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## GENETIC POTENTIAL OF BERMUDA GRASS (*CYNODON DACTYLON* L.) IN RESPONSE TO FOLIAR APPLICATION OF ORGANIC FERTILIZER (LIBRO) AND PACLOBUTRAZOL

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### SUMMARY

A study on the Bermuda grass (*Cynodon dactylon* L.) materialized from February to October 2022 at the Department of Horticulture and Landscaping, College of Agriculture, University of Anbar, Iraq. The organic fertilizer Libro used comprised four concentrations (0, 1, 2, and 3 ml L<sup>-1</sup>) and the growth retardant Paclobutrazol with three concentrations (0.00, 0.03, and 0.05 g<sup>2</sup>), with their interaction effects assessed on the vegetative, phenotypic, and chemical characteristics of Bermuda grass. All the 12 treatments had randomized complete block design (RCBD) arrangements, with three replications. The results showed that Bermuda grass with organic fertilizer Libro at a concentration of 3 ml L<sup>-1</sup> led to a significant increase in most vegetative growth and phenotypic and chemical characteristics. The number of vegetative branches, the percentage of chlorophyll and carbohydrates, and the degree of acceptability of quality and homogeneity emerged with 8.912 plant branches<sup>-1</sup>, 19.129%, 30.892 mg g<sup>-1</sup>, and 6.778, respectively. However, the rates of internode length and the number of mowing times decreased after treating the Bermuda grass with Paclobutrazol at 0.05 g<sup>2</sup> concentration, recorded with 5.840 mm and 2.000, respectively.

**Keywords:** Bermuda grass (*Cynodon dactylon* L.), organic fertilizer Libro, Paclobutrazol, vegetative growth, phenotypic and chemical characteristics

**Key findings:** The results revealed that Bermuda grass (*Cynodon dactylon* L.) applied with organic fertilizer Libro (3 ml L<sup>-1</sup>) exhibited a significant increase in vegetative branches, the percentage of chlorophyll and carbohydrates, and the degree of acceptability of quality and homogeneity, with recorded values of 8.912 plant branches<sup>-1</sup>, 19.129%, 30.892 mg g<sup>-1</sup>, and 6.778, respectively. The rates of interphalangeal lengths and the number of shearing times decreased after treating the Bermuda grass with Paclobutrazol (0.05 g<sup>2</sup>), recorded with 5.840 mm and 2.000, respectively.

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## INTRODUCTION

Lawn areas contribute significantly to our way of life due to their delightful nature and the global interest in expanding green areas' cultivation for clean, impressive, and environmentally safe surroundings from an aesthetic and healthy point of view (Uddin *et al.*, 2023). Large green areas today and in the future in several places act as a cushion to protect players and reduce their injuries, i.e., sports stadiums, children's parks, public parks, hospitals, health centers, and various educational institutions (Behe *et al.*, 2015; Jumaah *et al.*, 2021).

Bermuda grass (*Cynodon dactylon* L.), a long-enduring grass, belongs to the family Gramineae. It is a perennial creeping plant that reproduces by cuttings (rhizomes) and by seeds in the spring. Among its characteristics, it resists walking and trampling and tolerates drought stress conditions. The mowing and destruction processes of green areas are one of the environmental stresses that cause immense damage to the vegetation with the yellowing of the plants, reducing the green spaces in home gardens, sports fields, and children's playgrounds (Piscová *et al.*, 2023).

Organic fertilizers, in general, and according to their sources, enhance production in terms of quantity and quality, in addition to their vital role in increasing the soil suitability for agriculture by improving the soil's physical properties (Sposito, 2008). Humic components are the materials produced in the secondary biosynthesis process to create a group of polymeric complexes, with these materials further divided based on their molecular weight into fulvic acid, humic acid, and humin (Liu *et al.*, 2023). Humic acid is also the prime composition of the substance organic matter with an applicable role in increasing plants' growth at low concentrations through indirect influence on the vital processes that take place in the plant, such as increasing the absorption of nutrients and various physiological processes, i.e., photosynthesis, respiration, protein building processes, content of plant cells from green matter (chlorophyll), and carbohydrates accumulation (Ferrara and Brunetti, 2010; Ahmed *et al.*, 2020).

