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Impact of Organic Manure and Irrigation Amounts on Barley Quality

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تأثير مستويات الري والسماد العضوي على جودة الشعير

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Abstract:

In order to investigate the impact of irrigation levels and organic manure on the quality of barley (*Hordeum vulgare,* L.) cv., Giza 123, a field experiment was carried out in the Abu Hadi district of Sirte city during the winter of 2022–2023. Two factors in a randomized block design were a factorial combination of three irrigation levels (100, 50, and 25 percent) and four rates of organic manure (control, 20, 40, and 60 m3/fed.) with three replications. Plant height, leaf area, total chlorophyll, spike length, number of spikes/m2, and number of grains/spike were among the vegetative development characteristics that were studied, as were quality characteristics including grain weight/spike, 1000-grain weight, grain yield, straw yield, protein, and carbohydrate content. In contrast to control treatments, which showed the lowest values of these features, the obtained data showed that raising irrigation levels up to 100% considerably boosted all vegetative growth and quality attributes under study. The highest values of all vegetative growth, grains weight/spike, 1000-grain weight, grain yield, protein, and carbohydrates, on the other hand, were recorded when organic manure was increased to 60 m3/fed. In contrast, control treatments produced the highest mean values of straw yield but the lowest mean values of grains weight/spike, 1000-grain weight, grain yield, protein, and carbohydrates, respectively. This study examined the effects of irrigation levels and organic manure on all vegetative growth. The quality of barley grains, their weight per spike, their 1000-grain weight, their grain yield, their protein, and their carbohydrates were all highly significant, but total chlorophyll, grains weight per spike, protein, and carbohydrates were not.

Keywords: Barley (*Hordeum vulgare* L.), irrigation levels, organic manure, vegetative growth, yield quality.

الملخص :

أجريت التجربة الحقلية بمنطقة أبو هادي– مدينة سرت خلال الموسم الشتوي 2022-2023 لدراسة تأثير مستويات الري والسماد العضوي على جودة الشعير صنف جيزة 123. تم استخدام ثلاثة مستويات للري (100، 50، 25%) وأربعة معدلات للسماد العضوي (الكنترول، 20، 40 ، 60 م3/ فدان) بثلاثة مكررات كعاملين في تصميم القطاعات العشوائية. الصفات المدروسة هي النمو الخضري (ارتفاع النبات، المساحة الورقية، الكلوروفيل الكلي، طول السنبلة، عدد السنابل/ م2 وعدد الحبوب/ سنبلة) والصفات المحصولية (وزن الحبوب/ سنبلة، وزن 1000- حبة، محصول الحبوب، محصول القش والبروتين والكربوهيدرات). أشارت النتائج التي تم الحصول عليها إلى أن زيادة مستويات الري حتى 100% أدت إلى زيادة معنوية في جميع صفات النمو الخضري والصفات المحصولية المدروسة، مقارنة بمعاملات المقارنة التي سجلت أقل قيم لهذه الصفات. من ناحية أخرى سجلت زيادة السماد العضوي حتى 60 م3/ فدان أعلى القيم لكل النمو الخضري ووزن الحبوب/ سنبلة ووزن 1000 حبة ومحصول الحبوب والبروتين والكربوهيدرات بينما سجلت معاملة الكنترول أعلى متوسطات لقيم القش. في حين سجلت أقل متوسطات لوزن الحبوب/ سنبلة ووزن 1000 حبة ومحصول الحبوب والبروتين والكربوهيدرات على التوالي. وفي هذا الصدد كان التداخل بين مستويات الري والسماد العضوي في جميع صفات النمو الخضري وكانت جودة حبوب الشعير وزن/ سنبلة ووزن 1000 حبة ومحصول الحبوب والبروتين والكربوهيدرات معنوية عالية ولكنها غير معنوية في الكلوروفيل الكلي ووزن الحبوب/ سنبلة والبروتين والكربوهيدرات.

الكلمات المفتاحية: الشعير (*Hordeum vulgare* L.) ، مستويات الري، السماد العضوي، النمو الخضري، جودة المحصول.

Introduction

Barley, or *Hordeum vulgare* L., is a significant grain crop with significant agricultural and commercial value worldwide. Because it is a resilient and adaptable crop that can be cultivated in a range of conditions, it is one of the most widely adapted and produced cereal grains. Barley is classified as an annual crop during the colder months and is a member of the Poaceae family of grasses. For thousands of years, it has been cultivated as a staple food, animal feed, and a starting point for the brewing and malting processes. Barley is known for its hardiness, adaptability, and resilience to adverse environmental conditions [28]. With an average productivity of 3136 kg/ha and an annual production of 147.4 million tonnes, barley is one of the main cereals cultivated on 47 million hectares worldwide [14].

