

**EFFECT OF INORGANIC NPK FERTILIZER AND BIOORGANIC COMPOST ON GROWTH AND QUALITY OF NUMEX SAHARA BERMUDAGRASS (*Cynodon dactylon* (L.) Pers.) GROWN IN A SANDY SOIL**

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**ABSTRACT**

A field experiment was conducted during the two successive seasons 2007/2008/2009 and 2008/2009/2010 at the Agriculture Experimental Station of the College of Agriculture and Veterinary Medicine, Qassim University, Buraydah, Al-Qassim, Saudi Arabia. The experiment aimed to study the effects of mineral NPK fertilizer and incorporation of organic compost to the soil on growth and quality of NuMex Sahara Bermudagrass (*Cynodon dactylon* (L.) Pers.) grown in a sandy soil throughout the year. Seeds were planted on September 15<sup>th</sup> of 2007 and 2008 for the first and second seasons respectively. In treatments containing compost, compost was incorporated to the top 20 cm of the soil at two rates; 1 and 3 kg per square meter, before planting during soil preparation of the beds. Inorganic water soluble NPK fertilizer (14-38-10 +Mg +TE), was applied at three levels; low (100 g/m<sup>2</sup>/year), medium (200 g/m<sup>2</sup>/year), and high (300 g/m<sup>2</sup>/year). The mineral fertilizer was divided into four equal applications (after planting on February of the following year, May, September, and February of the next year). Data included turfgrass establishment (coverage) rate, clippings weight, turfgrass quality, root/shoot ratio, and chlorophyll content, carbohydrates, nitrogen, phosphorus, and potassium % in the clippings. Data showed that the earliest establishment of NuMex Sahara Bermudagrass was achieved using high NPK (300 g/m<sup>2</sup>/year) either alone or combined with 1 or 3 kg compost incorporated to the soil. These treatments also maintained turfgrass quality above the acceptable level throughout the entire season, including late fall and winter. The best results for growth, quality, and all previously mentioned measurements were obtained by applying 300 g/m<sup>2</sup>/year NPK fertilizer divided to 4 equal applications to Bermudagrass grown in the soil incorporated with 3 kg of the bioorganic compost during soil preparation.

**INTRODUCTION**

Turfgrasses used for home lawns, commercial landscapes, athletic fields, and golf courses improve quality of life by providing open space, recreational and business opportunities, enhanced property values, and the conservation of important natural resources (Duble, 2010).

The sand-based profiles are usually used in the construction of sports fields and golf course turfgrasses in order to limit compaction and to provide sufficient drainage, but these systems lack water-retention and nutrient holding capacity necessary for healthy turf growth (Bigelow *et al.*, 2001). Sandy soils, are poor in mineral, and organic colloids with low fertility as determined by the shortage of macro- and micronutrients (Weber *et al.*,

2007). In order to keep turf and landscapes functional and aesthetically pleasing, turfgrasses rely heavily on pesticides and proper fertilizer programs (Voigt *et al.*, 2006). The primary mineral nutrients used in fertilizer programs are nitrogen (N), phosphorus (P), potassium (K), and iron (Fe), respectively (Starrett *et al.*, 1995).

Nitrogen is the key element in turfgrass fertility programs and is required in greatest quantities by turfgrasses since it influences healthy growth, color and density (Hull, 1996). New lawns have a limited root system and require higher levels of phosphorus for healthy seedling development (Landschoot and Waddington, 1987). Potassium is important in improving stress tolerance (such as heat, cold, and wear disease) of turfgrasses and is essential to plant growth (Snyder and Cisar, 2000).

Sandy soils, such as used in athletic fields and golf greens, have been shown to result in high movement of nitrate-N to subsurface waters (Marshall *et al.*, 2001 and Shuman, 2002), and the amounts of N and/or P applied in excess of what the plants can use, move into ground water by leaching, thereby becoming an environmental hazard (Weber *et al.*, 2007).

The physical properties of sandy soils which are the crucial factors determining plant growth depend mainly on the amount of organic matter (Franzluebbers, 2002). Peat moss was the most commonly soil amendment incorporated into the sandy soil used for turfgrasses, but it breaks down, over time, into fine particles and reduces water infiltration rates and loses some of its nutrient retention capacity (Bigelow *et al.*, 2004).

Studies have shown that organic compost can enhance turfgrass establishment and quality compared with fertilizer sources of nutrients (Cisar and Snyder, 1992; Garling and Boehm, 2001; Loschinkohl and Boehm, 2001; Landschoot and McNitt, 1994).

Compost enhances physical structure of soil (Ginting *et al.*, 2003), makes it more efficient in water utilization, modifies and stabilizes the pH of the soil (Wright *et al.*, 2008), increases cation exchange capacity, provides nutrients in a slow release (Chantigny *et al.*, 2002), and provides organic matter to soil organisms (Wright *et al.*, 2008).

Bermudagrass (*Cynodon* spp.) is one of the most widely used grasses on athletic fields and golf courses in the warm humid and warm semi-arid regions of the world and grows on a wide range of soil types as long as there is adequate drainage and plenty of sunlight (Beard, 1973). NuMex Sahara Bermudagrass (*Cynodon dactylon* (L.) Pers.) was developed exclusively for turf. Sahara was released in 1988 after over 20 years of research, and was bred by Dr. Arden Baltensperger of Seeds West, Inc. ([www.allaboutturf.com](http://www.allaboutturf.com)). Compared to common Bermudagrass, Sahara is more uniform, has increased density and improved summer green color. In addition, Sahara is superior in drought tolerance to common and many other Bermudagrass varieties ([www.Bermudagrass.com](http://www.Bermudagrass.com)).

This research aimed to study the effects of mineral NPK fertilizer and incorporation of organic compost to the soil on growth and quality of NuMex Sahara Bermudagrass (*Cynodon dactylon* (L.) Pers.) grown in sandy soil throughout the year.

## MATERIALS AND METHODS

This experiment was carried out during the two successive seasons 2007/2008/2009 and 2008/2009/2010 at the Agriculture Experimental Station of the College of Agriculture and Veterinary Medicine, Qassim University, Buraydah, Al-Qassim Province, Saudi Arabia (Latitude 26° 33' North, Longitude 43° 97', and 608 meters elevation above sea level). The experimental soil analysis is shown in Table 1. Water used was well water with a 7.11 pH, 945 ppm TDS, and 2.66 'SAR'.

