated as the product of germination (%) and seedling dry weight **(Abdul-Baki and Anderson, 1973)**.

## Statistical Analysis

The obtained data were subjected to standard analysis of variance and the means of treatments were tested for significant differences using the least significant difference method (LSD) at probability (P = 0.05) as described by **Gomez and Gomez (1984)**. All statistical analyses were performed using an analysis, variance technique by means of Statistic 9 computer software.

# RESULTS AND DISCUSSION

## Yield and its Attributes

### Varietal differences

The results showed that, there were significant variations among the three barley cultivars (Giza 123, Giza 131 and Giza 136) in chlorophyll content, plant height, spike length, spike number/m$^2$, No. of grains/spike, spike grains weight, 1000 grain weight, grain and straw yields (kg/ fad.) and harvest index (Tables 2, 3, 4 and 5).

Results indicated that, Giza 136 cultivar produced greater values over both Giza131 and Giza123 in each of chlorophyll content (38.29%), No. of spikes/m$^2$ (270.47), No. of grains/spike (45.98), 1000-grain weight (52.91 g), spike grain weight (2.96 g), grain yield (2166.3 kg/fad) and harvest index (33.68%). Whereas, Giza123 surpassed significantly Giza 136 and Giza 131 in plant height and straw yield (kg/fad.) while spike length in the two cultivars (Giza 136

**Table 2. Chlorophyll content, plant height, spike length of barley as affected by different treatments during 2018-2019 and 2019-2020 seasons**

| Treatment | Chlorophyll content (%) | | | Plant height (cm) | | | Spike length (cm) | | |
|---|---|---|---|---|---|---|---|---|---|
| **Barley cultivar (C)** | **18/19** | **19/20** | **Comb** | **18/19** | **19/20** | **Comb** | **18/19** | **19/20** | **Comb** |
| **Giza 123** | 36.08b | 37.22 | 36.65b | 118.97a | 128.59a | 123.78a | 9.85a | 9.46a | 9.65a |
| **Giza 131** | 37.56a | 37.32 | 37.44ab | 106.99b | 116.41b | 111.70b | 8.33b | 8.46b | 8.39b |
| **Giza 136** | 38.44a | 38.13 | 38.29a | 103.03c | 112.77c | 107.90c | 10.03a | 9.43a | 9.73a |
| **F-test** | * | NS | * | * | * | * | * | * | * |
| **Fertilization regimes (F)** | | | | | | | | | |
| **$F_1$** | 31.73d | 32.23e | 31.98e | 94.31e | 103.54e | 98.93e | 7.66d | 8.25d | 7.96e |
| **$F_2$** | 40.59b | 40.17b | 40.38b | 114.40b | 129.36b | 121.88b | 10.29a | 9.57b | 9.93b |
| **$F_3$** | 42.40a | 42.38a | 42.39a | 126.36a | 135.47a | 130.91a | 10.84a | 10.17a | 10.51a |
| **$F_4$** | 38.51c | 38.58c | 38.54c | 110.33c | 120.53c | 115.43c | 9.59b | 9.09c | 9.34c |
| **$F_5$** | 33.57d | 34.42d | 33.99d | 102.92d | 107.38d | 105.15d | 8.64c | 8.50d | 8.57d |
| **F-test** | * | * | * | * | * | * | * | * | * |
| **Interaction** | | | | | | | | | |
| **C×F** | * | NS | NS | * | * | * | * | NS | NS |

Where: $F_1$(without fertilization), $F_2$ 100% N, P, K, $F_{3:}$50% $F_2$ + bio-fertilizer, $F_4$:25% $F_2$ + bio fertilizer and $F_5$ : bio fertilizer (Azotobacter + Phosphorein + Botassmage)

**Table 3. Spike number/m$^2$, number of grains/spike and spike grain weight of barley as affected by different treatments during 2018-2019 and 2019-2020 seasons**

| Treatment | Spike number/ $^{-}$m$^2$ | | | Number of grains/spike | | | Spike grains weight (g) | | |
|---|---|---|---|---|---|---|---|---|---|
| **Barley cultivar C** | **18/19** | **19/20** | **Comb** | **18/19** | **19/20** | **Comb** | **18/19** | **19/20** | **Comb** |
| **Giza 123** | 250.40b | 240.07 | 245.23b | 41.53c | 39.30c | 40.42c | 2.69b | 2.49b | 2.59c |
| **Giza 131** | 253.87b | 253.33 | 253.60b | 44.19b | 42.22b | 43.21b | 2.99a | 2.75a | 2.87b |
| **Giza 136** | 273.80a | 267.13 | 270.47a | 46.79a | 45.18a | 45.98a | 3.12a | 2.80a | 2.96a |
| **F-test** | * | NS | * | * | * | * | * | * | * |
| **Fertilization regimes (F)** | | | | | | | | | |
| **$F_1$** | 235.00c | 227.11c | 231.06d | 39.93e | 36.01e | 37.97e | 2.13d | 2.13 | 2.13e |
| **$F_2$** | 271.78b | 260.11b | 265.94b | 49.60a | 48.78a | 49.19a | 3.27b | 2.87 | 3.07b |
| **$F_3$** | 296.00a | 294.33a | 295.17a | 46.01b | 45.66b | 45.83b | 3.46a | 3.24 | 3.35a |
| **$F_4$** | 256.89b | 251.56b | 254.22c | 43.51c | 41.64c | 42.58c | 3.14b | 2.66 | 2.90c |
| **$F_5$** | 237.11c | 234.44c | 235.78d | 41.80d | 39.08d | 40.44d | 2.66c | 2.50 | 2.58d |
| **F-test** | * | * | * | * | * | * | * | NS | * |
| **Interaction** | | | | | | | | | |
| **C×F** | * | NS | * | * | * | * | * | NS | * |

Where: $F_1$(without fertilization), $F_2$ 100% N, P, K, $F_{3:}$50% $F_2$ + bio fertilizer, $F_4$: 25% $F_2$ + bio fertilizer and $F_5$ : bio fertilizer (Azotobacter + Phosphorein + Botassmage)

**Table 4. 1000- grain weight, grain yield and straw yield of barley as affected by different treatments during 2018-2019 and 2019-2020 seasons**

| Treatment | 1000 grain weight (g) | | | Grain yield(kg/fad.) | | | Straw yield (kg/fad.) | | |
|---|---|---|---|---|---|---|---|---|---|
| **Barley cultivar (C )** | **18/19** | **19/20** | **comb** | **18/19** | **19/20** | **Comb** | **18/19** | **19/20** | **Comb** |
| **Giza 123** | 51.89b | 49.70c | 50.79c | 2010.5b | 1960.5c | 1985.5c | 4462.4a | 4469.0a | 4465.7a |
| **Giza 131** | 50.81c | 51.54b | 51.17b | 2140.2a | 2025.8b | 2083.0b | 4183.1b | 4243.0c | 4213.1c |
| **Giza 136** | 53.52a | 52.30a | 52.91a | 2212.8a | 2119.9a | 2166.3a | 4155.4b | 4372.7b | 4264.0b |
| **F-test** | * | * | * | * | * | * | * | * | * |
| **Fertilization regimes (F)** | | | | | | | | | |
| **$F_1$** | 45.13e | 45.18e | 45.16e | 1866.3e | 1695.5e | 1780.9e | 3877.7e | 3896.9e | 3887.3e |
| **$F_2$** | 54.96b | 53.63b | 54.30b | 2280.2b | 2191.2b | 2235.7b | 4427.3b | 4700.6b | 4564.0b |
| **$F_3$** | 56.22a | 56.48a | 56.35a | 2471.7a | 2401.3a | 2436.5a | 4793.3a | 4788.2a | 4790.7a |
| **$F_4$** | 53.43c | 51.46c | 52.44c | 2050.3c | 1977.9c | 2014.1c | 4205.7c | 4278.0c | 4241.9c |
| **$F_5$** | 50.62d | 49.13d | 49.88d | 1937.4d | 1911.1d | 1924.2d | 4030.8d | 4144.2d | 4087.5d |
| **F-test** | * | * | * | * | * | * | * | * | * |
| **Interaction** | | | | | | | | | |
| **C×F** | NS | * | * | * | * | * | * | * | * |