For people who wish to live a healthy lifestyle or who have a number of medical concerns, barley is a highly recommended food choice. This cereal contains essential vitamins and minerals and is a wonderful source of soluble dietary fiber, particularly beta-glucans. Green barley is recommended due to its potent antioxidant qualities and as a source of vitamins and minerals. Barley is rich in several nutrients, which support the body's optimal operation. Barley water is another excellent option for maximizing the advantages of barley [6]**..**

The fourth most important crop in the world, barley, is a model species for temperate cereals, claim [52]. It is grown all over the world in a variety of climates and agricultural systems, including low-yielding, low-input and high-yielding, high-input systems. It provides animals with feed and fodder in addition to human food and water [40]. Barley is classified as a spring or winter crop, two-row or six-row, hullless or hulled [48]. Hullless barley is more nutrient-dense than hulled barley because it contains more protein, lipids, and soluble dietary fiber [54].

Barley is the fourth most significant and widely cultivated crop worldwide among cereals. Additionally, it is a well-known crop that is resistant to salt and drought [24]. Barley is one of the most significant crops produced globally and was among the first plants to be grown alongside wheat in cool climes [11]. Because barley can tolerate cold, dryness, and salt, it can be grown in arid and semi-arid regions with minimal precipitation, according to [5].

Barley is sometimes called the most cosmopolitan crop and is sometimes referred to as the poor man's crop due to its minimal input requirements and enhanced tolerance to drought, salt, alkalinity, and marginal soil [5] . The ability of barley to tolerate a variety of abiotic factors, including drought, cold, and salinity, makes it special. Barley's adaptability has made it a popular crop in regions with challenging growing conditions where other crops could struggle to thrive. Additionally, barley's high genetic diversity allows for the selection and development of cultivars with improved agronomic traits and stress tolerance [44].

Barley is one of the most economically significant cereal crops. In the production of feed, it is typically used as a raw material. When meat production increases, so does the demand for grain and fodder grains[14]. At the same time, there is a possibility that grain production will be constrained by the growing stress of environmental circumstances, which are primarily linked to an increased risk of heat stress and drought [45]. Therefore, several ways to encourage plant development and hardiness are being investigated; biostimulants have a lot of potential in this area [49].

The low soil moisture content in the root zone, which leaves crop water requirements unmet, is the primary problem impeding grain production in the NWC region during rainy seasons [2]. state that extreme water stress is rather typical and frequently happens when a plant is at its most vulnerable. Therefore, crop production potential may be increased if additional irrigation is provided in a suitable amount and at the right time. The timing and amount of supplemental irrigation are designed to supply adequate water during crucial growth stages in order to optimize yield per unit of water [34].

It is becoming more difficult to find fresh water, not only in arid, drought-prone regions but even in locations with high rainfall. Therefore, to efficiently manage water for agricultural output in water-scarce places, innovative and sustainable methods are required. Given the rising costs of food crops and the fact that some producing nations are using these crops to produce biofuel, expanding the national cultivation of these crops particularly those with lower water requirements is regarded as one of the most crucial and essential goals [21].

Water is essential to the protoplasm of all living things on Earth. However, the amount of available water is limited by periodic climate shifts, which causes serious problems as the current water-threatened regimes in different biomass areas [51]. Water scarcity is one of the most significant problems in many countries, including Pakistan5. By interfering with physiological processes such transpiration, photosynthesis, osmotic adjustment, and carbon metabolism, it adversely affects the growth and agricultural output of many traditional crops [53]. [33]. Additionally, proline concentration, relative water content, hydrogen peroxide, lipid peroxidation, enzyme activity, electrolyte leakage, and antioxidant machinery were all adversely affected under drought stress [17]**.**

One of the most valuable resources that is necessary for agricultural productivity is water, which is used most extensively in agriculture [19]. The issue of climate change affects many facets of society, such as irrigation water demand, water supplies, and agriculture [46]. Agriculture, the main source of sustainable food, is significantly impacted by climate change and extreme weather events, such as temperature fluctuations, erratic precipitation, and water scarcity [16].The nutritional value, productivity, and water availability of agricultural goods are all negatively impacted by these changes, endangering the consistent and sustainable supply of food derived from cereals [23].