The various chemicals belonging to the phyto regulators group serve as growth retardants, working as obstacles to have physiological effects in reducing the overall growth and boosting the production of crop plants (De-Faria-Souza *et al.*, 2023). Therefore, the plants treated with these chemicals appear normal; however, their stems and branches become short, and the plants become stunted. In the past, maleic hydrazide use also helped manage the plant's growth and development, and researchers have sought in the field of studying lawns for more than 60 years (March *et al.*, 2013; Patel *et al.*, 2023). Therefore, the presented study assessed the role of organic fertilizer in limiting leaf growth and reducing the number of mowing times by using a phyto regulator type of chemical Paclobutrazol in Bermuda grass *Cynodon dactylon* L.

## MATERIALS AND METHODS

The experiment commenced from February to October 2022 at the Department of Horticulture and Landscape, College of Agriculture, University of Anbar, Iraq, to study the effects of organic fertilizer (Libro) and Paclobutrazol with different levels and their interactions on the growth characteristics and completeness of the seedlings of the Bermuda grass (*Cynodon dactylon* L.).

The field designated for the implementation of the research started preparations by removing the old soil with a depth of 20 cm and replacing it with the soil transferred from the Research Station of the College of Agriculture, University of Anbar in the Al-Buitha area (Table 1) in square basins of blocks with dimensions of 1 m × 1 m, a height of 20 cm, and the distance between the treatments was 20 cm. Spreading one layer of polyethylene, a transparent one for each treatment, had each basin perforated with 10 holes for removing excess water from the plant's need. The fennel seeds' planting had dimensions of 10 cm × 10 cm, and the distance between one piece and another was 10 cm × 10 cm.

**Table 1.** Physical and chemical properties of soil used for the Bermuda grass.

Character	Unit	Value
EC	dc m <sup>-1</sup>	1.67
pH	—	7.34
O.M.	g kg <sup>-1</sup> soil	5.42
Sand	mg kg <sup>-1</sup> soil	690
Salt	mg kg <sup>-1</sup> soil	118
Clay	mg kg <sup>-1</sup> soil	192
Soil texture	Sandy loam	
Ready Nitrogen	mg kg <sup>-1</sup> soil	112.00
Ready Phosphorus	mg kg <sup>-1</sup> soil	11.30
Ready Potassium	mg kg <sup>-1</sup> soil	118.5
SO <sub>4</sub> <sup>-2</sup>	Meq L <sup>-1</sup>	7.42

A factorial experiment in the randomized complete block design (RCBD) comprised two factors, with the treatments distributed randomly with three replications each, with 12 treatments. The treatment was in one board, where the experimental units totaled 36.

The first factor included spraying the Bermuda grass shoots with a foliar spray with four levels of organic fertilizer (Libro), i.e., 0, 1, 2, and 3 ml L<sup>-1</sup>. The second factor used three levels (0, 0.03, and 0.05 g<sup>2</sup>) of growth retardant Paclobutrazol after dissolving each concentration with 5 ml of ethyl alcohol, bringing the volume to one liter, and then applying it as a foliar spray on the vegetative system. The date of spraying with organic fertilizer was 45 days after planting the cuttings of thyme after completing the crosslinking. After a week of treating the plants with thyme, spraying the plants with Paclobutrazol followed, and the number of sprays for all the treatments was twice.

Recording the average internode length in millimeters progressed. Counting the average number of branches per shoot (branches plant<sup>-1</sup>) ensued, according to Grossi *et al.* (2019). Chlorophyll in shoots (mg g<sup>-1</sup> fresh weight) also attained recording by following the method of Goodwin (1976). The percentage of carbohydrates in shoots (%) measurement used the technique of Joslyn (1970). The degree of acceptability of specificity and homogeneity employed the method of Wild and Voigt (1977). Also,

formulating the number of mowing times was according to the methodology of Zamin *et al.* (2019).

All the recorded data analysis per the randomized complete block design (RCBD) used the GenStat program. The mean averages' further comparison and separation used the least significant difference (LSD) test with a 5% probability level (Hamad *et al.*, 2023).