Where: $F_1$ (without fertilization), $F_2$ 100% N, P, K, $F_3$:50% $F_2$ + bio fertilizer, $F_4$: 25% $F_2$ + bio fertilizer and $F_5$ : bio fertilizer (Azotobacter + Phosphorein + Botassmage)

**Table 5. Harvest index, protein content and carbohydrate content of barley as affected by different treatments during 2018-2019 and 2019-2020 seasons**

| Treatment | Harvest index (%) | | | Protein content (%) | | | Carbohydrate (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| **Barley cultivar (C)** | **18/19** | **19/20** | **comb** | **18/19** | **19/20** | **Comb** | **18/19** | **19/20** | **Comb** |
| **Giza 123** | 30.96c | 30.36c | 30.66c | 8.89 | 10.41 | 9.65 | 49.18b | 48.55b | 48.78b |
| **Giza 131** | 33.78b | 32.28b | 33.03b | 9.39 | 10.61 | 9.99 | 52.29a | 50.68a | 51.49a |
| **Giza 136** | 34.74a | 32.61a | 33.68a | 9.55 | 9.92 | 9.74 | 51.11a | 50.55a | 50.83a |
| F-test | * | * | * | NS | NS | NS | * | * | * |
| **Fertilization regimes (F)** | | | | | | | | | |
| **$F_1$** | 32.46b | 30.33c | 31.40d | 8.57c | 8.54d | 8.56d | 48.91c | 46.32d | 47.62d |
| **$F_2$** | 34.009a | 31.79b | 32.90b | 9.85a | 11.32a | 10.59a | 52.73a | 50.82b | 51.78b |
| **$F_3$** | 34.01a | 33.39a | 33.70a | 9.51ab | 10.93ab | 10.22ab | 53.02a | 53.51a | 53.27a |
| **$F_4$** | 32.83b | 31.62b | 32.23c | 9.46ab | 10.61bc | 10.03b | 51.19b | 50.52b | 50.86c |
| **$F_5$** | 32.49b | 31.60b | 32.05c | 8.99bc | 10.17c | 9.58c | 48.45c | 48.48c | 48.46d |
| **F-test** | * | * | * | * | * | * | * | * | * |
| **Interaction** | | | | | | | | | |
| **C×F** | NS | * | NS | * | * | * | * | * | * |

Where: $F_1$ (without fertilization), $F_2$ 100% N, P, K, $F_3$:50% $F_2$ + bio fertilizer, $F_4$: 25% $F_2$ + bio fertilizer and $F_5$: bio fertilizer (Azotobacter + Phosphorein + Botassmage) and Giza 123) was at par. It could be concluded that variation among the three barley cultivars may be due to genetic differences as well as the two cultivars (Giza 131 and Giza 136) are naked barley, while Giza 123 is hulls barley. The higher mean values of the previous traits indicate the suitable genetic behavior of Giza 136 cultivar with environment factors which may lead to an increasing in spike grain weight, 1000-grain weight, number of spikes $m^{-2}$, number of grains/spike and carbohydrate content. . Similar trend was obtained by **Alam *et al.* (2007)**, **Ali (2011)**, **Moslim *et al.* (2017)** and **Asal *et al*. (2018)** who recoded significant differences between barley genotypes in yield components.

### Effect of fertilization regimes

Results in Tables 2, 3, 4 and 5 show that there are significant differences among the five fertilization regimes in combined analysis for all traits under study. From results in Tables 2, 3, 4 and 5 it could be noted that the fertilization regime (50% of recommended dose+bio-fertilizers Azotbacter, phosphorein and Potassmage) surpassed all others in each of chlorophyll content (42.39), plant height (130.91cm), No. of spikes/$m^2$ (295.17), spike grains weight (3.35 g), 1000 grain weight (56.35 g), grain yield (2436.5 kg/fad.), straw yield (4790.7 kg/fad.), harvest index (33.70%) and carbohydrate content (53.27%). The superiority of fertilization regime (50% of recommended dose+ bio-fertilizers Azotbacter, phosphorein and Potassmage) in grain yield than other fertilization regimes could be attributed to its superiority in each of spike grain weight, 1000 grain weight, number of spikes/$m^2$, number of grains/spike and carbohydrate content. Also, the highest mean value of harvest index (33.70%) was obtained by $F_3$ fertilization regime (50% of recommended dose+ bio-fertilizers). Thus, it is indicated that using bio-fertilizers caused an increase in harvest index due to effect on dry weight and allocating more photosynthetic matters to grain. These results are in harmony with **El-khawaga *et al*. (2013)** as well as **Abd El-Razek and El-Sheshtawy (2013)**. The percentages of increase in the values of the traits for treatment $F_3$ compared to treatment $F_2$ was about 4.74%, 6.90%, 5.52%, 9.9%, 8.36%, 3.64%, 8.24%, 4.73%, 2.37% and 2.80% for each of chlorophyll content, plant height, spike length , No. of spikes/$m^2$, spike grains weight, 1000- grain weight, grain and straw yields, harvest index and carbohydrate content, respectively. Dualist application of chemical or chemical + 25% bio- fertilizer (as in $F_2$ and $F_4$ fertilization treatments ranked second and third followed by sole bio- fertilizer fertilization treatment ($F_5$). The treatments $F_2$ and $F_3$ occupied the same statistical group in trait spike length. While control treatment $F_1$ (without any fertilizations) gave the lowest values for all previous traits. These results are in agreement with those of **El-Shahat *et al.* (2014)** who reported that all the biofertilizers treatments recorded significant increases for grains and straw yields as compared with uninoculated treatments control. **Moslim *et al.* (2017)** found that replacing 25 or 50% of chemical fertilizers by double inoculation of Algae extract + Microbein as biofertilizers improved yield and its components, (**Wali *et al*., 2021)** and **Abd El-Lattief *et al*. (2021)**. Inoculation with any of the bacterial strains used and mineral fertilizers increased the root and shoot weight compared to control (**Mustafa *et al*., 2006)**. The present results cleared that the positive effect of application of 50% chemical NPK + bio-fertilization may be due to the enhancing plant growth which increased plant metabolites which encouraged the growth of microorganisms through the save of chemical NPK fertilizers.

On the other hand, the fertilization treatment $F_2$ (100% of recommended dose of N, P, K) was superior to the treatment $F_3$ and the others in spike grains number and the percentage of protein in grains.

## Interaction Effect

The interaction effect between barley cultivars and fertilization regimes in Figs. 1, 2, 3, 4, 5, 6, 7, 8 and 9 shows that interactions effect were significant on plant height (cm), number of spikes/m$^2$, number of grains/spike, spike grains weight (g), 1000 grain weight, grain yield ,straw yield, protein content and carbohydrate content in combined analysis, it appears from figures (1-9) that Giza 136 achieved the highest value in each of spike grain weight, 1000 grain weight, number of spikes/m$^2$, grain yield/ fad., straw yield/fad., carbohydrates (%) in grains when fertilizing with treatment $F_3$ (50% NPK + biofertilization), while Giza 123 achieved the highest plant height under the same treatment. Whereas, treatment $F_2$ (100% NPK) achieved the highest value of spike grain number for Giza 136 and the highest protein (%) in grains in Giza 131. In general, the control treatment gave the lowest values for the previous traits in all the cultivars under study. From the results of the interaction between the cultivars and the different fertilization treatments, the role of bio-fertilization in improving the productivity of the barley cultivars under study while reducing the amount used of mineral fertilizers is evident, which contributes to preserving the agricultural environment from pollution.