**Table (1): Soil analysis of the experimental area.**

| Chemical properties |     |   |                  |                  |  |                               |                 |                    |                |
|---------------------|-----|---|------------------|------------------|--|-------------------------------|-----------------|--------------------|----------------|
|                     |     | Stouble cations<br>(meq.L <sup>-1</sup> ) |                  |                  | Soluble anions<br>(meq.L <sup>-1</sup> ) |                               |                 | Ca CO <sub>3</sub> | Organic matter |
| pH                  | EC  | Na <sup>+</sup>                           | Ca <sup>2+</sup> | Mg <sup>2+</sup> | HCO <sub>3</sub> <sup>-</sup>            | SO <sub>4</sub> <sup>2-</sup> | Cl <sup>-</sup> | %                  |                |
| 8.2                 | 2.1 | 11  | 4.55             | 2.2              | 2.5                                      | 11.7                          | 7.6             | 3.2                | 0.23           |
| Available NPK (ppm) |     | N   |                  |                  | P  |                               |                 | K                  |                |
|                     |     | 5.4                                       |                  |                  | 4.8                                      |                               |                 | 119                |                |
| Physical properties |     |   |                  |                  |  |                               |                 |                    |                |
| Fractions (%)       |     |   |                  |                  | Texture                                  |                               |                 |                    |                |
| Sand                |     | Silt                                      |                  | Clay             | Sandy soil                               |                               |                 |                    |                |
| 95.3                |     | 3.6                                       |                  | 1.1              |  |                               |                 |                    |                |

In each season, the experiment was set up in different areas and followed the same procedures. In each season, the soil of the experimental area was watered thoroughly and all vegetations showed for up to 3 weeks before planting and later throughout the experiment weeds were removed manually. The experimental soil was then ploughed thoroughly, and afterwards raked and dragged to smooth the soil surface. The experimental design was set up as a randomized complete block design with three replicates, each consisted of 12 planting beds. Each bed was 1 × 1.5 m, and the beds were spaced one meter apart. A sprinkler irrigation system was set up for each experimental area and was controlled manually. In treatments containing compost, compost was incorporated to the top 20 cm of the soil at two rates; 1 and 3 kg per square meter, before planting during soil preparation of the beds. A bioorganic compost was used in this experiment; a product of Protein Organic Compost Inc., Riyadh, Saudi Arabia. The composition of the compost is shown in Table (2) (according to the company label). After compost was incorporated, soil samples were tested at the Soil Science Laboratory for soil pH and EC, and the water holding capacity of the soil samples was measured geometrically (data shown in Table, 3).

**Table (2): Analysis of the bioorganic compost used.**

| Organic matter | Moisture content | %     |      |       |       |       |       |
|----------------|------------------|-------|------|-------|-------|-------|-------|
|                |                  | N     | P    | K     | Mg    | Ca    | Na    |
| 45.6           | 8.52             | 1.647 | 1.39 | 0.9   | 0.272 | 1.527 | 0.016 |
|                |                  | ppm   |      |       |       |       |       |
| EC             | 6.03             | Al    | Mn   | Fe    | Cu    | Zn    | Cl    |
| pH             | 7.21             | 175   | 55.1 | 173.7 | 4.3   | 24.3  | 470   |
| C/N            | 30:1             |       |      |       |       |       |       |

**Table (3): Water holding capacity (%), EC, and pH of the experimental soil with or without compost.**

|                          | Soil | 1kg compost /m <sup>2</sup> soil | 3kg compost /m <sup>2</sup> soil |
|--------------------------|------|----------------------------------|----------------------------------|
| Water holding capacity % | 35.6 | 36.28                            | 38.5                             |
| EC                       | 2.1  | 2.9                              | 3.9                              |
| pH                       | 8.2  | 8.04                             | 7.85                             |

NuMex Sahara bermuda grass *Cynodon dactylon* (L.) Pers. (thiram treated) seeds from Al Centro Seed Company, California, USA, imported by ARZAM Agriculture and Trading Inc., Riyadh, Saudi Arabia was used in this experiment.

Seeds were planted on September 15<sup>th</sup> of 2007 and 2008 for the first and second seasons respectively. Seeds were planted at the rate of 1kg seeds/30 m<sup>2</sup> area, evenly broadcasted over the soil and lightly incorporated using a rake. Immediately after planting, the beds were thoroughly watered, and thereafter twice a day until emergence. After emergence, beds were watered as needed depending on the environmental and soil conditions. Inorganic water soluble NPK fertilizer (14-38-10 +Mg +TE), a product of SABEC, Saudi Arabia was applied at three levels; low (100 g/m<sup>2</sup>/year), medium (200 g/m<sup>2</sup>/year), and high (300 g/m<sup>2</sup>/year) to the turfgrass. The mineral fertilizer was divided into four equal applications (after planting in February of the following year, May, September, and February of the next year).

**Measurements:**

**1-Rate of Establishment:** was measured as the percentage of area fully covered with the turfgrass of the total area of each plot. This measurement was assessed starting from February 1<sup>st</sup> of the following year in each season (from February 2008 until May 2008 for the first season and from February 2009 until May 2009 for the second season).

**2-Fresh weight of clippings:** starting from May 1<sup>st</sup> 2008 until end of May 2009 in the first season and from May 1<sup>st</sup> 2009 until end of May 2010 in the second season, the turfgrasses were hand cut clipped once or twice a month (depending on the turfgrass growth) throughout the experiment and the fresh weight of clipping was recorded as fresh weight (g) per m<sup>2</sup> per month.

**3-Turf quality:** each month, turf quality was visually scored (According to Alshammary *et al.*, 2004) on a scale of 1–9, based on density, uniformity and color, where 9 = ideal green, dense, and uniform turf, and 1 = completely dead or dormant brown/yellowish colored turf. Any value below 5 was considered as unacceptable quality.

**4-Root/shoot ratio :** was measured as dry weight of below-ground portion divided by the dry weight of the above-ground portion of the turfgrass. At the end of May 2009 and 2010 in the first and second seasons, respectively, profile samples were randomly collected from three different spots in each plot using a standard green cup cutter with 10 cm diameter to a depth of 25 cm. Plugs were washed to obtain soil free, and all the above-ground plant material were excised from the top of the plug with a scissor at the thatch-soil level. Stolons were included with the above-ground portion, while rhizomes were with the below-ground portion. The fresh weight of each portion was weighed, dried in an oven at 70°C for three days, and their dry weights were recorded.

**5-Chemical analysis:** samples for chemical analysis were collected at the end of May the next year in each season. Clippings were collected and analyzed for the following determinations:

**a. Chlorophyll content:** was determined in the fresh clippings according to the method described by Marquard and Timpton, (1987).

**b. Total carbohydrates (%)** was determined in the clippings dried samples using the method described by Dubois *et al.*, (1956).

**c. N, P, and K (%)**: dried clipping samples were used to determine nitrogen (%) using Micro-Kjeldahl, and phosphorus and potassium (%) using flame photometer according to the methods described by Jackson, (1973).