## RESULTS AND DISCUSSION

The results confirmed that the various treatments comprising foliar application of organic fertilizer and chemical Paclobutrazol revealed significant differences in the mean length of the internodes of Bermuda grass (*Cynodon dactylon* L.) (Table 2). The average extent of the internodes decreased significantly at the comparison concentration with zero organic fertilizer Libro (F0) among the organic fertilizer treatments, amounting to 5.644 mm. However, the length of the internodes notably increased in the treatment of organic fertilizer with a concentration of 3 ml L<sup>-1</sup> (7.856 mm). In the case of the growth represented by the chemical Paclobutrazol application, the average internode length decreased significantly in the two treatments with 0.05 (P2) and 0.03 (P2) g<sup>2</sup> and recorded the size of 5.840 and 5.938 mm, respectively, compared with the control with an increased internodal length (9.253 mm).

**Table 2.** Effect of organic fertilizer Libro and Paclobutrazol on the internode length (mm) of Bermuda grass.

Fertilizer Libro	P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	F average
F <sub>0</sub>	8.210	4.567	4.157	5.644
F <sub>1</sub>	9.140	6.130	5.610	6.960
F <sub>2</sub>	9.603	6.360	6.780	7.581
F <sub>3</sub>	10.060	6.693	6.813	7.856
P average	9.253	5.938	5.840	
	LSD F		0.297	
	LSD P		0.257	0.05
	LSD F*P		0.515	

**Table 3.** Effect of organic fertilizer Libro and Paclobutrazol on the branches per plant of Bermuda grass.

Fertilizer Libro	P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	F average
F <sub>0</sub>	16.230	16.565	17.303	16.699
F <sub>1</sub>	18.300	18.207	17.447	17.984
F <sub>2</sub>	18.367	19.230	19.550	19.049
F <sub>3</sub>	19.420	19.627	23.207	20.751
P average	18.079	18.407	19.377	
	LSD F		2.171	
	LSD P		N.S	0.05
	LSD F*P		3.761	

The interaction between organic fertilizer and chemical Paclobutrazol expressed that the two treatments, F<sub>0</sub>P<sub>2</sub> and F<sub>0</sub>P<sub>1</sub>, were significantly distinct from the rest of the treatments in recording the shortest length of internodes (4.157 and 4.567 mm, respectively). However, the average length of the internodes increased in the treatment F<sub>3</sub>P<sub>0</sub> (Libro 3 ml L<sup>-1</sup> and Paclobutrazol 0 mg<sup>2</sup>) and reached 10.060 mm. In general, the organic additions changed the percentage of organic matter in the soil, which improved its characteristics by raising the readiness of nutrients, the activity of microorganisms in the ground and quantity, then enhancing the effectiveness of soil decomposing enzymes, which increases the elements' availability for plant absorption (March *et al.*, 2013; Baidalina *et al.*, 2023; Patel *et al.*, 2023; De-Faria-Souza *et al.*, 2023).

### Branches per plant

In *Cynodon dactylon* L., the application treatments of organic fertilizer and chemical Paclobutrazol revealed significant differences for branches per plant (Table 3). In the organic fertilizer treatments Libro, spraying with a

concentration of 3 ml L<sup>-1</sup> (F<sub>3</sub>) was significantly superior compared with the rest of the doses in the average number of branches per plant, amounting to 20.751 branches plant<sup>-1</sup>. However, the average number of branches decreased during the comparison treatment and amounted to 16.699 branches plant<sup>-1</sup>. Concerning Paclobutrazol treatments, P<sub>2</sub> was remarkably superior in the average number of branches per plant (19.377 plant branches<sup>-1</sup>), while the comparison treatment recorded the lowest rate of branches per plant (18.079).

However, the interaction effects for both factors revealed nonsignificant differences. The influence of organic fertilizer on grass and plants is better and greener, but it took time to see the results; this indicated an extended retention period in plants. Several studies have included organic fertilizers and their derivatives in providing plant nutrients, ensuring soil fertility, and increasing crop productivity. Organic and animal materials in organic fertilizer can decompose in the soil into useful micro-parts and convert them from organic to inorganic nitrogen. This process is called mineralization, and the plant absorbs the nutrients as and when needed (Sposito, 2008; El-Tayeh *et al.*, 2023; Liu *et al.*, 2023).

**Table 4.** Effect of organic fertilizer Libro and Paclobutrazol on total chlorophyll content (mg g<sup>-1</sup> fresh weight) of Bermuda grass.