## Viability and Vigor Traits

### Varietal differences

The results in Tables 6 and 7 appear significant variation among barley cultivars in the two seasons and their combined, where Giza 136 surpassed Giza 123 and Giza 131 in seedling dry weight and seedling vigor index. While, the two cultivars Giza 136 and Giza 131 gave the highest germination percentage (95.47 and 94%) compared with Giza 123 (91.60%). On the other hand, (MGT) was not affected by cultivar variation. The varies depending on environmental conditions in experimental years and on the genetic diversity of barley cultivars. These results are in agreement with those obtained by **Coventry *et al*. (2003), Knežević *et al.* (2011)** and **Desimir *et al*. (2019)**.

### Effect of fertilization regimes

Analysis of variance indicated that fertilization regimes had a significant effect on germination (%), seedling dry weight and seedling vigor index (Tables 6 and 7). Results data revealed significant differences among the five fertilization regimes for all studied traits, except (MGT). Mineral fertilization ($F_2$) and 50% of $F_2$ + bio fertilization ($F_3$) was superior and had the highest G (%). As regard to seedling dry weight and seedling vigor index, ($F_3$) 50% $F_2$ + bio fertilization gave the highest values compared with the other treatments. Moreover, it is obvious from Tables 6 and 7 that sole bio fertilization and control, generally gave the lowest value in most traits. Reducing of germination (%) can be attributed to, damage of seed were not fertilized and with a risk of fungal and insect infestation can cause a decline in percentage. Seed viability is controlled by plant hormones, including abscisic acid (ABA), gibberellins, cytokinins *etc*. Germination percentage, seedling dry weight and seedling vigor are influenced by seed size, with the increase in seed size, there was an increase in seed weight, germination percentage, and seed vigor as estimated by seedling dry weight and seedling vigor index. This supports the conclusion reported by **Bhattacharjee *et al*. (2000)** and **Desimir *et al*. (2019)**. The importance of the macro fertilizing is due to its impact on physiologic and biochemical quality of brewing barley seeds produced, **(Lanes *et al.*, 2019)**.

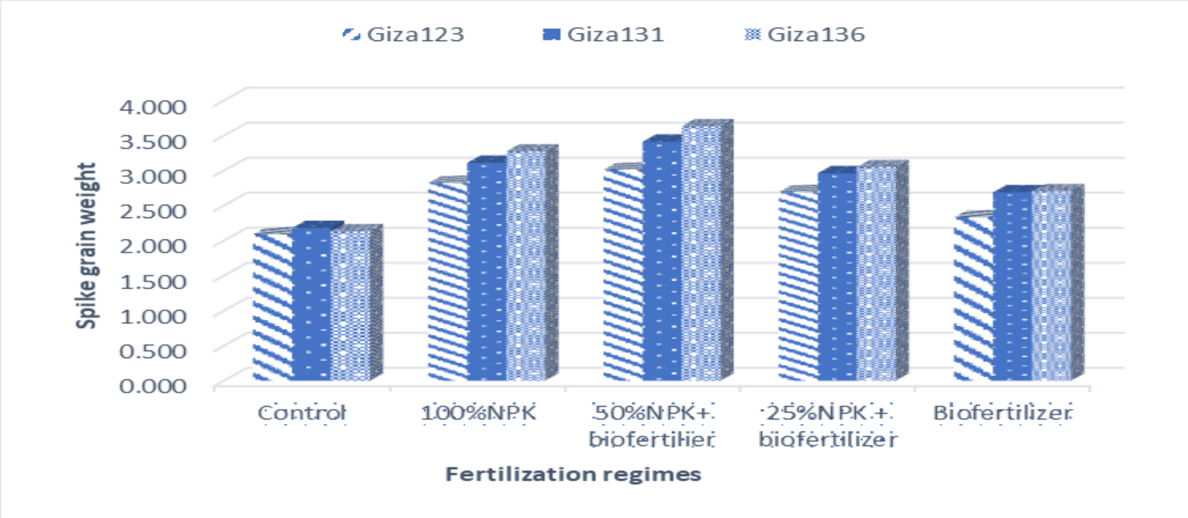


**Fig. 1. Interaction effect between fertilization regimes and barley cultivars on spike grain weight (g) in the combined analysis**

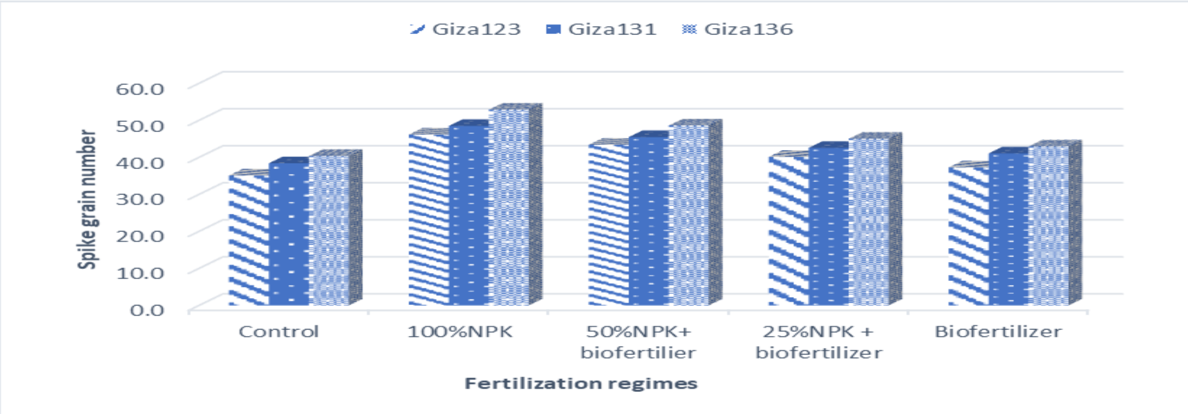


**Fig. 2. Interaction effect between fertilization regimes and barley cultivars on spike grain number in the combined analysis**

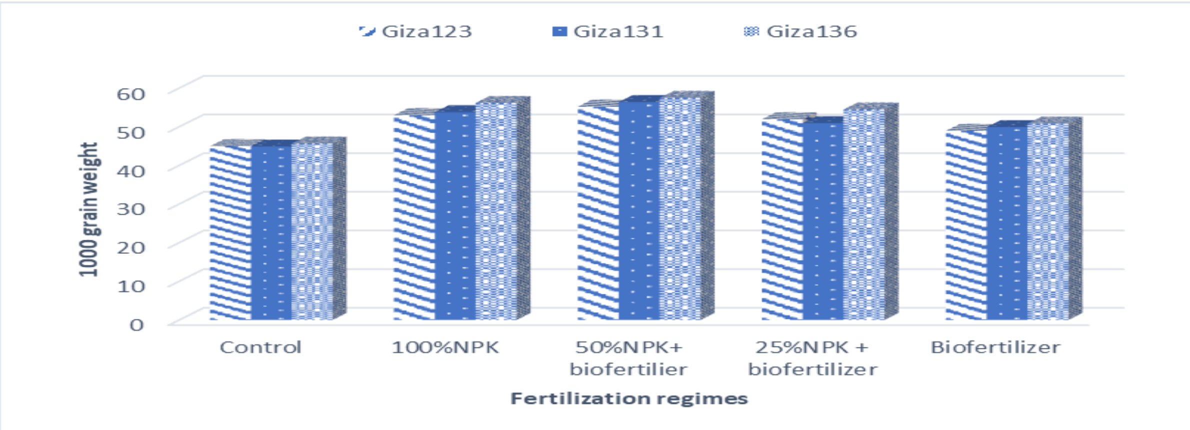


**Fig. 3. Interaction effect between fertilization regimes and barley cultivars on 1000 grain weight (g) in the combined analysis**

