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# Comparative responses of seashore paspalum (*Paspalum vaginatum*) to nano micronutrients under different bio fertilization types

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**Abstract**

For evaluating the responses of seashore paspalum grasses to nano micronutrients (0.0, 250, 500 and 1000 ppm) under different bio-fertilization types (control, nitrobein, phosphorein and nitrobein + phosphorein) experiment was done. This experiment was assessed in beds (28 × 40 cm) at roof of Horticulture Department, Faculty of Agriculture, Zagazig University, Egypt during 2021/2022 and 2022/2023 seasons. Split-plot design was used to conduct the experiment, which had 16 treatments spread across three replicates. The data indicated that the combination treatment between nitrobein + phosphorein improved plant height, covering density, total chlorophyll content as well as N, P, K and total carbohydrates percentages in herb compared to the other types under study. Moreover, the highest concentration of nano micronutrients significantly enhanced growth and quality traits under study. From achieved results, it can be recommended to apply the seashore paspalum plants with nitrobein + phosphorein each at 2 kg /feddan (4200m$^2$) and 1000 ppm of nano micronutrients to obtain the best covering density and leaf green color degree of *Paspalum vaginatum* turf grasses.

**Keywords:** *Paspalum vaginatum*, nano micronutrients, bio fertilization, growth, quality.

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## 1. Introduction

The succulent warm-season turf grass known as seashore paspalum (*Paspalum vaginatum*, Swartz) is a member of the Gramineae family. Unlike Bermuda grass, seashore paspalum tends to turn yellow in the winter months and on short days, seashore paspalum looks healthy all year round [1]. With the help of cuttings and ready-made rolls, it may be readily multiplied. Stolons, which are lateral developing stems, allow it to expand quickly. In tropical and subtropical regions, it creates a visually appealing perennial turf that can survive high salinity irrigation water, as well as wear and tear, mowing, and treading [2]. When compared to other turf grasses, seashore paspalum has shown higher salt tolerance [3,4].

In order to boost soil fertility and crop productivity, bio-fertilizers - a complex of microorganisms - are thought to be a viable alternative to chemical fertilizers. They can facilitate seed germination and root system development and mobilize essential nutrients from unavailable to available sources. Increasing the biomass of medicinal plants without using hazardous chemical fertilizers is crucial given their significance and function in human health. The regulation of hormones, development of growth, and uptake of nutrients were the three main benefits of growth promotion bacteria [5]. In addition, the results of applying biofertilizer to clipped gazon grass indicated a highly significant reaction in terms of covering density, plant height, and fresh and dry weights [6].

Several studies on nanoparticles in a variety of plants have shown improvements in yield, vegetative development, protein content, and physiological activities, all of which point to their potential for use in crop improvement [7]. Studies have demonstrated, however, that the use of nano-fertilizers increases nutrient utilization efficiency (NUE), lowers treatment frequency, and lessens the potential risks associated with overdosing. Thus, there is great potential for sustainable agriculture with nanotechnology, particularly in under developed nations [8]. While micronutrients can be supplemented with mineral salts, it is important to comprehend how phenological evolution affects the amount of micronutrients in forage in order to optimize feeding schedules and feed additions. It is commonly known that while dry matter increases and crude protein content and energy decrease with plant development and growth [9]. In this regard, the highest values in abovementioned characters of (*Paspalum vaginatum*, Swartz) were noticed by nano-

micronutrients at 0.50 and 1.00 g/l rates compared to control [10].

The most important aim of this study was study the influence of using different bio-fertilization types, nano-micronutrients and their combinations on growth, quality and chemical constituents of seashore paspalum plant.

## 2. Materials and Methods

A beds (28 × 40 cm) experiment in roof garden of Horticulture Department, Faculty of Agriculture, Zagazig University, Egypt were conducted during the two winter consecutive seasons of 2021/2022 and 2022/2023. This study was carried out to evaluate the influence of bio fertilization types (control, nitrobein, phosphorein and nitrobein + phosphorein) as well as nano-micronutrients [control (sprayed with tap water), 250, 500 and 1000 ppm] as foliar applications and their combinations on growth, covering density %, total chlorophyll content and NPK and total carbohydrates percentages of seashore paspalum plants.