Food production is at jeopardy because of this. Applying organic fertilizer can boost crop growth by improving the physical, chemical, and biological properties of the soil and providing plant nutrients, including micronutrients. Additionally, it is essential for improving the structure of the soil, which improves the conditions for root growth [9] [25]. claim that adding organic matter to the soil improves soil quality by increasing soil organic carbon, cation exchange capacity, soil water content, and beneficial soil microbes. Using organic fertilizers is essential for preserving biodiversity, improving soil fertility, helping to control diseases and pests, keeping the environment's natural balance, and creating high-quality products [3].

Using organic fertilizers promotes high biodiversity and maintains soil and crop productivity [39]. Enhancing the biological, physical, and chemical properties of soil is largely dependent on the application of organic manure [38]. Soil microorganisms and their biomass have a major impact on the growth of the soil's organic content and the availability of essential aggregates for agricultural purposes [7]**.**

Materials and Methods

In order to investigate the impact of irrigation levels and organic manure on the quality of barley (*Hordeum vulgare*, L.) cv., Giza 123, a field experiment was carried out in the Abu Hadi district of Sirte city during the winter of 2022–2023. Seven treatments total, each with three replicates, were set up in a Randomized Completely Block Design (RCBD) with two covariates.

The treatments of this experiment could be summarized as follows:

A) Irrigation levels (%)
- 100
- 50
- 25

B) Organic manure (m^3/fed)
- Control
- 20
- 40
- 60

Data recorded

A) Vegetative growth
- **Plant height (cm),** was taken from five randomly selected plants in the central rows at the dough growth stage and measured in centimeters. To calculate the height per plant, the total measured plant height was added up and divided by the total number of plants.
- **Leaf area (cm^2).**
- **Total chlorophyll (SPAD)**
- **Spike length (cm):** The spike length of barely plant was measured by randomly sampled five plants per net plot at harvest.
- Spike number/ m^2
- Grains number/ spike: At harvesting, the number of seeds generated per spike from the five randomly selected plants per net plot area was noted.

B) Yield and Yield Components
- Grains weight/ spike
- Thousand-grain weight (g): count two samples of 250 grain from each plot by weigh the samples separately and add to get 500 seed weight. Then multiply to get 1000 seed weight adjusted to 8 % moisture.
- Grain yield (t/fed): the grain yield per plot area was weighed in gram or kilograms and converted in to hectares bases and adjusted to 10% moisture level.
- Straw yield (t/fed)
- Protein (%): analyzing the samples' total nitrogen concentration is one of the most popular techniques for determining the protein content of food.
  Such approaches are shown by [27][10]. Kjeldahl's formula was used to measure the total nitrogen (TN) of barley, and the total crude protein (TCP) was calculated by multiplying the grain's TN content by 6.25.
  Protein (%) = N-content * 6.25
- Carbohydrates (%): were quantitatively identified in the grain barley using the Anthron approach in accordance with [31]. in the following manner: Dry matter was ground in Mahadavaine buffer (sodium citrate buffer, pH 6.8) in order to do extraction. After three minutes of homogenization, the extracts were centrifuged for fifteen minutes at 4000 rpm. Total carbs were then calculated using the supernatant.

- **Statistical analysis**:

The recorded data underwent statistical analysis to clarify the discrepancy between the different treatments under study, as described by [50]. A joint statistical analysis of the results for both seasons was conducted using the approach taken by [47]. in which the least significant differences (LSD with significance at <0.05) were employed to compare the average values of the recorded data.

Results and Discussion

A) Vegetative growth

The effects of irrigation levels and organic manure rates on the vegetative growth of the barley plant cv. Giza 123, as measured by plant height, leaf area, total chlorophyll, spike length, number of spikes/m2, and number of grains/spike, were shown in **Table (1) and Fig. (1).** In contrast to 25% irrigation levels, which recorded the lowest values of these traits (61.88 cm, 24.52 cm^2, 38.40 SPAD, 8.39 cm, 375.89, and 41.53), increasing irrigation levels up to 100% increased all vegetative growth studied, recording the highest values of these traits (100.31 cm, 35.10 cm^2, 50.19 SPAD, 13.63 cm, 405.62, and 51.51). Different rates of organic manure were found to significantly increase the vegetative growth of barley, as measured by plant height, leaf area, total chlorophyll, spike length, number of spikes/m^2, number of grains/spike, and so on. However, the highest vegetative growth was recorded by 60 m3/fed organic manure (100.07 cm, 37.16 cm2, 52.72 SPAD, 12.95 cm, 415.80, and 54.87), followed by organic manure at rate 40 m3/fed (96.34 cm, 34.51 cm^2, 47.32 SPAD, 11.69 cm, 407.72 and 50.59) in comparison to the control, which recorded lower values of these parameters (91.09 cm, 25.14 cm2, 40.67 SPAD, 7.62 cm, 354.20, and 40.79).