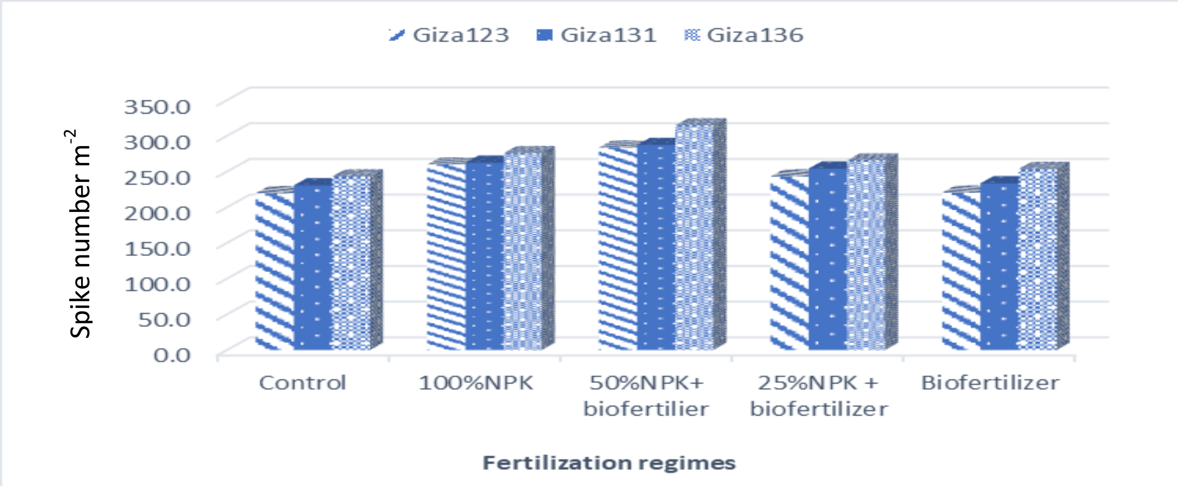


**Fig. 4. Interaction effect between fertilization regimes and barley cultivars on spike number m$^{-2}$ in the combined analysis**

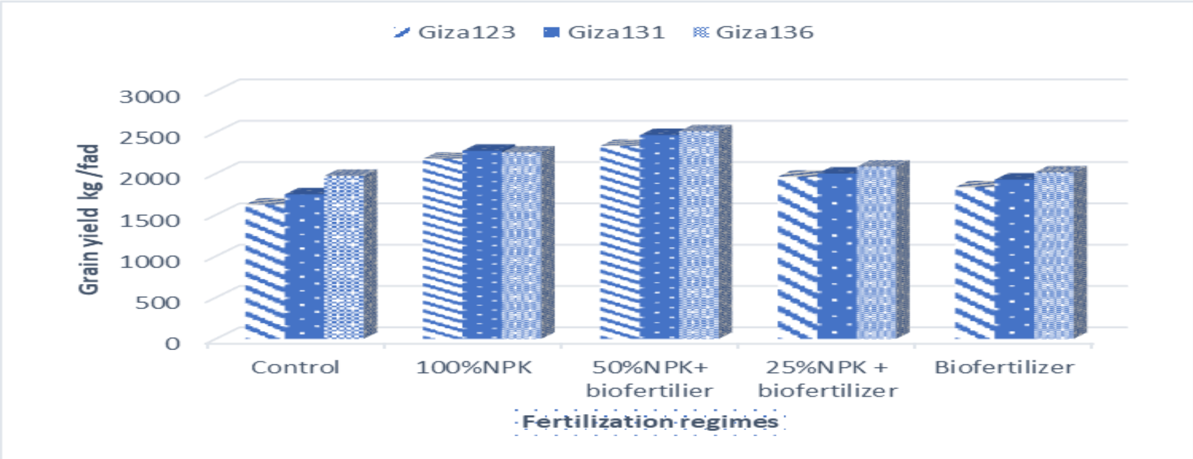


**Fig. 5. Interaction effect between fertilization regimes and barley cultivars on grain yield kg/fad., in the combined analysis**

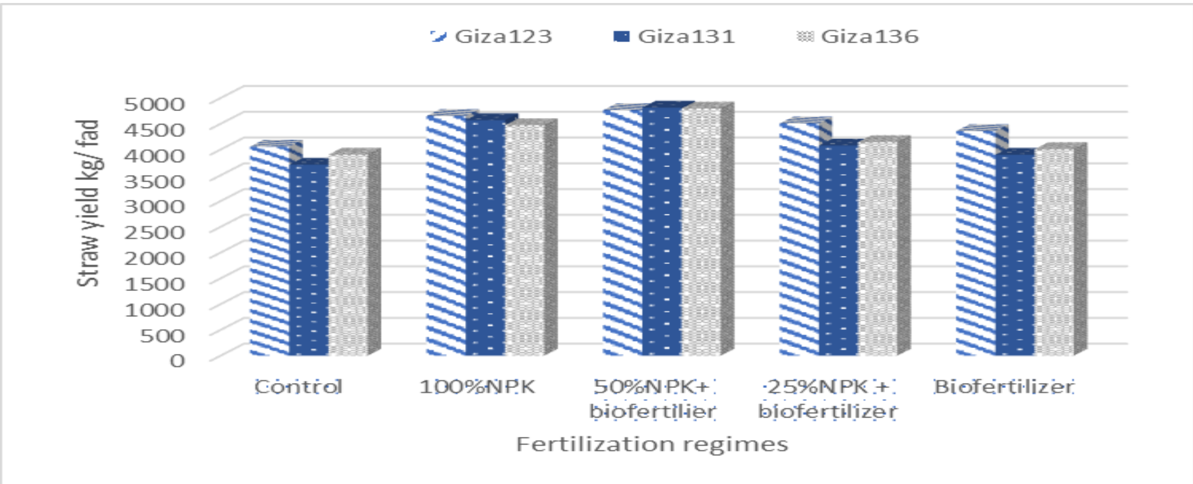


**Fig. 6. Interaction effect between fertilization regimes and barley cultivars on straw yield kg/fad., in the combined analysis**

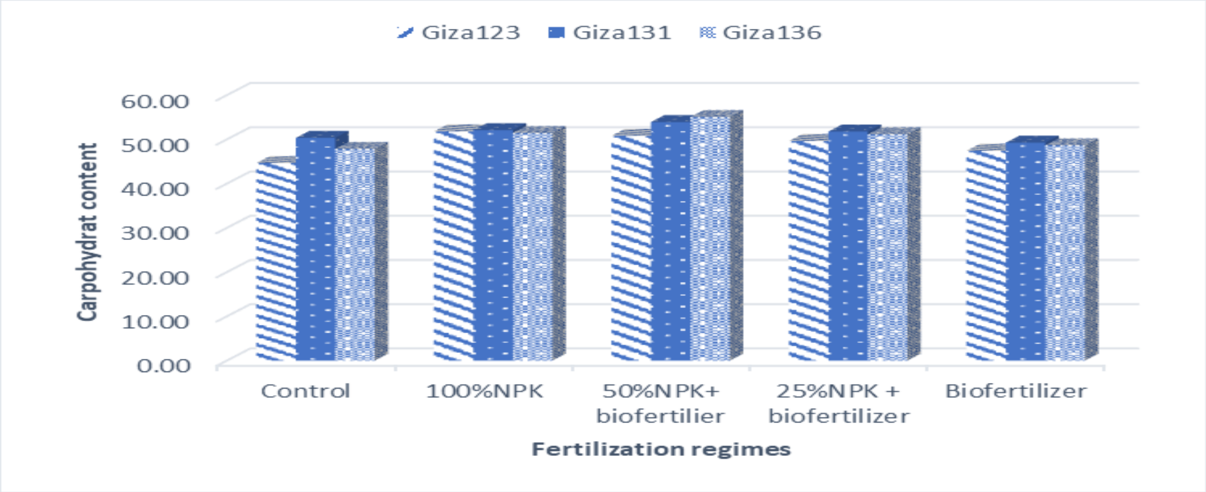


**Fig. 7. Interaction effect between fertilization regimes and barley cultivars on carpohydrat contenent (%) in the combined analysis**