### *2.1: Cultivation*

On October 3rd of both seasons, rectangular pieces of 28 × 40 cm were planted in beds (28 × 40 × 25 cm) with one piece per bed, each filled with around 14 kg of sand: clay (1: 1 v/v) combination. Table 1 displays the mixed soil's physical and chemical characteristics [11]. Following the planting of the seashore paspalum pieces, which had been gently compacted by hand to become more assimilated with the mixed soil, a thin coating (1 cm) of the same soil was applied. For two weeks, beds were irrigated daily with 1500 ml of tap water to just wet the zone where the pieces were established.

### *2.2: Bio-fertilization application*

Phosphorein (*Bacillus megatherium*) and nitrobein (*Azospirillum lipofrum*) were applied during soil preparation in compliance with the manufacturer's recommendations. The treatments of bio fertilization were control (without bio fertilizer application), 2 kg/feddan of nitrobein, 2 kg/feddan of phosphorein and 2 kg/feddan of nitrobein + 2 kg/feddan of phosphorein.

### *2.3: Nano-micronutrients application*

The Modern Agricide Company (MAC) provided the nano-micronutrients, also marketed as Magro NanoMix, which are composed of the following minerals: Fe (6%), Zn (6%), B (2%), Mn (5%), Cu (1%) and Mo (0.1%), and 4 percent citric acid. Nevertheless, three foliar sprays of varying concentrations of nano-micronutrients were applied to seashore paspalum plants at 30, 45, and 60 days following the date of planting, as well as following each cutting. The seashore paspalum plants were produced in an environment where standard agricultural practices were followed.

### *2.4: Experimental Design*

With three replicates, these treatments were set up in a split-plot randomized complete blocks design. In the main plots, the types of bio fertilization were placed at random, and in the subplots, the rates of nano-micronutrients were also randomly distributed.

### *2.5: Data Recorded*

On December 18, 75 days after planting, the first cut was made with a fully sharp stainless steel cutter, leaving behind 3 cm long stubbles. After that, two more cuts were made in 60 days on February 18 and April 18. Then the following data were recorded:

#### *2.5.1: Plant height and covering density*

Before each cut in the both seasons, plant height (cm) was noticed, also covering density percentage as recorded by [12] which calculated as number of tillers/area × 100. However, the growth characters of seashore paspalum grass were shown as an average of three cuts during the 1st and 2nd seasons.

#### *2.5.2: Chlorophyll content and chemical constituents*

Total chlorophyll content a+ b (mg/ 100g as fresh weight) in seashore paspalum leaves were determined after the 1st cut during both seasons according to [13]. Total nitrogen, total phosphorus and potassium percentages were determined in seashore paspalum herb after the 1st cut during both seasons according to that reported by [14]. Also, Total carbohydrates percentage was determined in the same sample according to [15].

### *2.6: Statistical Analysis*

The statistical layout of this experiment was a split-plot experiment in completely randomized block design (CRBD). Data were analyzed by using LSD at 5% level according to [16]. The obtained data means were compared using computer program of Statistix version 9 [17].

## 3. Results and Discussion

### *3.1: Plant height and covering density:*

Bio fertilization types (nitrobein, phosphorein and nitrobein + phosphorein) had significant effect on plant height average of seashore paspalum plants compared to control by in both seasons (Table 2). Nitrobein + phosphorein at 2 kg/feddan gave the highest values in this regard followed by phosphorein alone at 2 kg/feddan in both seasons. Furthermore, all bio fertilization type significantly increased covering density percentage compared to control (Table 3). Numerous aspects, such as improvements in soil health, microbial activity, and nutrient availability during a variety of methods, may contribute to the beneficial effects of microorganisms [18]. According to [19], the celery plant's growth parameters reached their maximum values when seeds were injected with a combination of mycorrhizal and mycrobein.

The findings presented in Tables 2 and 3 demonstrated a substantial increase in plant height and covering density percentage when seashore paspalum was sprayed with nano-micronutrients three times each cut, as compared to the control in both seasons. Furthermore, when comparing *Paspalum vaginatum* to the control, the highest concentration of nano-micronutrients (1000 ppm) produced the highest values in these parameters. These results could be interpreted as follows: nano-fertilizers make it easier for plants to consume a nutrient, which speeds up photosynthesis and the creation of dry matter while also improving vegetative development [20]. Additionally, when compared to the control, nano-micronutrients at 0.50 and 1.00 g/l rates showed the highest values in plant height and covering density of *Paspalum vaginatum*, Swartz [10].