Fertilizer Libro	P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	F average
F <sub>0</sub>	22.107	26.147	26.610	24.954
F <sub>1</sub>	27.543	28.483	28.817	28.281
F <sub>2</sub>	29.863	30.113	30.660	30.212
F <sub>3</sub>	29.177	29.633	33.867	30.892
P average	27.173	28.594	29.988	
	LSD F		1.028	
	LSD P		0.890	0.05
	LSD F*P		1.781	

**Table 5.** Effect of organic fertilizer Libro and Paclobutrazol on the carbohydrates (%) of Bermuda grass.

Fertilizer Libro	P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	F average
F <sub>0</sub>	10.170	10.510	10.693	10.458
F <sub>1</sub>	11.457	11.700	12.260	11.806
F <sub>2</sub>	12.283	14.747	17.780	14.937
F <sub>3</sub>	15.867	20.387	21.133	19.129
P average	12.444	14.336	15.467	
	LSD F		0.864	
	LSD P		0.748	0.05
	LSD F*P		1.496	

### Total chlorophyll (mg g<sup>-1</sup> fresh weight)

Total chlorophyll (mg g<sup>-1</sup> fresh weight) results indicated that the treatment with organic fertilizer significantly differed and showed varied values (Table 4). The highest and at par total chlorophyll content exhibited by three treatments of organic fertilizer Libro, i.e., F<sub>3</sub>, F<sub>2</sub>, and F<sub>1</sub> (3, 2, and 1 ml L<sup>-1</sup>) ranged from 28.281 to 30.892 mg g<sup>-1</sup> fresh weight, whereas the rate of chlorophyll decreased in shoots in the control (0 ml L<sup>-1</sup>) treatment (24.954 mg L<sup>-1</sup>). In the case of Paclobatrazol treatments, the highest chlorophyll content (29.988 mg L<sup>-1</sup> fresh weight) was evident in treatment P<sub>2</sub> (0.05 g<sup>2</sup>), followed by P<sub>1</sub> (28.594 mg L<sup>-1</sup> fresh weight); and the rate of chlorophyll decreased in the control treatment (P<sub>0</sub> - 0.00 g<sup>2</sup>), amounting to 27.173 mg L<sup>-1</sup> fresh weight.

The results in Table 4 further showed the superiority of the interaction between organic fertilizer and Paclobutrazol (F<sub>3</sub> and P<sub>2</sub>) in the chlorophyll content of the shoot, amounting to 33.867 mg L<sup>-1</sup> fresh weight, followed by F<sub>2</sub> and P<sub>2</sub> (30.660 mg L<sup>-1</sup> fresh weight). However, the minimum chlorophyll content of the shoot appeared in the interaction treatment (F<sub>0</sub> and P<sub>0</sub>) at 22.107

mg L<sup>-1</sup> fresh weight. Biofertilization is an essential element in reducing the damage caused by chemical fertilizers' use, and it fills a large part of the fertilizer needs, saves a vast amount spent on its production, and helps reduce the production's energy usage. In addition, many leguminous crops have links with the biofertilizers use, and it increases the amount of proteins needed by humans, thus achieving a balance in food components at the lowest costs and preventing environmental pollution (Masrahi *et al.*, 2023; Piscová *et al.*, 2023).

### Carbohydrates in shoots (%)

The various treatments comprising foliar application of organic fertilizer Libro and Paclobutrazol resulted in significant differences in the percentage of carbohydrates in the vegetative body of the plant (Table 5). For carbohydrates in the shoot system, the highest percentage (19.129%) occurred with the organic fertilizer Libro at the rate of 3 ml L<sup>-1</sup> (F<sub>3</sub>), followed by Libro 2 ml L<sup>-1</sup> (F<sub>2</sub>) at 14.937%, whereas the lowest percentage rate of carbohydrates in shoots was apparent in the control (0 ml L<sup>-1</sup>) treatment (10.458%).

**Table 6.** Effect of organic fertilizer Libro and Paclobutrazol on the degree of acceptability of quality and homogeneity of Bermuda grass.