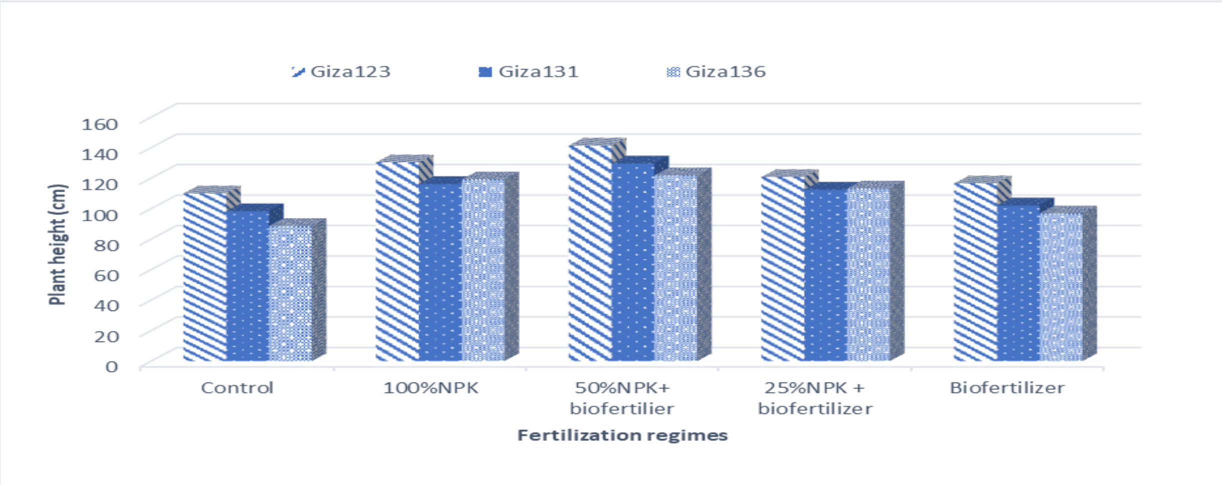


**Fig. 8. Interaction effect between fertilization regimes and barley cultivars on plant height (cm) in the combined analysis**

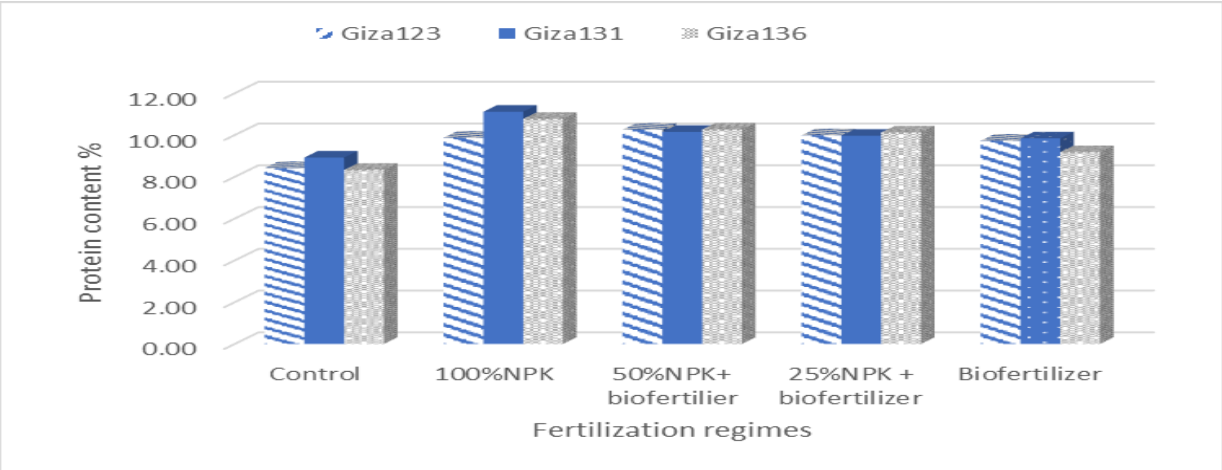


**Fig. 9. Interaction effect between fertilization regimes and barley cultivars on protein content (%) in the combined analysis**

**Table 6. Effect of N, P, K and bio fertilization on germination (%) and seedling dry weight of three barley cultivars during two seasons of 2018-2019 and 2019-2020**

| Treatment | Germination (%) | | | Seedling dry weight(g) | | |
|---|---|---|---|---|---|---|
| **Barley cultivars (C )** | **18/19** | **19/20** | **comb** | **18/19** | **19/20** | **Comb** |
| **Giza 123** | 90.67b | 92.53b | 91.60c | 0.1668c | 0.1621c | 0.1644c |
| **Giza 131** | 94.40a | 93.60b | 94.00a | 0.2614b | 0.1771b | 0.2192b |
| **Giza 136** | 95.20a | 95.73a | 95. 47a | 0.2900a | 0.2066a | 0.2483a |
| F-test | * | * | * | * | * | * |
| **Fertilization regimes (F)** | | | | | | |
| **$F_1$** | 89.78c | 87.56c | 88.67d | 0.2124d | 0.1615d | 0.1870c |
| **$F_2$** | 95.56ab | 97.78a | 96.67a | 0.2572b | 0.1989a | 0.2281b |
| **$F_3$** | 96.89a | 98.22 a | 97.56a | 0.2787a | 0.1986a | 0.2387a |
| **$F_4$** | 94.67b | 93.78b | 94.22b | 0.2324c | 0.1799b | 0.2062b |
| **$F_5$** | 90.22c | 92.44b | 91.33c | 0.2162d | 0.1707c | 0.1934b |
| F-test | * | * | * | * | * | * |
| **Interaction** | | | | | | |
| CxF | NS | * | * | NS | * | * |

Where: F1 (without fertilization), F2 100% N, P, K, F3:50% F2 + bio fertilizer, F4: 25% F2 + bio fertilizer and F5: bio fertilizer (Azotobacter + Phosphorein + Botassmage)

**Table 7. Effect of N, P, K and bio fertilization on mean germination time(MGT) and seedling vigor index of three barley cultivars during two seasons of 2018-2019 and 2019-2020**

| Treatment | Mean germination time(day) | | | Seedling vigor index | | |
|---|---|---|---|---|---|---|
| **Barley cultivars (C )** | **18/19** | **19/20** | **Comb** | **18/19** | **19/20** | **Comb** |
| **Giza 123** | 2.66b | 2.76 | 2.71 | 1514.2c | 1504.5c | 1509.3c |
| **Giza 131** | 2.85a | 2.74 | 2.80 | 2478.2b | 1663.7b | 2070.9b |
| **Giza 136** | 2.70ab | 2.72 | 2.71 | 2769.6a | 1982.9a | 2376.3a |
| F-test | * | NS | NS | * | * | * |
| **Fertilization regimes (F)** | | | | | | |
| **$F_1$** | 2.75 | 2.72bc | 2.73 | 1912.6d | 1416.4d | 1664.5e |
| **$F_2$** | 2.78 | 2.81ab | 2.79 | 2468.3b | 1945.6a | 2206.9b |
| **$F_3$** | 2.74 | 2.86a | 2.80 | 2716.3a | 1955.0a | 2335.6a |
| **$F_4$** | 2.65 | 2.67c | 2.66 | 2214.8c | 1689.1b | 1951.9c |
| **$F_5$** | 2.76 | 2.66c | 2.71 | 1957.9d | 1579.2c | 1768.5d |
| F-test | NS | * | NS | * | * | * |
| **Interaction** | | | | | | |
| CxF | NS | * | * | * | * | * |

Where: $F_1$ (without fertilization), $F_2$ 100% N, P, K, $F_3$:50% $F_2$ + bio fertilizer, $F_4$: 25% $F_2$ + bio fertilizer and $F_5$: bio fertilizer (Azotobacter + Phosphorein + Botassmage)

**Interactions effect**

Results indicated that there was a significant effect due to the interaction between cultivars and fertilization treatments on all traits of viability and vigor as shown in Tables 6 and 7. The interaction effect between the two studied factors on each of germination (%), seedling dry weight, mean germination time and seedling vigor index was significant. The interaction effect between cultivars and fertilization regimes, indicated that Giza 136 cultivar achieved the highest seedling dry weight and seedling vigor index when the seed was treated by bio fertilizer and applying 50% mineral fertilizer recommended dose. While the lowest germination (%), seedling dry weight and seedling vigor index were obtained by Giza123 cultivar under control of fertilization treatment (Figs. 11 and 12).