The total chlorophyll of the barley plant cv. Giza 123 was not significantly affected by the interaction between irrigation levels and organic manure rates, although it was for all vegetative growth.

By reducing ion transfer to the root surface, root development, and cell division, water stress stunts plant growth. During a plant's growth cycle, water stress adversely affects many physiological growth processes, such as photosynthesis, the translocation of carbohydrates and growth regulators, ion uptake, transport, and assimilation, N_2 fixation, turgidity, respiration, as well as the morphology and growth of shoots and roots [12]. According to [22]. the quantity of grains/ear that is most severely impacted by moisture stress occurs during the flowering stage. A terminal drought caused the worst decline in all metrics, while a water constraint in wheat reduced yield and yield component [4]**.**. It is essential to use organic fertilizers and manures to guarantee the best possible growth and development. The organic manure not only improves the soil's structure but also increases its ability to retain water. It also facilitates the aeration of soil. Because organic farming produces higher-quality vegetables, it has recently become more popular among vegetable consumers [42] [15]. observed similar results Additionally, [55][36]. reported that the systems are clearly unsustainable and that the use of organic fertilizer is increasing as a result of higher yields and profitability. The quality of the soil and groundwater might noticeably deteriorate with the highest fertilizer inputs.

Table (1): Impact of organic manure rates and irrigation levels on vegetative growth of Barley plant cv. Giza 123

Treatments	Plant height (cm)	Leaf area (cm^2)	Total Chlorophyll (SPAD)	Spike length (cm)	No. of spike/m^2	No. of grains/ spike
A) Irrigation levels						
100 %	100.31	35.10	50.19	13.63	405.62	51.51
50%	95.38	31.54	45.89	10.63	389.63	48.94
25%	61.88	24.52	38.40	8.39	375.89	41.53
$LSD_{(0.05)}$	**0.53**	**0.62**	**1.20**	**0.23**	**3.47**	**0.37**
B) Organic manure						
Control	91.09	25.14	40.67	7.62	354.20	40.79
20 m^3/fed.	93.70	29.23	43.28	9.76	383.33	46.66
40 m^3/fed.	96.34	34.51	47.32	11.69	407.72	50.59
60 m^3/fed.	100.07	37.16	52.72	12.95	415.80	54.87
$LSD_{(0.05)}$	**0.67**	**0.82**	**1.32**	**0.31**	**5.04**	**0.54**
Interaction (A×B)	**	**	**ns**	**	**	**