Fertilizer Libro	P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	F average
F <sub>0</sub>	3.667	2.667	2.337	2.890
F <sub>1</sub>	3.667	2.333	2.333	2.777
F <sub>2</sub>	5.000	2.667	2.000	3.222
F <sub>3</sub>	7.000	3.000	1.333	3.777
P average	4.833	2.666	2.000	
	LSD F		0.710	
	LSD P		0.615	0.05
	LSD F*P		N.S	

**Table 7.** Effect of organic fertilizer Libro and Paclobutrazol on the mowing rate of Bermuda grass.

Fertilizer Libro	P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	F average
F <sub>0</sub>	3.000	4.333	3.667	3.667
F <sub>1</sub>	4.333	5.000	4.333	4.556
F <sub>2</sub>	4.333	6.333	4.333	5.000
F <sub>3</sub>	5.000	8.333	7.000	6.778
P average	4.167	6.000	4.833	
	LSD F		0.916	
	LSD P		0.794	0.05
	LSD F*P		N.S	

For the growth retardant treatments represented by Paclobutrazol, the dosage concentration of 0.05 g<sup>2</sup> gave the highest percentage of carbohydrates in the shoot system (15.467%), followed by P1 (14.336%), and the decreased values in the control treatment (12.444%).

On the interaction between the treatments, Libro and Paclobutrazol, the interactions F3 and P2, and F3 and P1 were markedly superior in the percentage of carbohydrates, amounting to 21.133% and 20.387%, respectively, compared with a decreased proportion in the control treatment (10.170%). It may be due to the role of organic fertilizers in reducing the effectiveness of the urease enzyme, which reduces the loss of nitrogen through volatilization, in addition to the organic fertilizer's role in soil properties by increasing water retention via water absorption on humus colloids, as well as, expanding aeration and drainage in the soil. On root system development, requiring a good absorption of the elements, humic acid works additionally to absorb the elements, making them easily absorbed by the roots. The soil, especially in the second season, contains a

good percentage of organic matter, increasing the content of organic nitrogen in it (Behe *et al.*, 2015; Jumaah *et al.*, 2021; Dasgan *et al.*, 2023).

#### **Degree of quality acceptability and balance**

The analysis results confirmed the significant differences in various treatments of organic fertilizer Libro and growth retarder Paclobutrazol for the degree of acceptability of quality and homogeneity (Table 6). It was noteworthy that a significant increase in the degree of acceptability of quality and homogeneity emerged when treating the Bermuda grass plants with organic fertilizer at a concentration of 3 ml L<sup>-1</sup> with a value of 3.777, while the F1's recorded degree of acceptability of quality, the homogeneity rate is the lowest at 3.777, and the results in the table showed that the comparison treatment was significantly superior in the degree of acceptability of quality and homogeneity at 4.833. The average degree of quality and homogeneity decreased in the P2 treatment at 2.000.

Concerning the interaction between the treatments of Libro and Paclobutrazol, the results in the table indicated no significant differences in the degree of acceptability of specificity and homogeneity. Consequently, growth characteristics, particularly biological yield, were often better in the second year. It could be due to proper nutrient perception, good soil wetness, and suitable assimilation and translocation into the plants' sections, all receiving enhanced photosynthetic rates elevating vegetative expansion but decreased grain yield (Grossi *et al.*, 2019; Zamin *et al.*, 2019; Testani *et al.*, 2023).

### The average number of shearing times for the stubble

The outcomes showed significant differences in the rate of the number of shearing times (Table 7). The number of shearing times decreased when spraying with treatments F0 and F1 at 3.667 and 4.556, respectively, while the shearing rate increased with treatment F3, amounting to 6.778. Table 7 further details the shearing rates decreased when treated with the growth retardant Paclobutrazol at a concentration of 0.00 g<sup>2</sup>, amounting to 4.167, with the treatment P1 reaching 6.000, and the interaction between the treatments did not show any significant differences in the number of shearing times. The use of phytohormone group chemicals helped as growth retardants and have physiological effects in reducing the overall growth and boosting the production of crop plants (March *et al.*, 2013; Patel *et al.*, 2023; De-Faria-Souza *et al.*, 2023).

### CONCLUSIONS

The results showed a significant effect of organic fertilizer on all the studied traits, and it was also evident that fertilizers with high doses have a considerable impact on plant growth and development of Bermuda grass. However, at the same time, it reduced the amount of chemical fertilizers, their harmful effects, and high costs.

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