**Statistical analysis:**

The experimental design was set up as a randomized complete block design with three replicates, each consisted of 12 planting beds. Treatments were as follows:

**Control:** neither compost nor fertilizer added.

**C1:** low compost (1 kg compost incorporated to the soil).

**C2:** high compost (3 kg compost incorporated to the soil).

**M1:** low inorganic fertilizer (100 g NPK /m<sup>2</sup>/year).

**M2:** medium inorganic fertilizer (200 g NPK /m<sup>2</sup>/year).

**M3:** high inorganic fertilizer (300 g NPK /m<sup>2</sup>/year).

**M1+C1:** low inorganic fertilizer + low compost.

**M1+C2:** low inorganic fertilizer + high compost.

**M2+C1:** medium inorganic fertilizer + low compost.

**M2+C2:** medium inorganic fertilizer + high compost.

**M3+C1:** high inorganic fertilizer + low compost.

**M3+C2:** high inorganic fertilizer + high compost.

The experiment was analyzed as a randomized complete block design with three replicates. Analysis of variance was performed using SAS

software (SAS, 1998). Treatment means were compared using LSD at the 5 % probability.

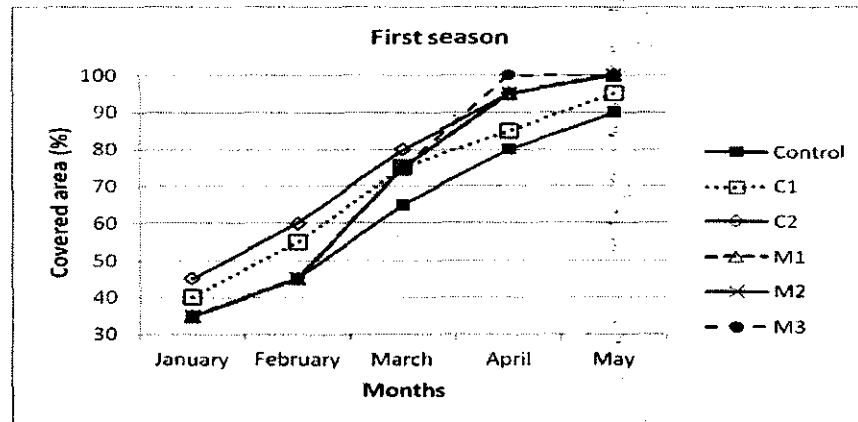
## **RESULTS AND DISCUSSION**

For the sake of convenience, any record represented in graphics was split into two separate graphics (A&B); the first (A) represented individual treatments, and the second (B) represented the combined treatments.

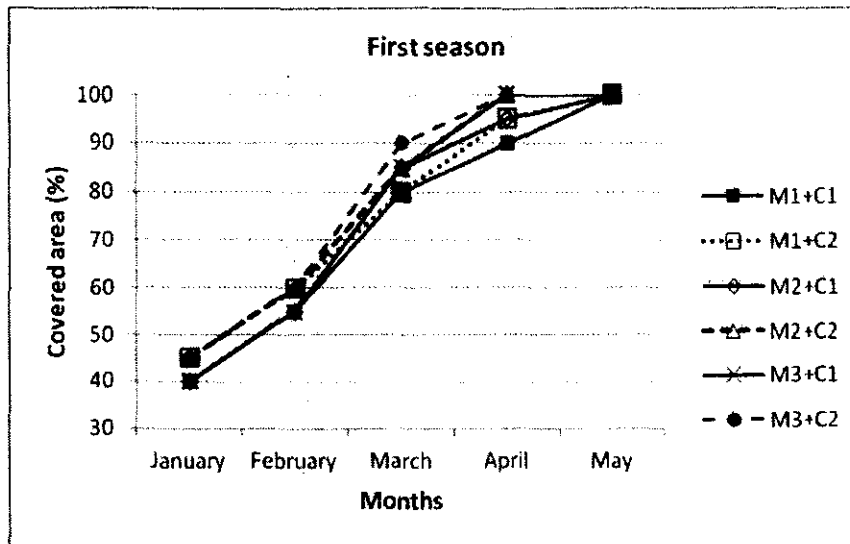
### **Turfgrass establishment:**

The establishment rate measured as percentage of area covered with Bermudagrass during the following spring after sowing in the first season (Fig 1A and 1B) showed that high NPK treated plots by April 1<sup>st</sup> achieved 100 % establishment, and by May all NPK fertilized plots and those planted in high compost (C2) plots reached 100% coverage. As for the combined treatments (Fig 1B), early establishment (on April) was achieved using high NPK (M3) treatment combined with either compost treatments (C1 or C2) and medium NPK (M2) combined with high compost treatment (C2). In the second season (Fig 2A), early establishment on April was achieved using high and medium NPK treatments. In addition, all combined treatments (Fig 2B) achieved full establishment by April except for low NPK combined with low compost. These results showed that increasing NPK dose especially when combined with high compost incorporated to the soil strongly encouraged growth and establishment of Bermudagrass.

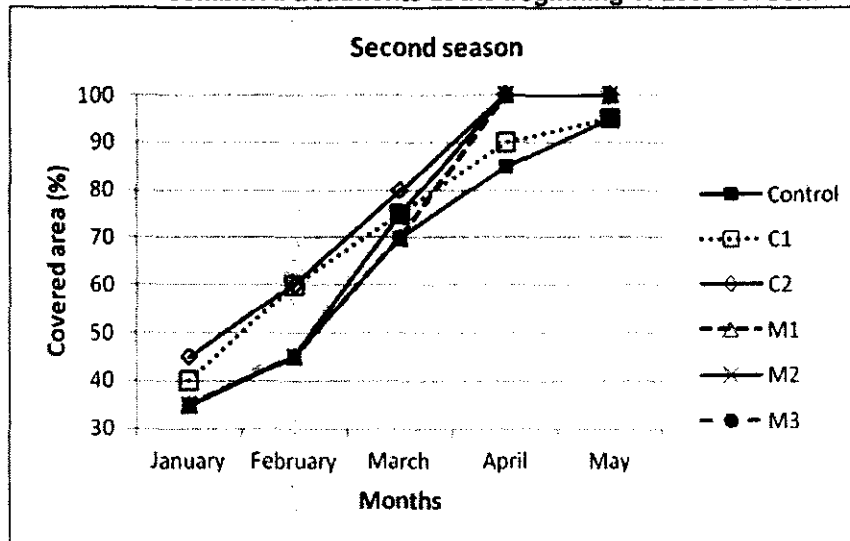
The results agree with previous research which showed that increasing inorganic fertilization enhance establishment of turfgrasses (Geron *et al.*, 1993 and Grigg, 1999). Also studies have shown that the amendments with organic compost can enhance turfgrass establishment (Angle *et al.*, 1981; Cisar and Snyder, 1992; Garling and Boehm, 2001; Landschoot and McNitt, 1994). Thus, the combined effects of both high NPK fertilization with organic amendments would result in more effect on turfgrass establishment.