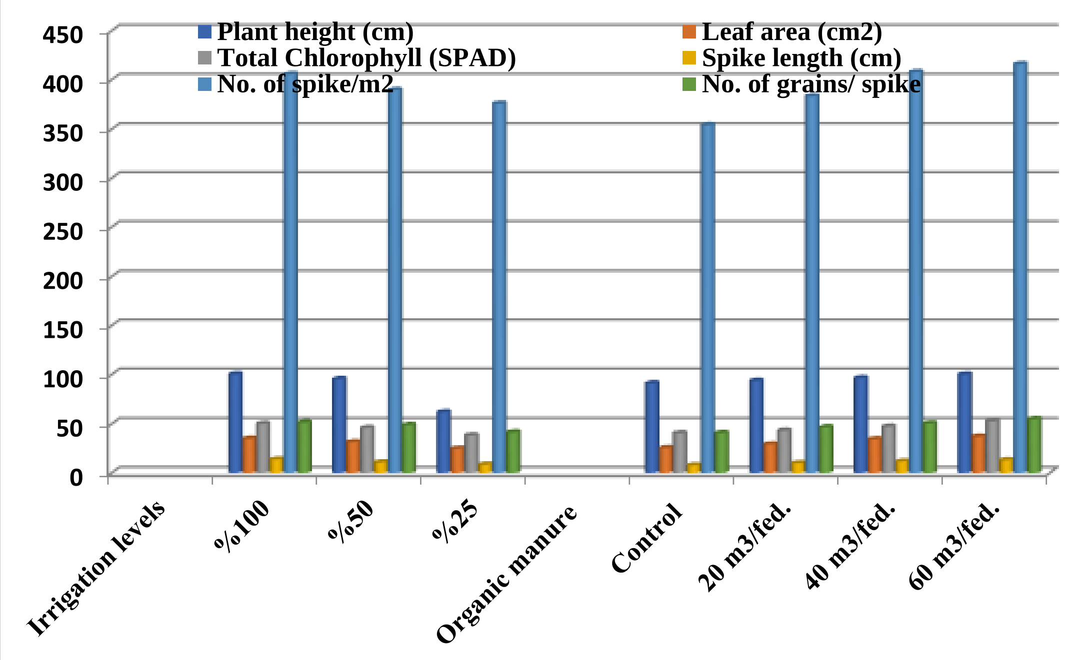

Figure. (1): Impact of organic manure rates and irrigation levels on vegetative growth of Barley plant cv. Giza 123

B) Yield quality

Grain weight/spike, 1000-grain weight, grain yield, straw yield, protein, and carbohydrate content of the barley plant cv. Giza 123 were all affected by irrigation levels and organic manure rates, according to the results shown in **Table (2) and Fig. (2).** While straw yield recorded the highest value with irrigation levels at 25% (1.97 t/fed), the results showed that increasing irrigation level up to 100% increased all yield quality studied that recorded the highest values of these traits (3.66 g, 64.53 g, 15.67 t/fed, 10.67 %, and 80.06%). Additionally, grain weight/spike, 1000-grain weight, grain yield, protein, and carbohydrates recorded the lowest values (2.38 g, 55.88 g, 10.20 t/fed, 6.38 %, and 57.75%), respectively.

Conversely, the results demonstrated that all rates of organic manure considerably improved the quality of the barley plant cv. Giza 123's production, including grain weight/spike, 1000-grain weight, grain yield, protein, and carbs. However, compared to the control, which recorded lower values of (grains weight/spike, 1000-grain weight, grain yield, protein, and carbohydrates) (3.22 g, 56.39 g, 13.45 t/fed, 9.71%, and 74.15 %), 60 m3/fed of organic manure recorded the higher yield quality studied (4.33 g, 68.15 g, 16.39 t/fed, 11.21%, and 82.81%), followed by organic manure at rate 40 m3/fed (3.47 g, 65.07 g, 15.34 t/fed, 10.70 %, and 80.26 %).

On the yield quality of the barley plant cv. Giza 123, the relationship between irrigation levels and rates of organic manure was very significant on 1000-grain weight, grain yield, and straw yield, but not on grains weight/spike, protein, or carbs.

The effect of water stress on barley production is influenced and conditional by the extent of the water deficit and its rate of growth. Since there were fewer potential grains per unit of planted area, the experiments' overall results confirmed the idea that a lack of irrigation water throughout the plant development stage led to a noticeable decrease in production [1].

The quality of the barley grains used in the fermenting process is reportedly impacted by the lack of additional irrigation water. This is especially true when the time response and delay of seeds are being observed during the grain formation stage. Numerous studies have demonstrated the negative effects of water stress caused by inadequate irrigation water, which can also cause plants to absorb and distribute nutrients more slowly [30].

[29] planted barley in pots and subjected them to drought stress, which resulted in a considerable reduction in grain output. When water stress was applied at any stage of development (grain formation), grain production decreased due to the lower 1000-grain weight. Lower grain weight from soil moisture stress during the pre-heading stage was the main cause of the grain yield loss [4]. Adding organic manure to soils has long been a common and generally recognized custom. According to research, this increases soil fertility and improves crop quality and yield [35]. When field capacity is larger, the final tuber yield is increased due to increased growth characteristics, which are represented in faster rates of photosynthetic processes and the synthesis of carbohydrates. On the other hand, the overall yield reduction caused by the water deficit can be attributed to a decrease in photosynthesis, which is caused by a decrease in transpiration rate, an increase in stomatal resistance and gas exchange, fewer and smaller leaves, and a reduction in leaf area [18].Furthermore, organic material is used to improve or avoid the negative effects of stress on plants, including reduced yield. For instance, it's a material that

reduces soil salinity. Increase the soil's organic matter content, improve its structure, and allow more water and air to reach the developing roots. This is one of the best fertilizers [20].