Moreover, Giza 131 gave the highest germination (%) when seeds was treated by bio fertilizer + 50% mineral fertilizer recommended dose (Fig. 10). Also, Giza 131 barley cultivar recorded the lowest (MGT) when applying mineral fertilization only (Fig. 12).

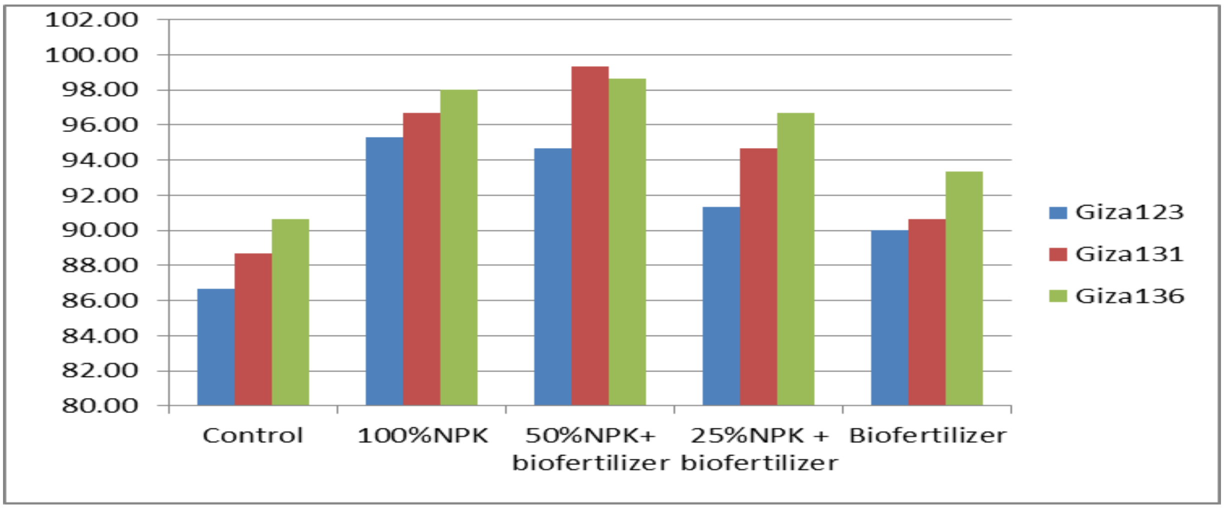


**Fig. 10. Interaction effect between fertilization regimes and barley cultivars on germination (%) in the combined analysis**

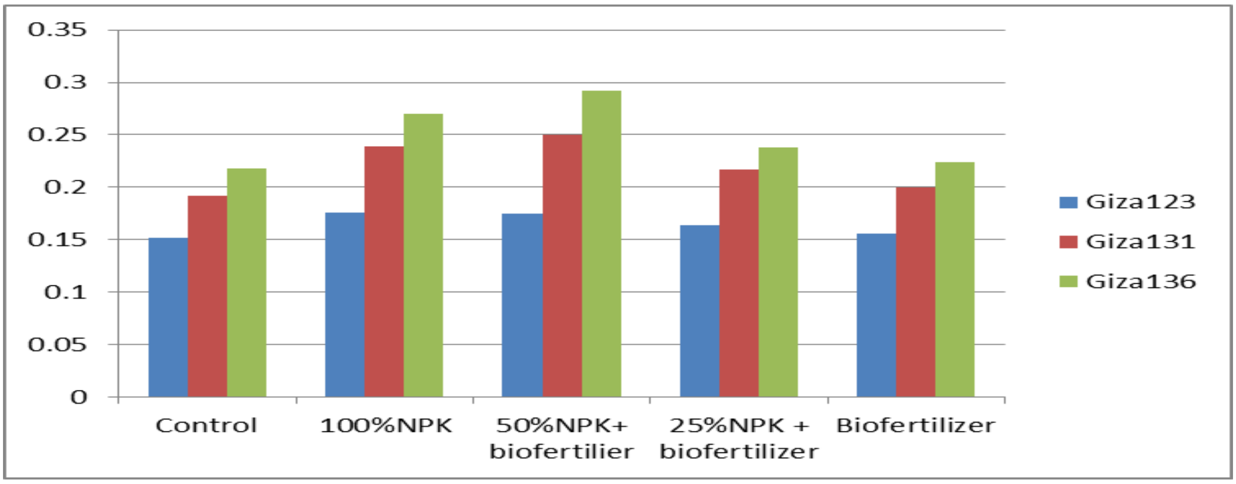


**Fig. 11. Interaction effect between fertilization regimes and barley cultivars on seedling dry weight (g) in the combined analysis**

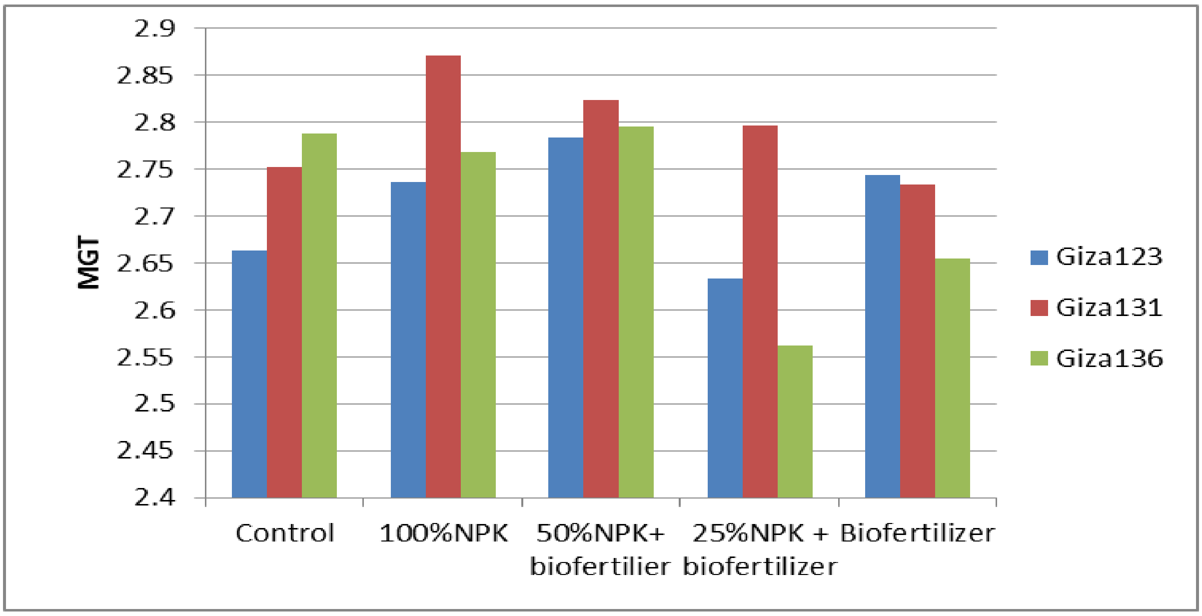


**Fig. 12. Interaction effect between fertilization regimes and barley cultivars on mean germination time (MGT) in the combined analysis**