**Figure (1A): Establishment rate of Bermudagrass treated with different individual treatments at the beginning of 2008 season.**



**Figure (1B): Establishment rate of Bermudagrass treated with different combined treatments at the beginning of 2008 season.**



**Figure (2A): Establishment rate of Bermudagrass treated with different individual treatments at the beginning of 2009 season.**

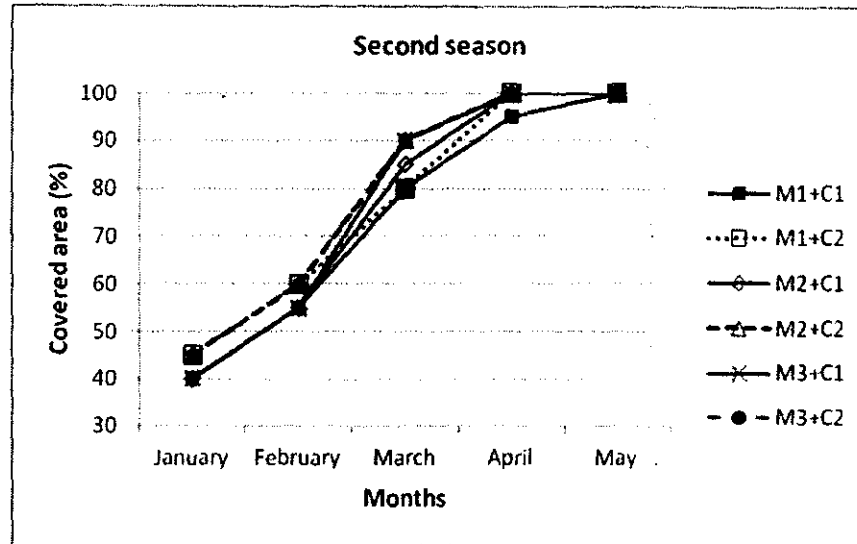


Figure (2B): Establishment rate of Bermudagrass treated with different combined treatments at the beginning of 2009 season.

#### Turfgrass growth and Quality:

Clippings fresh weight in the first season increased from May until fall, then started to decrease during late fall and winter to the lowest level by January, and start to increase again by March until the following May. In both seasons, among single treatments (Fig 3A & 4A), plots which received high NPK treatment (M3) resulted in the highest fresh weight of clippings, followed by those received medium NPK fertilizer treatment(M2). The trend through the months was very much similar among combined treatments (Fig 3B & 4B), and the highest clippings fresh weight was achieved when high NPK fertilizer treatment was combined with high compost treatment (M3+C2), followed by that combined with low compost treatment (M3 +C1), then medium NPK combined with high compost treatment (M2+C2).



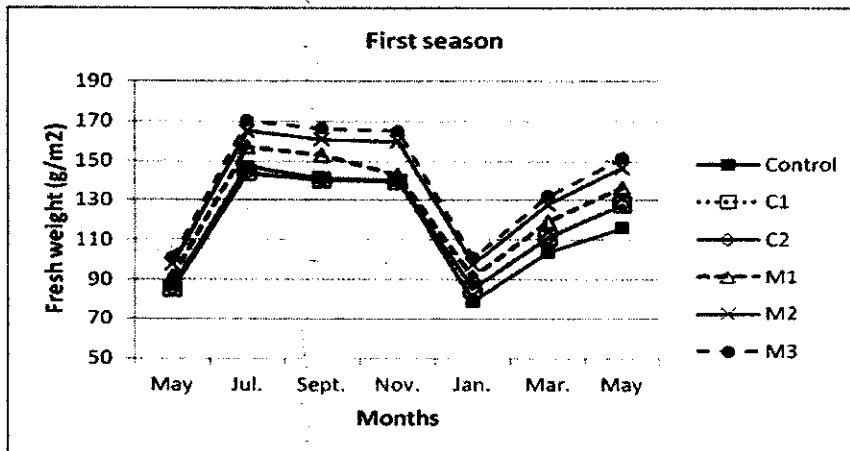


Figure (3A): Clippings fresh weight of Bermudagrass treated with different individual treatments during 2008/2009 season.

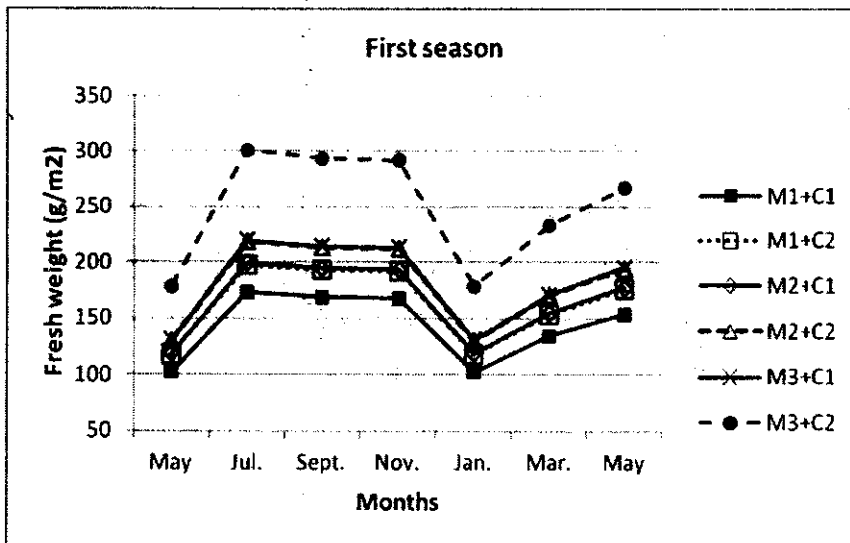


Figure (3B): Clippings fresh weight of Bermudagrass treated with different combined treatments during 2008/2009 season.

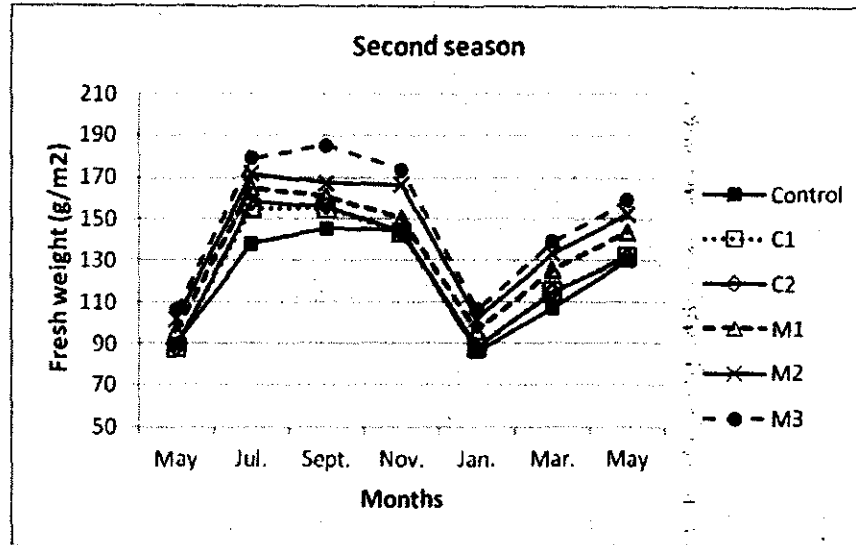


Figure (4A): Clippings fresh weight of Bermudagrass treated with different individual treatments during 2009/2010 season.