**Table 1:** Physical and chemical properties of experimental farm soil (average of 2018/2019 and 2019/2020 seasons)

| Clay (%) | Physical analysis | | | | | | | | Soil texture | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Silt (%) | | | | Sand (%) | | | | Sandy | | |
| 18.35 | 6.89 | | | | 74.64 | | | | | | |
| **Chemical analysis** | | | | | | | | | | | |
| pH | E.C. ($dsm^{-1}$) | Soluble cations (m.mol/l) | | | | | Soluble anions (m.mol/l) | | | Available (ppm) | | |
| | | $Ca^{++}$ | $Mg^{++}$ | $Na^{+}$ | $Zn^{++}$ | $Mo^{++}$ | $Cl^{-}$ | $HCO_3^{-}$ | $SO_4^{--}$ | N | P | K |
| 7.78 | 0.52 | 1.78 | 0.95 | 0.30 | 1.10 | 1.32 | 3.06 | 1.12 | 0.84 | 108 | 46 | 51 |

**Table 2:** Influence of bio-fertilization (A), nano-micronutrients (B) and their combinations (A×B) on plant height of *Paspalum vaginatum* during 2021/2022 and 2022/2023 seasons

| Bio-fertilization type (A) | Nano-micronutrients (ppm) | | | | Mean (A) |
|---|---|---|---|---|---|
| | 0.0 | 250 | 500 | 1000 | |
| | 2021/2022 season | | | | |
| Control | 21.00 | 23.00 | 24.00 | 25.33 | **23.33** |
| Nitrobein | 23.67 | 24.67 | 25.67 | 27.67 | **25.42** |
| Phosphorein | 24.67 | 26.00 | 28.33 | 30.33 | **27.33** |
| Nitrobein + Phosphorein | 27.00 | 29.67 | 31.67 | 34.33 | **30.67** |
| Mean (B) | **24.08** | **25.83** | **27.42** | **29.42** | |
| L.S.D. at 5 % | For (A)= 0.55 | | For (B)= 0.85 | | For (AB)= 1.57 |
| | 2022/2023 season | | | | |
| Control | 17.67 | 20.00 | 22.00 | 23.67 | **20.83** |
| Nitrobein | 19.67 | 22.33 | 24.67 | 26.33 | **23.25** |
| Phosphorein | 21.33 | 23.33 | 26.00 | 27.67 | **24.58** |
| Nitrobein + Phosphorein | 24.67 | 27.67 | 30.33 | 33.00 | **28.91** |
| Mean (B) | **20.83** | **23.33** | **25.75** | **27.67** | |
| L.S.D. at 5 % | For (A)= 0.55 | | For (B)= 0.62 | | For (AB)= 1.21 |

**Table 3:** Influence of bio-fertilization (A), nano-micronutrients (B) and their combinations (A×B) on covering density (%) of *Paspalum vaginatum* during 2021/2022 and 2022/2023 seasons

| Bio-fertilization type (A) | Nano-micronutrients (ppm) | | | | Mean (A) |
|---|---|---|---|---|---|
| | 0.0 | 250 | 500 | 1000 | |
| | 2021/2022 season | | | | |
| Control | 122.00 | 129.33 | 133.67 | 136.33 | **130.33** |
| Nitrobein | 127.00 | 134.67 | 137.00 | 139.00 | **134.42** |
| Phosphorein | 127.33 | 136.00 | 140.33 | 143.67 | **136.83** |
| Nitrobein + Phosphorein | 132.67 | 139.00 | 144.00 | 150.33 | **141.50** |
| Mean (B) | **127.25** | **134.75** | **138.75** | **142.33** | |
| L.S.D. at 5 % | For (A)= 1.44 | | For (B)= 1.09 | | For (AB)= 2.36 |
| | 2022/2023 season | | | | |
| Control | 126.00 | 130.67 | 134.67 | 137.33 | **132.17** |
| Nitrobein | 129.33 | 134.00 | 137.67 | 140.43 | **135.36** |
| Phosphorein | 131.00 | 137.00 | 138.33 | 146.00 | **138.08** |
| Nitrobein + Phosphorein | 135.67 | 141.67 | 146.00 | 153.00 | **144.08** |
| Mean (B) | **130.50** | **135.83** | **139.17** | **144.19** | |
| L.S.D. at 5 % | For (A)= 1.10 | | For (B)= 0.79 | | For (AB)= 1.74 |

Results in Tables 2 and 3 reveal that all combination between bio fertilization and nano-micronutrients treatments significantly increased seashore paspalum growth traits in both seasons. The mixture of bio fertilizers (nitrobein + phosphorein) which sprayed with nano-micronutrients at 1000 ppm concentration resulted in the highest values of plant height and covering density % of seashore paspalum compared to the other combinations under study in both seasons.