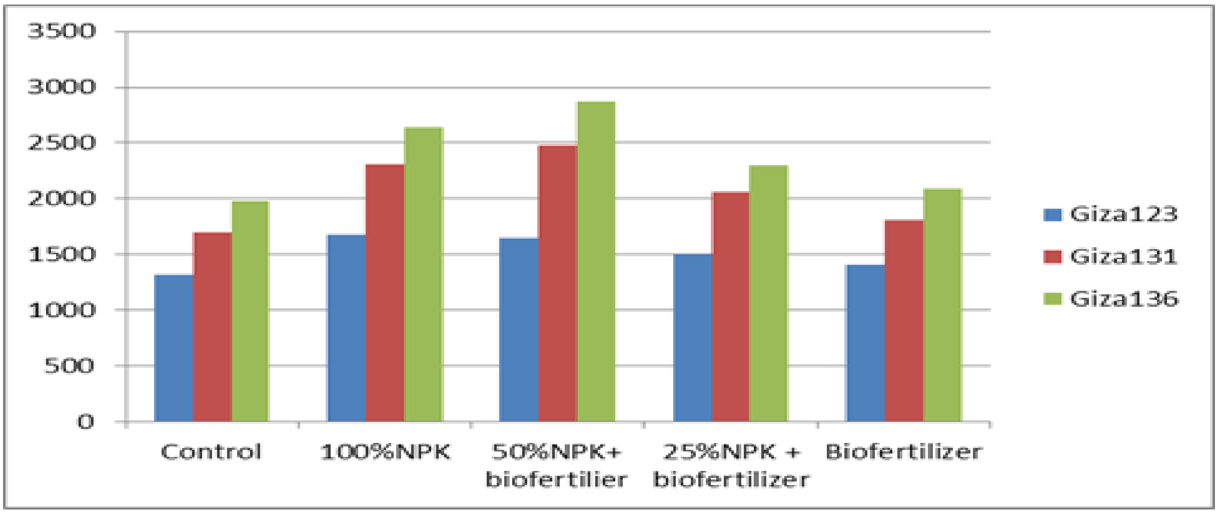


**Fig. 13. Interaction effect between fertilization regimes and barley cultivars on seedling vigor index in the combined analysis**

## Conclusion

The results obtained from this study summarized that barley yield influenced by cultivar differences, fertilization regimes. Giza 136 was superior in all traits nearly. Moreover, the results showed that applying $F_3$ fertilization regime (50% of recommended dose from mineral fertilization + bio-fertilization) gave the highest value for barley yield and its attributes compared with 100% recommended does from mineral fertilization or other bio fertilizer regimes. Under this investigation it is possible to reduce supply of mineral fertilizers by 50% and apply bio-fertilizers while, obtaining the best yield from the barley crop. Which contributes to preserving the agricultural environment from pollution. Also, both of $F_2$ and $F_3$ gave the highest germination (%) and seedling traits. Germination percentage as a marker for determining the capacity of barley plants for predicting the adaptability of cultivars during germination, early seedling growth and using forage.

## REFERENCES

**Abd El-Lattief, E.A.; Ali, M.A. and Hmadi, H.M. (2021)**. Effect of sowing dates and fertilization treatments on productivity of barley crop under Upper Egypt conditions. -Int. J. Agric. Sci., (3): 192-204.

**Abd El-Razek, U.A. and El-Sheshtawy, A.A. (2013).** Response of some wheat varieties to bio and mineral nitrogen fertilizers. Asian J. Crop Sci., (3): 1-9.

**Abdul-Baki, A.A. and Anderson, J.D. (1973).** Vigour determination in soybean seed by multiple criteria. Crop Sci., 13: 630- 633.

**Alam M.Z.; Haider, S.A. and Paul, N.K. (2007).** Yield and components of barley (*Hordeum vulgare* L.) cultivars in relation to nitrogen fertilizer. J. Appl. Sci. Res., 3 (10): 1022-1026.

**Ali, E.A. (2011).** Impact of nitrogen application time on grain and protein yields as well as nitrogen use efficiency of some two-row barley cultivars in sandy soil. Ame. Euras. J. Agric. and Environ. Sci., 10 (3): 425-433.

**AOAC (2000)**. Official Methods of Analysis, of the Association of Official Analytical Chemist. 17th Ed. Washington, DC, USA.

**AOAC (2007).** Official Methods of Analysis. 18th Ed. Association of Official Analytical Chemists, Inc., Gaithersburg, MD, Method 04.

**Asal, M.W.; Abdelaal, F.I.; Radwan, E.M. and Abd El-Lateef, N.M. (2018).** Response of barley (*Hordeum vulgare*) cultivars to humic mineral and biofertilization under calcareous soil conditions. Mid. East J. Agric. Res., 07 (1): 71-82.

**Bhattacharjee, A.K.; Mittra, B.N. and Mitra, P.C. (2000).** Seed agronomy of jute. I. Production and quality of *Corchorus olitorius* seed as influenced by seed size used at planting, Seed Sci. and Technol., 28: 129-139.

**Coventry, S.J.; McDonald, G.K.; Barr A.R. and Eglington, J.K. (2003).** Genome locations influencing grain weight and size in Australian international mapping populations of barley (*Hordeum vulgare* L.). Aust. J. Agric. Res., 54: 1103- 1115.

**Desimir, K.; Aleksandar, P.; Danijela, K.; Adriana, R.; Artiona, L.; Vlado, K. and Danica, M. (2019).** Variability in seed germination of barley cultivars (*Hordeum vulgare* L.) grown under different nitrogen application rates. Acta Agriculturae Serbica, XXIV (47): 61-69.

**Diaz-Mendoza, M.; Diaz, I. and Martinez M. (2019).** Insight on the proteases involved in barley and wheat grain germination. Int., J., Molec. Sci., 20 (9): 2087.

**El-Khawaga, A.A.H.; Farag, I.A.A. and Eliwa, N.E. (2013).** Influence of both Gamma radiation and nitrogen fertilizer levels on growth and productivity of barley. Isotope and Rad. Res., 45 (2): 385 - 400.

**El-Shahat, R.M.; Sherif, A.E.A. and Mohamed, F.M. (2014).** Response of barley grown in saline soil to bio-fertilizer as a partial substitutive of mineral fertilizer. Glob. J. Sci. Res., 2 (5): 144-153.

**FAO (2022).** Food and Agriculture anization. Faostat, FAO Statistics Division, January 2022. http://www. https://www. fao.org/faostat /en/#data /QC.

**Gomez, A.K. and Gomez, A.A. (1984).** Statistical Procedure for Agricultural Research. 2nd Ed. John Wiley and Sons, Inc., New York.

**Helam, J.; Temelli, F. and Juskiw, P. (1999).** The effect of environment on the level of non-starch polysaccharides of hulless barley. Research report. Field crop Develop. Contra, Alberta, Canada.

**ISTA (2003).** International rules for seed testing. Seed Sci. Technol. 29 Supplement, 2: 132.

**Jackson, M.L. (1973).** Soil Chemical Analysis. Prentic Hall of India private Limited. New. Delhi.

**Khattab, A.W.M.; El-Khawaga, A.A.H.; Saleh, M.E. and Ramadan, I.E. (2016).** Some bio-chemical nitrogen and phosphorus fertilization regimes impacts on wheat (*Triticum aestivum* L.) productivity. Zagazig J. Agric. Res., 43 (1): 11-25.

**Knežević, D.; Milošević, M.; Torbica, A.; Broćić, Z. and Ćirić, D. (2011).** Variability of grain yield and quality of winter barley genotypes (*Hordeum vulgare* L.) under the influence of nitrogen nutrition. Növénytermelés Suppl., 60: 25-28.