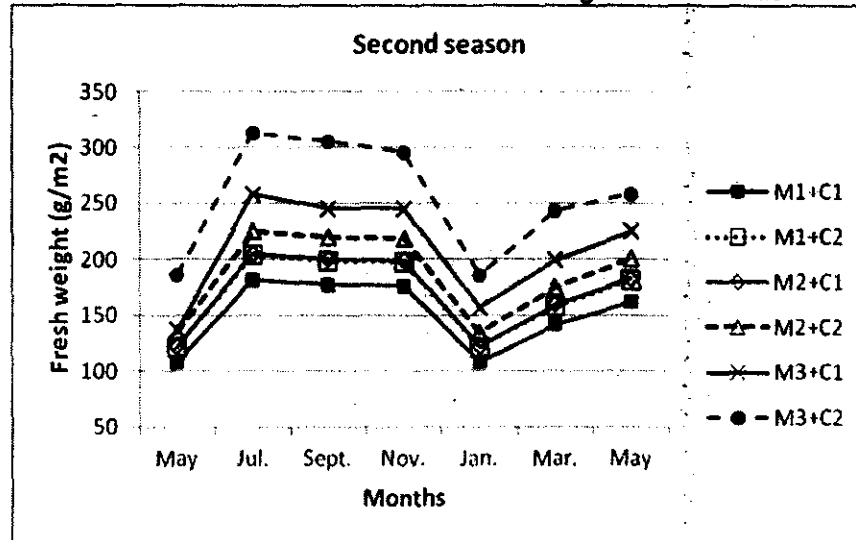


Figure (4B): Clippings fresh weight of Bermudagrass treated with different combined treatments during 2009/2010 season.

In both seasons, the quality rating of Bermudagrass treated with single treatments (Figures 5A& 6A) showed that the quality rating of Bermudagrass had highest scores during September until November, then dropped during winter to unacceptable values. Through the following spring,

Bermudagrass started to regain its quality and, by May, were all above the acceptable level. Plots fertilized with high NPK level (M3) had highest quality score than all other single treatments throughout the year. The quality ratings of Bermudagrass treated with combined treatments showed a similar trend (Figures 5B & 6B), but quality of all treatments were acceptable during winter. However, high NPK fertilization combined with high compost treatment (M3+C2) averaged better quality than other combined treatments. This indicates the importance of both high NPK fertilization and high compost to improving and preserving the quality of Bermudagrass even during winter months.

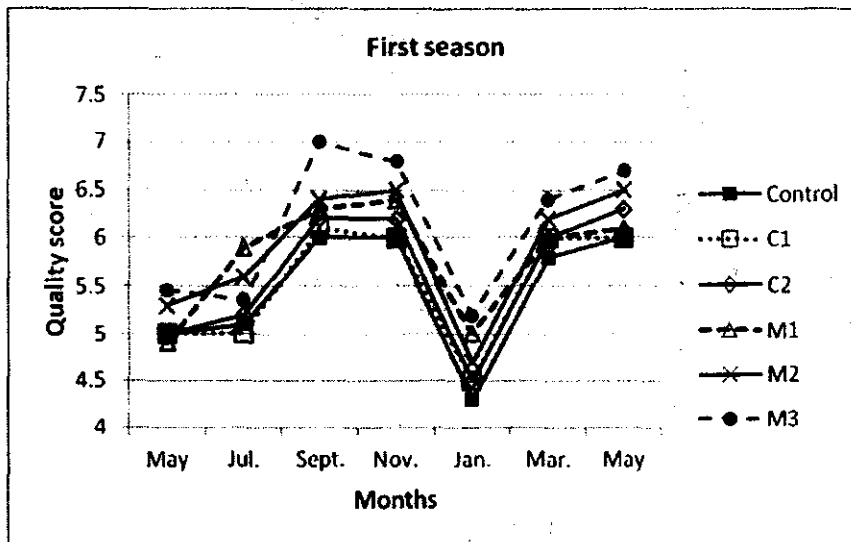


Figure (5A): Quality of Bermudagrass treated with different individual treatments during 2008/2009 season.

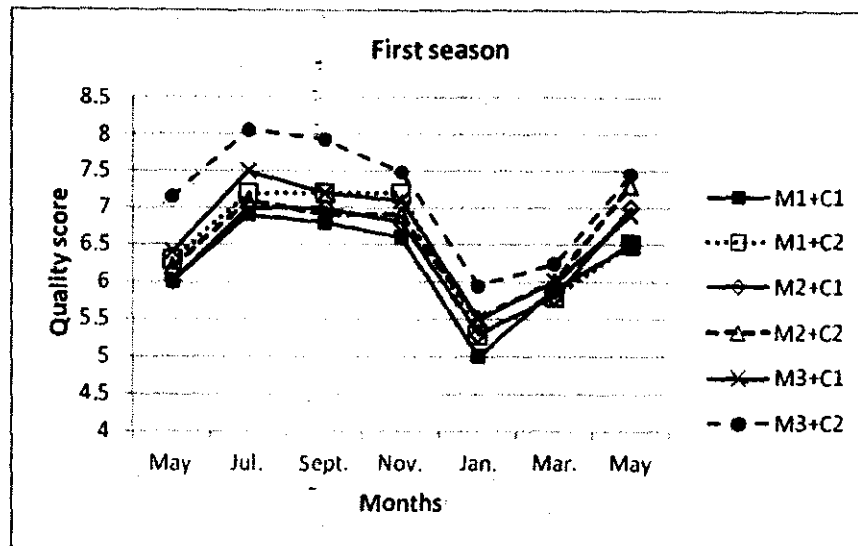


Figure (5B): Quality of Bermudagrass treated with different combined treatments during 2008/2009 season.