### *3.2: Total chlorophyll and chemical constituents*

Data listed in Tables 4, 5, 6, 7 and 8 that, all bio fertilization treatments significantly increased total chlorophyll content as well as N, P, K and total carbohydrates percentages seashore herb compared to control in the two seasons. Generally, using the mixture type of bio fertilization under study gave the highest values in total chlorophyll (a +b) content in leaves and N, P, K and carbohydrates compared to control and the lowest rate under study. Moreover, [21] noticed that effective microorganisms caused considerable increase the three photosynthetic pigments and N, P and K % of bermuda turfgrass. Additionally, [22] found that for the chemical contents (pigment content, and percentage of total carbohydrates) of two dill genotypes, biofertilizer and 100% chemical fertilizer were the optimal fertilization treatments.

The highest values of total chlorophyll content (Table 4), total nitrogen percentage (Table 5), total phosphorus percentage (Table 6), potassium percentage (Table 7) and total carbohydrates percentage (Table 8) in seashore paspalum was obtained from the highest concentration of nano-micronutrients compared to control. In general, all concentrations of nano-micronutrients significantly enhanced chemical constituents of seashore paspalum grasses. Additionally, the increased amount of chlorophyll is a result of the impact of nano-micronutrients, which enter plant tissues quickly through stomata and are essential to the physiological and biological functions of seashore paspalum grasses. The results obtained on the lemongrass plant were consistent with those reported by [23].

The interaction between bio fertilization and nano-micronutrients increased total chlorophyll content as well as N, P, K and total carbohydrates percentages comparing to control (without bio fertilization and sprayed by water). Also, using 1000 ppm of nano-micronutrients increased chemical constituents of seashore paspalum in comparison to the bio fertilization application under the same levels alone in both seasons. Generally, the highest values in this regard were achieved by the combination treatment between mixture type of bio fertilizers plus 1000 ppm of nano-micronutrients in both seasons. Nonetheless, micronutrients are regarded as one of the key growth factors influencing how plants develop while under stress [24]. Furthermore, micronutrients are widely recognized as a crucial nutrient that promotes plant growth and dramatically reduces damage brought on by biotic stressors [25].

**Table 4:** Influence of bio-fertilization (A), nano-micronutrients (B) and their combinations (A×B) on total chlorophyll content (mg/100 g as fresh weight) of *Paspalum vaginatum* during 2021/2022 and 2022/2023 seasons

| **Bio-fertilization type (A)** | **Nano-micronutrients (ppm)** | | | | **Mean (A)** |
|---|---|---|---|---|---|
| | **0.0** | **250** | **500** | **1000** | |
| | **2021/2022 season** | | | | |
| **Control** | 2.85 | 2.91 | 2.96 | 2.90 | **2.91** |
| **Nitrobein** | 2.81 | 2.94 | 3.03 | 3.17 | **2.99** |
| **Phosphorein** | 2.86 | 3.13 | 3.21 | 3.18 | **3.09** |
| **Nitrobein + Phosphorein** | 2.92 | 3.23 | 3.41 | 3.44 | **3.25** |
| **Mean (B)** | **2.86** | **3.05** | **3.15** | **3.17** | |
| **L.S.D. at 5 %** | **For (A)= 0.04** | | **For (B)= 0.03** | | **For (AB)= 0.06** |
| | **2022/2023 season** | | | | |
| **Control** | 2.78 | 2.96 | 3.00 | 3.03 | **2.94** |
| **Nitrobein** | 2.96 | 3.06 | 3.18 | 3.31 | **3.13** |
| **Phosphorein** | 3.00 | 3.24 | 3.30 | 3.40 | **3.24** |
| **Nitrobein + Phosphorein** | 3.03 | 3.34 | 3.59 | 3.66 | **3.40** |
| **Mean (B)** | **2.95** | **3.15** | **3.27** | **3.35** | |
| **L.S.D. at 5 %** | **For (A)= 0.03** | | **For (B)= 0.03** | | **For (AB)= 0.06** |