Table (2): Impact of organic manure rates and irrigation levels on barley plant cv. Giza 123 yield quality

Treatments	Grains weight /spike (g)	1000-grain weight (g)	Grain yield (t/fed)	Straw yield (t/fed)	Protein (%)	Carbohydrates (%)
A) Irrigation levels						
100 %	3.66	64.53	15.67	1.28	10.67	80.06
50%	3.61	62.96	13.46	1.63	8.77	76.46
25%	2.38	55.88	10.20	1.97	6.38	57.75
$LSD_{(0.05)}$	**0.08**	**0.75**	**0.35**	**0.02**	**0.09**	**0.55**
B) Organic manure						
Control	3.22	56.39	13.45	2.11	9.71	74.15
20 m^3/fed.	3.38	58.41	14.62	1.91	10.17	76.9
40 m^3/fed.	3.47	65.07	15.34	1.89	10.70	80.26
60 m^3/fed.	4.33	68.15	16.39	1.83	11.21	82.81
$LSD_{(0.05)}$	**0.08**	**1.04**	**0.06**	**0.06**	**0.24**	**0.67**
Interaction (A×B)	**Ns**	**	**	**	**ns**	**ns**

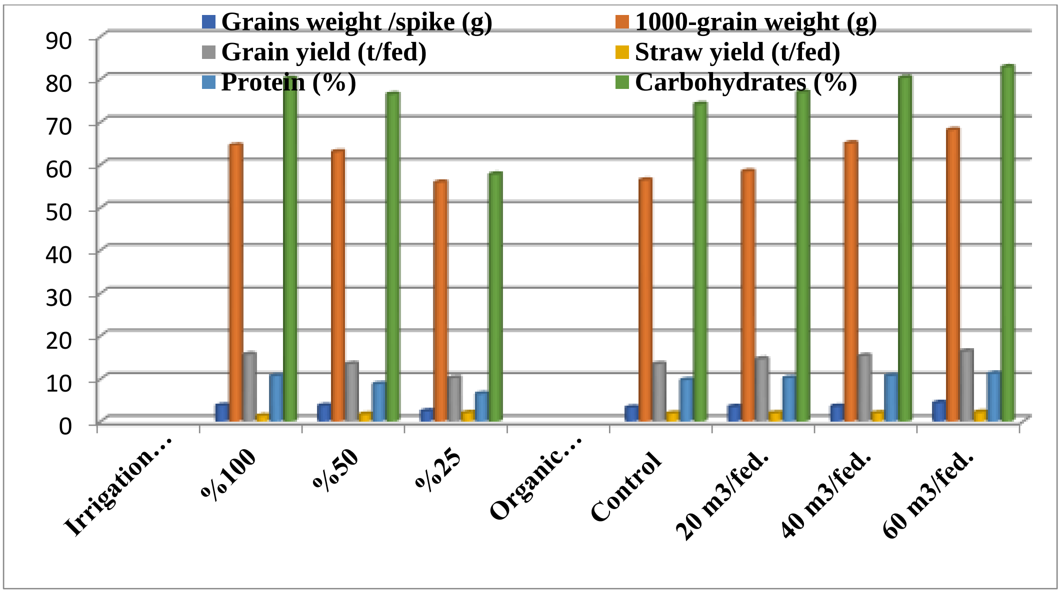

Figure. (2): Impact of organic manure rates and irrigation levels on barley plant cv. Giza 123 yield quality

Conclusion

In any agricultural system that primarily relies on irrigation and intensive fertilization, increased crop output is mostly dependent on improved crop yield and resource use efficiency. According to the results, barley plants' output decreased by %50 and 25% while they were under water stress, which was explained by changes in a number of physiological systems. However, the yield of both well-watered and drought-stressed barley increased when organic manure was applied externally at concentrations of 40 or 60 m3/fed, particularly at 60 m3/fed. In addition to the nutritional advantages of the harvested grains, this enhancement is mainly associated with an increase in photosynthetic pigment levels, endogenous IAA, and specific osmoprotectants.

Recommendations

Therefore, it is advised to cultivate a crop in these water-scarce areas that uses less water while maintaining better yield productivity. Biocontrol methods for plant protection and recycled farmyard manure for fertilizing are common components of organic farming systems.

Compliance with ethical standards

Disclosure of conflict of interest

The author(s) declare that they have no conflict of interest.

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