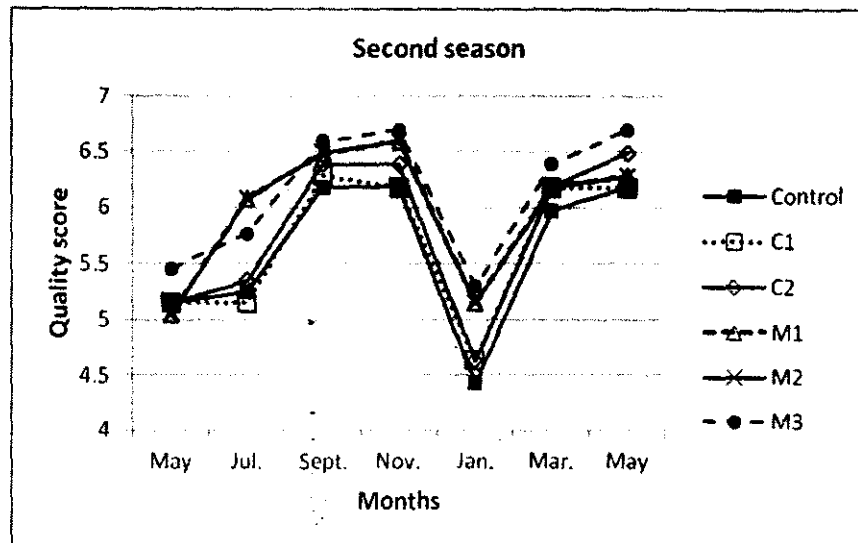
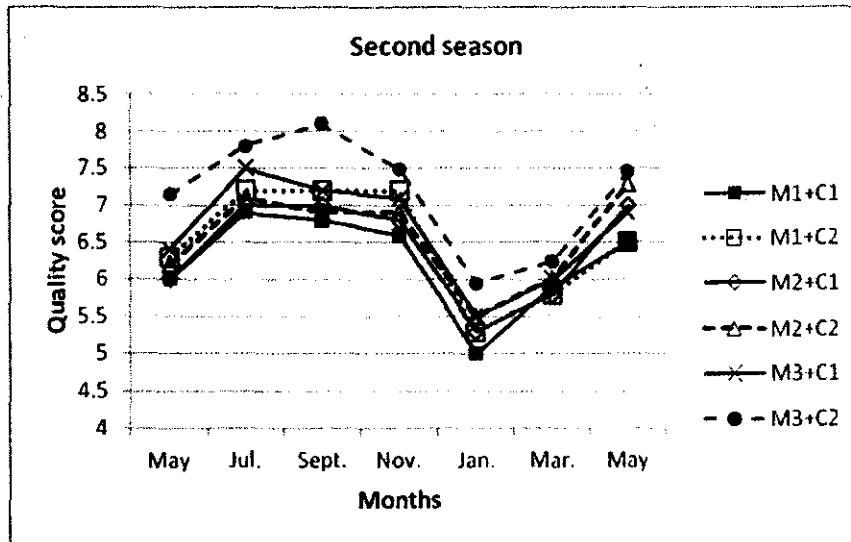


Figure (6A): Quality of Bermudagrass treated with different individual treatments during 2009/2010 season.



**Figure (6B): Quality of Bermudagrass treated with different combined treatments during 2009/2010 season.**

The growth behavior throughout the experiment months is typical, since Bermudagrass is a warm season perennial species that grows best under extended periods of high temperatures and mild winters, makes the best growth where average daily temperatures are above 75°F (23.9 °C), and the optimum daytime temperature for Bermudagrass is between 95° and 100°F (35 to 38 °C) (Beard, 1973). Research has demonstrated that when average temperatures drop below 50°F (10 °C), growth stops, and the grass begins to discolor, until the average daily temperatures rise above 50°F (10 °C) for several days in the following spring (Duble, 2010).

Sandy soils, are poor in mineral and organic colloids, and have low fertility as determined by a shortage of macro- and micronutrients (Weber *et al.*, 2007). The addition of essential minerals in the form of soluble NPK would supply the turfgrass with nutrients required for growth and development, and results showed that the higher the rate of fertilizer, the more the growth and the better quality of Bermudagrass were achieved. In this concern, Razmjoo and Kaneko, (1993) suggested that a well- balanced fertility ratio and rate of the NPK fertilizer used for turfgrasses are the key to prevent dormancy and promote growth and improve quality. Callahan and Overton, (1978) reported a significant increase in 'Common' Bermudagrass density when N was increased from 10 to 20 g m<sup>-2</sup> y<sup>-1</sup>. In addition, Paswan and Machahary, (2000) showed that increasing N rate from 0 to 40 g/m<sup>2</sup> increased shoot length, fresh weight (g/m<sup>2</sup>) and quality score of bahiagrass. Moreover, Van Auken and Bush, (1997) reported that, addition of P and N together to native

soil increased above- and belowground dry mass 2.9-6.5 times in *Paspalum plicatulum*.

Physical characteristics of sandy soils, as well as their other fertility factors, depend mainly on the amount of organic matter (Franzluebbers, 2002).

The chemical analysis of the soil in this experiment showed that adding compost to the soil increased water holding capacity and lowered pH of the soil (Table, 3). Organic manure increased structural stability and water retention of sandy soils (Ginting *et al.*, 2003), and caused a decrease in the soil pH (Habteselassie *et al.*, 2006; Sims, 1990; Wright *et al.*, 2008), near neutral pH values (6.5–8.1), which represent a range favorable for turfgrass root growth (Landschoot, 1996).

The chemical composition of the bioorganic compost used in this experiment revealed that it contained considerable amount of nutrients (Table, 2). Previous results indicated that, application of composts and organic amendments increases soil nutrient levels (Chantigny *et al.*, 2002; Gregorich *et al.*, 1998), which is often attributed to the presence of soluble materials in composts (Chantigny *et al.*, 2002).

Thus, adding compost to sandy soil during soil preparation and the addition of NPK fertilizer resulted in better growth and quality of Bermudagrass. Early reports by Sikora *et al.*, (1980) showed that clipping yields of all fescue were increased further when inorganic fertilizer (N, P, or N + P) was applied with compost. The largest increases were associated with turf treated with both compost and supplemental N + P.

The average clipping fresh weight per month (Table, 4) showed that the highest NPK plus high compost application (M3+C2) resulted in the highest average fresh weight of clippings per months, followed by (M3+C1). All NPK single treatments (M3, M2, and M1) gave higher average fresh weight of clippings than either compost treatments alone (C1 or C2). The highest average fresh weight of clippings was that of highest NPK fertilizer combined with high compost (M3+C2). High NPK fertilizer treatment combined with low compost (M+C1), medium NPK fertilizer combined with high compost (M2+C1), and high NPK fertilizer alone (M3) treatments ranked second among all treatments and were not significantly different among each other. These results indicated that high NPK fertilizer was the key to improving growth of Bermudagrass especially when combined with high compost incorporated to the sandy soil. The largest increases in clipping yields were associated with turf treated with both compost and supplemental N + P (Sikora *et al.*, 1980; Tester *et al.*, 1982; Tester, 1989).