**Table 5:** Influence of bio-fertilization (A), nano-micronutrients (B) and their combinations (A×B) on total nitrogen percentage of *Paspalum vaginatum* during 2021/2022 and 2022/2023 seasons

| Bio-fertilization type (A) | Nano-micronutrients (ppm) | | | | Mean (A) |
|---|---|---|---|---|---|
| | 0.0 | 250 | 500 | 1000 | |
| | 2021/2022 season | | | | |
| Control | 2.460 | 2.660 | 2.700 | 2.697 | **2.629** |
| Nitrobein | 2.673 | 2.743 | 2.853 | 2.923 | **2.798** |
| Phosphorein | 2.800 | 2.853 | 2.943 | 3.133 | **2.933** |
| Nitrobein + Phosphorein | 2.703 | 2.977 | 3.07 | 3.203 | **2.989** |
| Mean (B) | **2.659** | **2.808** | **2.893** | **2.989** | |
| L.S.D. at 5 % | For (A)= 0.019 | | For (B)= 0.011 | | For (AB)= 0.027 |
| | 2022/2023 season | | | | |
| Control | 2.550 | 2.737 | 2.850 | 2.853 | **2.748** |
| Nitrobein | 2.583 | 2.787 | 2.947 | 3.023 | **2.835** |
| Phosphorein | 2.753 | 2.880 | 3.080 | 3.203 | **2.979** |
| Nitrobein + Phosphorein | 2.823 | 3.010 | 3.093 | 3.333 | **3.065** |
| Mean (B) | **2.678** | **2.853** | **2.993** | **3.103** | |
| L.S.D. at 5 % | For (A)= 0.014 | | For (B)= 0.013 | | For (AB)= 0.027 |

**Table 6:** Influence of bio-fertilization (A), nano-micronutrients (B) and their combinations (A×B) on total phosphorus percentage of *Paspalum vaginatum* during 2021/2022 and 2022/2023 seasons

| Bio-fertilization type (A) | Nano-micronutrients (ppm) | | | | Mean (A) |
|---|---|---|---|---|---|
| | 0.0 | 250 | 500 | 1000 | |
| | 2021/2022 season | | | | |
| Control | 0.290 | 0.296 | 0.306 | 0.317 | **0.302** |
| Nitrobein | 0.319 | 0.323 | 0.320 | 0.327 | **0.322** |
| Phosphorein | 0.318 | 0.335 | 0.343 | 0.348 | **0.336** |
| Nitrobein + Phosphorein | 0.318 | 0.335 | 0.349 | 0.363 | **0.341** |
| Mean (B) | **0.312** | **0.322** | **0.330** | **0.339** | |
| L.S.D. at 5 % | For (A)= 0.001 | | For (B)= 0.003 | | For (AB)= 0.005 |
| | 2022/2023 season | | | | |
| Control | 0.292 | 0.302 | 0.313 | 0.320 | **0.307** |
| Nitrobein | 0.300 | 0.318 | 0.339 | 0.342 | **0.325** |
| Phosphorein | 0.325 | 0.341 | 0.348 | 0.351 | **0.341** |
| Nitrobein + Phosphorein | 0.330 | 0.348 | 0.363 | 0.376 | **0.354** |
| Mean (B) | **0.312** | **0.327** | **0.341** | **0.348** | |
| L.S.D. at 5 % | For (A)= 0.004 | | For (B)= 0.002 | | For (AB)= 0.005 |

**Table 7:** Influence of bio-fertilization (A), nano-micronutrients (B) and their combinations (A×B) on potassium percentage of *Paspalum vaginatum* during 2021/2022 and 2022/2023 seasons

| Bio-fertilization type (A) | Nano-micronutrients (ppm) | | | | Mean (A) |
|---|---|---|---|---|---|
| | 0.0 | 250 | 500 | 1000 | |
| | 2021/2022 season | | | | |
| Control | 1.267 | 1.330 | 1.413 | 1.450 | **1.365** |
| Nitrobein | 1.367 | 1.430 | 1.477 | 1.490 | **1.441** |
| Phosphorein | 1.380 | 1.413 | 1.473 | 1.520 | **1.447** |
| Nitrobein + Phosphorein | 1.423 | 1.523 | 1.620 | 1.640 | **1.552** |
| **Mean (B)** | **1.359** | **1.424** | **1.496** | **1.525** | |
| **L.S.D. at 5 %** | **For (A)= 0.015** | | **For (B)= 0.010** | | **For (AB)= 0.023** |
| | 2022/2023 season | | | | |
| Control | 1.320 | 1.383 | 1.430 | 1.463 | **1.399** |
| Nitrobein | 1.340 | 1.453 | 1.480 | 1.520 | **1.448** |
| Phosphorein | 1.410 | 1.463 | 1.507 | 1.580 | **1.490** |
| Nitrobein + Phosphorein | 1.410 | 1.480 | 1.587 | 1.630 | **1.527** |
| **Mean (B)** | **1.370** | **1.445** | **1.501** | **1.548** | |
| **L.S.D. at 5 %** | **For (A)= 0.012** | | **For (B)= 0.016** | | **For (AB)= 0.030** |