**Lanes, B.A.; Carvalho, V.J.; Szareski, H.E.; Rodrigues, T.P.; Dubal, C.T.; João, R.P.; Mayara, T.M.; Giordano, G.C.; Ricardo, T.P.; Francisco, A.V.; Tiago, Z.A. and Tiago, P. (2019).** Physiologic quality and biochemical characters of barley seeds produced under nitrogen doses and growing environments. J. Agric. Sci., 1: 12.

**MARA (2009).** Ministério da Agricultura e da Reforma Agrária. Rules for seed analysis. Brasília: Secretariat of Agric. Defense. Brasília: MAPA/ACS, 399.

**Mariey, S.; Farid, M.A. and Khattab I.A. (2016).** Physiological and molecular characterization of some Egyptian barley *(Hordeum vulgare* L.) cultivars for salt tolerance. Egypt. J. Genet. Cytol., 45: 367-382.

**Mariey, S.A. and Khedr R.A. (2017).** Evaluation of some Egyptian barley cultivars under water stress conditions using drought tolerance indices and multivariate analysis. J. Sus. Agric. Sci., 43 (2): 105- 114.

**Massimi, M.; Al-Rifaee, M.; Alrusheidat, J.; Al-Dakheel, A.; Al-Qawaleet, B. and Haddad, Sh. (2016**). Validating farmers' adoption for salt-tolerated crop seeds in Jordan. Asian J. Agric. Ext., Econ. and Sociol., 10:1-5.

**Moslim, S.H.A.; Dawood, R.A.; Abd Elmotagally, F.M.F. and Amer, H.A. (2017).** Response of two barley cultivars to partial substitution of mineral fertilizers by biofertilizers under New Valley Conditions. Assiut J. Agric. Sci., 48 (6) :1-10.

**Mustafa, Y.C.; Kenan, R.C. and Akamkc, F.A. (2006).** Effects of mineral and biofertilizers on barley growth on compacted soil. Acta Agriculturae Scandinavica Section B-Soil and Plant Sci., (56): 324-332.

**Pandiselvi, T.; Jeyajothiand, R. and Kandeshwari, M. (2017).** Organic nutrient management a way to improve soil fertility and sustainable agriculture A review. Int. J. Adv. Life Sci., 10 (2): 175 - 181.

**Paunović, A.; Madić, M.; Knežević, D.; Jelić, M. and Djalović, I. (2010).** The effect of N fertilization and sowing density on the first-class grain contents in two-rowed spring barley. In Proc. (ed. Z. Loncaric) $45^{th}$ Croatian and $5^{th}$ Int. Sympposium Agric., Opatija, 874-877.

**Peng, S.; Garcia, F.C.; Laza, R.C. and Cassman, K.G. (1993).** Adjustment for specific leaf weight improves chlorophyll meters estimation of rice leaf nitrogen concentration. Agron. J., 85: 987 - 990.

**Seboka, B. and Deressa, A. (2000).** Validating farmers' indigenous social networks for local seed supply in Central Rift Valley of Ethiopia. J. Agric. Ed. and Ext., 6: 245-254

**Sharma, A. and Chetani, R. (2017).** Review on the effect of organic and chemical fertilizers on plants. Int. J. Res. in Appl. Sci. and Eng. Technol. (IJRASET), 677.

**Singh, M.; Chauhan, A.; Kumar, R.; Joshi, D.; Soni, P.G. and Meena, V.K. (2017).** Dual purpose barley as affected by date of sowing, varieties and stage of harvesting-A review. Agric. Rev., 38 (2): 159-164.

**Wali, A.M.; Shamseldin, A.; Radwan, F.I.; Abd El-Lateef, E.M. and Zaki, N.M. (2021).** Response of barley (*Hordeum vulgare*) cultivars to humic acid, mineral and biofertilization under calcareous soil conditions. Mid. East J. Agric. Res., 7(1): 71-82.

**Youssef, M.A. (2011).** Synergistic Impact of Effective Microorganisms and Organic Manures on Growth and Yield of Wheat and Marjoram Plants. Ph.D. Thesis, Fac. Agric., Cairo Univ., Egypt.

## الملخص العربي

# تأثير نظم التسميد المعدني والحيوي على إنتاجية وحيوية حبوب بعض أصناف الشعير

**أسماء عبدالسلام، سلوى محمد اليمانى إبراهيم الشرملسي**

قسم المحاصيل، كلية الزراعة، جامعة الزقازيق، مصر.

أقيمت تجربتان حقليتان خلال الموسمين الشتويين 2019/2018 و2020/2019 م بالمزرعة التجريبية (بقرية غزالة) التابعة لكلية الزراعة، جامعة الزقازيق، محافظة الشرقية، مصر، بهدف دراسة تأثير التسميد المعدني والحيوي على إنتاجية، قوة وحيوية حبوب بعض أصناف الشعير وكانت معاملات الدراسة كما يلي: بدون إضافة اسمده (معاملة الكنترول)، الجرعة الموصي بها من الأسمدة المعدنية النيتروجينية، الفوسفاتية والبوتاسية (100% اسمدة معدنية)، 50% اسمدة معدنية + اسمدة حيوية، 25% أسمدة معدنية + أسمدة حيوية وأسمدة حيوية فقط على أصناف الشعير جيزة 123، جيزة 131 وجيزة 136. واستخدم تصميم القطع المنشقة مرة، واحدة في ثلاث مكررات. وتتلخص أهم النتائج المتحصل عليها فيما يلي: وجود اختلافات معنوية بين الأصناف في غالبية الصفات تحت الدراسة في كلا الموسمين وتحليل التباين المشترك، وأظهر الصنف جيزة 136 تفوقا معنويا على باقي الأصناف في محتوى الأوراق من الكلوروفيل، عدد السنابل/م$^2$، عدد حبوب السنبلة، وزن حبوب السنبلة، وزن 1000 حبة، محصول الحبوب كجم/فدان، دليل الحصاد ومحتوى الحبوب من الكربوهيدرات وكذلك نسبة الانبات، الوزن الجاف للبادرة وقوة البادرة. بينما تفوق الصنف جيزة 123 في ارتفاع النبات، طول السنبلة ومحصول القش كجم/فدان. لم تصل الفروق بين الاصناف الثلاثة الي مستوى المعنوية في نسبة البروتين بالحبوب وكذلك سرعة الانبات. أدت معاملة التسميد 50% اسمدة معدنية + الاسمدة حيوية للحصول على أفضل القيم لمعظم صفات المحصول ومكوناته في الأصناف الثلاثة تحت الدراسة. بينما أعطت كلا المعاملتين (التسميد المعدني منفردا ومعاملة 50% معدني + حيوي) أعلى القيم بالنسبة للصفات الحيوية وقوة البادرات. لقد اظهر التفاعل بين الأصناف ومعاملات التسميد المختلفة أن الصنف جيزة 136 حقق أعلى النتائج وأفضل القيم لكل من محصول الحبوب/فدان ومحصول القش/فدان ومعظم مكوناتهما عند تطبيق البرنامج ألتسميدي (50% معدني + المخصبات الحيوية). من هذه الدراسة يتضح دور التسميد الحيوي في تحسين إنتاجية أصناف الشعير تحت الدراسة مع استخدام 50% من الأسمدة المعدنية مما يساهم ذلك في الحفاظ على البيئة الزراعية من التلوث.

**الكلمات الاسترشادية:** أصناف الشعير، الكيمياء، التسميد الحيوي NPK، الصلاحية.

---

**REVIEWERS:**
**Dr. ElSayed Gheith** | gheith2010@yahoo.com
Dept. Agronomy, Fac. Agric., Cairo Univ., Egypt.
**Dr. Aml Elseidy** | amlelseidy@yahoo.com
Dept. Agron., Fac. Agric., Mansoura Univ., Egypt.