In addition, Sakr *et al.* (2008) reported that combining sewage sludge compost (0.01m<sup>3</sup> /m<sup>2</sup>) with the highest rate of conventional NPK fertilizer (55.6 g/m<sup>2</sup>/month) resulted in the highest values for vegetative growth parameters of *Zoysia japonica* turfgrass grown in sandy soil, and recommended that the soil should be amended with sewage sludge compost (0.01m<sup>3</sup> /m<sup>2</sup>) during soil preparation, and the plants should be supplied with 55.6 g/m<sup>2</sup>/month of the conventional NPK fertilizer (9% N-5% P<sub>2</sub>O<sub>5</sub>- 5% K<sub>2</sub>O).

**Root/shoot ratio, chlorophyll content, and quality:**

The highest significant root/shoot ratio, chlorophyll content, and quality score at the end of the experiment (Table, 4) were those of Bermudagrass planted in high or low compost incorporated soil and received high NPK treatment (M3+C2 and M3+C1). Treatments received medium or low NPK plus compost or high NPK alone ranked second. This indicates that compost addition to the soil had positive effect on root growth and quality of Bermudagrass.

Similarly, Paswan and Machahary, (2000) reported that increasing N rate from 0 to 40 g/m<sup>2</sup> increased leaf chlorophyll content and nitrogen content of shoot tissue of *Paspalum notatum*. Also, Schumann *et al.*, (1993) observed enhanced color of tall fescue (*Festuca arundinaceae* Schreb.) and a Kentucky bluegrass (*Poa pratensis* L.)–perennial ryegrass (*Lolium perenne* L.) mixture following the application of composted biosolids. NPK fertilizer encourages the growth and quality of turfgrasses. Nitrogen is the key element in turfgrass fertility programs since it influences healthy growth, color and density (Hull, 1996). Nitrogen (N) requirements to maintain good quality of Tifway Bermudagrass was reported by Carrow *et al.*, 1987 to be at least 20 to 30 g N m<sup>-2</sup> yr<sup>-1</sup>. Totten, (2007) stated that clipping yield and turf quality ratings of Bermudagrass, were significantly higher at 254 kg N ha<sup>-1</sup> yr<sup>-1</sup>, compared to 190 kg N ha<sup>-1</sup> yr<sup>-1</sup>. Additionally, Callahan and Overton (1978) reported a significant increase in 'Common' Bermudagrass density when N was increased from 10 to 20 g m<sup>-2</sup> y<sup>-1</sup>.

New lawns have a limited root system and require higher levels of phosphorus for healthy seedling development (Voigt *et al.*, 2006). Potassium is important in improving stress tolerance (such as heat, cold, and wear disease) of turfgrasses and is essential to plant growth (Snyder and Cisar, 2000). Recommended rates of fertilization for establishment of seashore paspalum are 98 to 147 kg ha<sup>-1</sup> of phosphorus and potassium for root establishment and rhizome and stolon growth, and spoon feeding nitrogen with 24 to 49 kg ha<sup>-1</sup> on a two to six week schedule (Trenholm *et al.*, 2001).

Angle *et al.*, (1981) showed that the quality of the turf increased with both time and the compost amendment rate during sod establishment due to increased amounts of nutrients from the compost. Organic compost was reported to enhance turfgrass quality in many previous studies (Loschinkohl and Boehm, 2001; Norrie and Gosselin, 1996; Schumann *et al.*, 1993).

The changes (gain and loss) of N and P nutrients and their availability are regulated and controlled by soil organic matter, which is one of the most important factors in the storage of nutrients in these nutrient-poor sandy soils (Wezel *et al.*, 2000). One element could be added to the effects of compost is that soils with organic amendments had near neutral pH values (6.5–8.1), which represent a range favorable for turfgrass root growth (Landschoot, 1996).

**Table (4): Average clippings fresh weight per month and root/shoot ratio, total chlorophyll, and quality score of Bermudagrass treated with NPK fertilizer and compost at the end of the two seasons 2008/2009 and 2009/2010.**

|         | Average fresh weight of clipping (g/m <sup>2</sup> /month) |           | Root/shoot ratio |           | Total chlorophyll (mg/100g fw) |           | Quality score |           |
|---------|--|-----------|------------------|-----------|--------------------------------|-----------|---------------|-----------|
|         | 2008/2009  | 2009/2010 | 2008/2009        | 2009/2010 | 2008/2009                      | 2009/2010 | 2008/2009     | 2009/2010 |
| Control | 67.88  | 69.91     | 1.17             | 1.19      | 0.39                           | 0.40      | 5.5           | 5.6       |
| C1      | 69.5   | 71.5      | 1.24             | 1.26      | 0.40                           | 0.41      | 5.5           | 5.7       |
| C2      | 69.5   | 71.6      | 1.28             | 1.32      | 0.41                           | 0.42      | 5.6           | 5.8       |
| M1      | 83.67  | 86.18     | 1.65             | 1.72      | 0.40                           | 0.42      | 6.24          | 6.43      |
| M2      | 96.39  | 99.28     | 1.67             | 1.75      | 0.40                           | 0.42      | 6.43          | 6.62      |
| M3      | 107.95   | 111.19    | 1.7              | 1.82      | 0.41                           | 0.44      | 6.80          | 7.00      |
| M1+C1   | 83.7   | 87.9      | 1.7              | 1.73      | 0.40                           | 0.41      | 6.2           | 6.3       |
| M1+C2   | 95.5   | 98.4      | 1.78             | 1.82      | 0.42                           | 0.43      | 6.5           | 6.7       |
| M2+C1   | 96.4   | 99.3      | 1.8              | 1.85      | 0.42                           | 0.43      | 6.48          | 6.6       |
| M2+C2   | 106.0  | 109.1     | 1.82             | 1.89      | 0.43                           | 0.45      | 6.6           | 6.8       |
| M3+C1   | 113.3  | 111.6     | 1.9              | 2.00      | 0.43                           | 0.45      | 7.0           | 7.1       |
| M3+C2   | 145.4  | 151.2     | 1.9              | 2.03      | 0.47                           | 0.51      | 7.2           | 7.4       |
| LSD 5%  | 6.8  | 8.2       | 0.12             | 0.16      | 0.03                           | 0.05      | 0.4           | 0.5       |

**Total carbohydrates, nitrogen, phosphorus, and potassium percentages:**

In the first and second seasons, at the end of the experiment, total carbohydrates, nitrogen, potassium, and phosphorus % (Table, 5) were all the highest in Bermudagrass which received high NPK fertilizer combined with either compost treatments (M3+C2 and M3+C1), and were significantly higher in all measurements than high NPK fertilizer treatment alone (M3). Similarly, results showed that applications of composted biosolids at increasing rates resulted in a linear increase in tall fescue foliar N concentrations (Sikora *et al.*, 1980; Tester *et al.*, 1982; Tester, 1989). Sakr *et al.*, (2008) reported that combining sewage sludge compost (0.01m<sup>3</sup> /m<sup>2</sup>) with the highest rate of conventional NPK fertilizer(55.6 g/m<sup>2</sup>/month) resulted in the highest values for vegetative growth parameters as well as the contents of N, P, K, Fe, and Zn in clippings.