**Table 8:** Influence of bio-fertilization (A), nano-micronutrients (B) and their combinations (A×B) on total carbohydrates percentage of *Paspalum vaginatum* during 2021/2022 and 2022/2023 seasons

| Bio-fertilization type (A) | Nano-micronutrients (ppm) | | | | Mean (A) |
|---|---|---|---|---|---|
| | 0.0 | 250 | 500 | 1000 | |
| | 2021/2022 season | | | | |
| Control | 12.367 | 12.580 | 12.647 | 12.827 | **12.605** |
| Nitrobein | 12.457 | 12.730 | 13.167 | 12.993 | **12.837** |
| Phosphorein | 12.480 | 12.673 | 13.070 | 13.220 | **12.861** |
| Nitrobein + Phosphorein | 13.017 | 13.137 | 13.457 | 13.437 | **13.262** |
| **Mean (B)** | **12.580** | **12.780** | **13.085** | **13.119** | |
| **L.S.D. at 5 %** | **For (A)= 0.027** | | **For (B)= 0.032** | | **For (AB)= 0.062** |
| | 2022/2023 season | | | | |
| Control | 12.463 | 12.537 | 12.693 | 12.770 | **12.616** |
| Nitrobein | 12.500 | 12.563 | 12.950 | 13.130 | **12.786** |
| Phosphorein | 12.687 | 13.057 | 13.283 | 13.400 | **13.107** |
| Nitrobein + Phosphorein | 12.760 | 12.947 | 13.333 | 13.547 | **13.147** |
| **Mean (B)** | **12.603** | **12.776** | **13.066** | **13.212** | |
| **L.S.D. at 5 %** | **For (A)= 0.054** | | **For (B)= 0.031** | | **For (AB)= 0.076** |

## 4. Conclusions

Fertilization and inoculation of seashore paspalum with suitable bio fertilizers type as well as concentration of nano micronutrients is recommended to enhance the growth, quality and chemical constituents. Bio fertilization with nitrobein+ phosphorein at 2 kg /feddan combined with 1000 ppm of nano-micronutrients was the most favorable treatment for increasing plant growth, quality and total chlorophyll as well as carbohydrates percentage of *Paspalum vaginatum* plant.

## References


[1] A. Huxley, M. Griffiths & M. Levy. (1992). The New Royal Hort. Society Dictionary of Gardening. The Stockton Press, 257 Park Avenue South, New York, N. Y. 10010, USA, Vol. 3, pp. 790.

[2] J. F. Morton (1974). Salt tolerant silt grass (*Paspalum vaginatum* Swartz). Proceeding of the Florida State, Hort. Sci., Miami Univ., USA, 86: 482-490.

[3] Marcum, K. B. & C. L. Murdoch. (1990). Growth responses, ion relations, and osmotic adaptations of eleven C4 turf grasses to salinity. Agron. J., 82:892–896.

[4] M. A. Shahba. (2010). Interaction effects of salinity and mowing on performance and physiology of Bermuda grass cultivars. Crop Sci., 50: 2620–2631.

[5] E. M.Gewaily, Fatma, I. El-Zamik, Tomader, T. EL –Hadidy, Abd ElFattah H. I. & Seham H. Salem. (2006). Efficiency of biofertilizers, organic and inorganic amendments application on growth and essential oil of marjoram (*Majorana hortensis* L.) plants grown in sandy and calcareous soils. Zagazig J. Agric. Res. 33: 205-230.

[6] M. A. Abdou, A. A. El-Sayed, Ragaa A. Taha & M. E. Tolba. (2020). Response of gazon grass plants to compost, humic acid and bio-fertilizer. Minia J. of Agric. Res. & Develop. 40 (2): 243-255.