The results of this experiment showed that higher inorganic fertilizer rate and the incorporation of 3kg of the bioorganic compost resulted in better growth and quality of Bermudagrass grown in sandy soils. However, quality did not exceed 7.5 score and even less than that score throughout most of the year. This is supported by the fact that N, P, and K contents of the clippings in best case were less than those reported by Voigt *et al.*, (2006). This indicates that turfgrasses in this type of soils require more attention regarding quantity, type, methods of soluble fertilizer application, and amount and type of soil amendments used.



**Table (5): Percentages of the total carbohydrates, nitrogen , phosphorus, and potassium in the clippings of Bermudagrass treated with NPK fertilizer and compost at the end of the two seasons 2008/2009 and 2009/2010.**

|                | Total carbohydrates (%) |           | N%        |           | P%        |           | K%        |           |
|----------------|-------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
|                | 2008/2009               | 2009/2010 | 2008/2009 | 2009/2010 | 2008/2009 | 2009/2010 | 2008/2009 | 2009/2010 |
| <b>Control</b> | 19.5                    | 19.9      | 1.15      | 1.17      | 0.07      | 0.09      | 1.11      | 1.13      |
| <b>C1</b>      | 20.5                    | 20.9      | 1.30      | 1.33      | 0.09      | 0.09      | 1.16      | 1.18      |
| <b>C2</b>      | 21.2                    | 21.6      | 1.32      | 1.35      | 0.08      | 0.08      | 1.18      | 1.20      |
| <b>M1</b>      | 21.9                    | 22.3      | 1.40      | 1.43      | 0.09      | 0.09      | 1.20      | 1.22      |
| <b>M2</b>      | 23.6                    | 24.1      | 1.45      | 1.48      | 0.13      | 0.12      | 1.26      | 1.29      |
| <b>M3</b>      | 24.2                    | 24.7      | 1.60      | 1.63      | 0.12      | 0.14      | 1.43      | 1.46      |
| <b>M1+C1</b>   | 21.8                    | 22.7      | 1.47      | 1.53      | 0.18      | 0.19      | 1.44      | 1.50      |
| <b>M1+C2</b>   | 22.4                    | 23.3      | 1.48      | 1.54      | 0.19      | 0.20      | 1.50      | 1.56      |
| <b>M2+C1</b>   | 23.7                    | 24.6      | 1.52      | 1.58      | 0.22      | 0.23      | 1.52      | 1.58      |
| <b>M2+C2</b>   | 23.9                    | 24.9      | 1.58      | 1.64      | 0.23      | 0.24      | 1.54      | 1.60      |
| <b>M3+C1</b>   | 24.1                    | 25.1      | 1.73      | 1.80      | 0.24      | 0.25      | 1.62      | 1.68      |
| <b>M3+C2</b>   | 24.9                    | 25.9      | 1.79      | 1.86      | 0.29      | 0.27      | 1.70      | 1.78      |
| <b>LSD 5%</b>  | 1.3                     | 1.2       | 0.11      | 0.13      | 0.1       | 0.09      | 0.06      | 0.11      |

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تأثير السماد المعدني (نتروجين - فسفور - بوتاسيوم) والكمبوست العضوي على نمو وجودة مسطح البرمودا (*Cynodon dactylon* (L.) Pers.) صنف صحارى نوميكس النامي في تربة رملية  
هشام هاشم عبد القادر<sup>1</sup> و عبد الرحمن إبراهيم الحميد<sup>2</sup>  
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تم عمل تجربة حقلية في الموسمين المتتاليين ٢٠٠٧، ٢٠٠٨، ٢٠٠٩، ٢٠٠٨، ٢٠٠٩، ٢٠٠٩، ٢٠١٠ في محطة الأبحاث والتجارب الزراعية بكلية الزراعة والطب البيطري جامعة القصيم، المملكة العربية السعودية، وهدفت التجربة إلى دراسة تأثير السماد المعدني (نتروجين - فسفور - بوتاسيوم) القابل للذوبان في الماء وإضافة الكمبوست العضوي للتربة على نمو وجودة مسطح البرمودا صنف صحارى نوميكس النامي في التربة الرملية على مدار العام. تم زراعة البنجر في ١٥ سبتمبر من عامي ٢٠٠٧ و ٢٠٠٨ للموسم الأول والثاني على الترتيب. بالنسبة للمعاملات المحتوية على الكمبوست، تم إضافة الكمبوست العضوي للـ ٢٠ سم العليا من التربة بمعدل ١ أو ٣ كجم م<sup>-٢</sup> أثناء إعداد الأرض للزراعة. وتم إضافة السماد المعدني القابل للذوبان في الماء (١٤ - ٣٨ - ١٠ + مغ + عناصر صفري) بثلاثة معدلات هي: منخفض (١٠٠ جم م<sup>-٢</sup> السنة) ومتوسط (٢٠٠ جم م<sup>-٢</sup> السنة) أو مرتفع (٣٠٠ جم م<sup>-٢</sup> السنة) بحيث تم تقسيم السماد المعدني لأربع دفعات (فبراير التالي للزراعة، مايو، سبتمبر، فبراير من السنة التالية)، وقد أخذت القياسات على معدل التغطية للمسطح ووزن ناتج القصب وجودة المسطح ونسبة المجموع الجذري للمجموع الخضري ومحتوي الكلوروفيل و النسبة المئوية للكربوهيدرات الكلية و النتروجين والفسفور والبوتاسيو في ناتج قص المسطح.

وأظهرت النتائج أن أبكر تغطية لمسطح البرمودا صنف صحارى نوميكس تم الحصول عليها باستخدام السماد المعدني المعدل المرتفع (٣٠٠ جم م<sup>-٢</sup> السنة) إما وحده أو مع إضافة الكمبوست للتربة بمعدل ١ أو ٣ كجم م<sup>-٢</sup>. هذه المعاملات حافظت أيضا على جودة المسطح في مستوى أعلى من المستوى المقبول خلال الموسم كله متضمنا الخريف المتأخر والشتاء. وتم الحصول على أفضل النتائج من حيث النمو والجودة وجميع القياسات السابق ذكرها عن طريق إضافة ٣٠٠ جم م<sup>-٢</sup> السنة من السماد المعدني مقسما إلى ٤ دفعات متساوية لمسطح البرمودا النامي في التربة المضاف إليها ٣ كجم م<sup>-٢</sup> من الكمبوست العضوي أثناء إعداد الأرض للزراعة.

قام بتحكيم البحث

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