[7] C. Kole, P. Kole, K.M. Randunu, P. Choudhary, R. Podila, P. C. Ke, A. M. Rao & R. K. Marcus. (2013). Nanobiotechnology can boost crop production and quality: first evidence from increased plant biomass, fruit yield and phytomedicine content in bitter melon (*Momordica charantia*). BMC Biotechnology, 13(37): 1472-6750.

[8] M. R. Naderi & A. Danesh-Shahraki. (2013). Nano-fertilizers and their roles in sustainable agriculture. International Journal of Agriculture and Crop Sciences, 5(19): 2229-2232.

[9] D. E. Beever N. Offer & E. M. Gill. (2000). The feeding value of grass and grass products. In: Hopkins A. (ed.) Grass: its production and utilization, 3rd edn, pp. 140–195. Oxford, UK: Blackwell Science.

[10] O. A. Abdelsadek. (2020). Improving growth and quality of seashore paspalum by nano-micronutrients under soil salinity stress. J. of Plant Production, Mansoura Univ., 11 (10): 991-996.

[11] D. H. Chapman & R. F. Pratt. (1978). Methods of Analysis for Soils, Plants and Waters. Div. Agric. Sci. Univ. of California USA pp16-38.

[12] M. Z. Mahdi. (1953). The influence of management on botanical composition and quality of turf. Ph.D. Thesis, Fac. Agric., California Univ., Los Angeles, USA.

[13] D. V. Wettstein. (1957). Chlorophyll lethal under sub mikroskoshrel der plastieden. Ex. PF Celi. Res., (12): 427-433

[14] A.O.A.C., Association of Official Agriculture Chemists (2005). Official methods of analysis of association of official analytical chemists. 17th ed. Washington, DC, USA.

[15] M.A. Dubois, W.F. Geddes & F. Smith. (1960). The carbohydrate of the Gramineae .X-A Quantitative study of carbohydrates of wheat germ. Cereal Chem., 37; 557.

[16] N. K. Gomez & A. A. Gomez. (1984). Statical Procedures for Agricultural Research. 2nd Ed., John wiley and sons, New York. USA, 680.

[17] Analytical Software (2008). Statistix Version 9, Analytical Software, Tallahassee, Florida, USA.

[18] C. Kammann S. Ratering, C. Eckhard & C. Müller (2012). Biochar and hydrochar effects on greenhouse gas (carbon dioxide, nitrous oxide, methane) fluxes from soils. J. Environ. Quality, 41: 1052- 1066.

[19] M. K. Khalil, K. F. Taha, M.A.Nesem & S. S. Sallam (2019). Effect of chemical fertilization, biofertilizer and thidiazuron on growth and yield of celery (*Apium graveolens* L.) plant. Az. J. Pharm Sci., 59 (3): 27-53.

[20] M.H.S. Hediat. (2012). Effects of silver nanoparticles in some crop plants, common bean (*Phaseolus vulgaris* L.) and corn (*Zea mays* L.). International Research Journal of Biotechnology, 3:190-197.

[21] A.F. Ali, M.A.H. Abdou, E.H. Amer & H.A.E.I. Ammar. (2018). Influence of compost, mineral and effective microorganisms application on sandy soil-grown bermuda turfgrass. Scientific J. Flowers & Ornamental Plants, 5(2):127-140.

[22] Sh. I. M. Elsayed, A. A. Glala, A. M. Abdalla, A. A. El-Sayed & M. A. Darwish. (2020). Effect of biofertilizer and organic fertilization on growth, nutrient contents and fresh yield of dill (*Anethum graveolens*). Bulletin of the National Research Centre, 44:1-10.

[23] A.M. Refaat. (1996). Effect of soil and foliar nutrition on growth and volatile oil of lemongrass plant. Bull. Fac. Agric., Cairo Univ., (47): 629-638.

[24] A.M. Reffaat & L.K. Balbaa. (2001). Yield and quality of lemongrass plants (*Cymbopogon flexusus* Stapf) in relation to foliar application of some vitamins and microelements . Egyptian J. Hort., 28 (1): 41-57.

[25] S. Noreen, Z. Fatima, S. Ahmad, H. Athar & M. Ashraf. (2018). Foliar application of micronutrients in mitigating abiotic stress in crop plants. Plant Nutrients and Abiotic Stress Tolerance, 6 (2): 95-117.