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THE RESPONSE OF GROWTH OF SOME LAWN PLANTS TO CHEMICAL FERTILIZATION WITH HUMIC ACID UNDER LOW-LIGHT CONDITIONS OF HOUSE GARDEN

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ABSTRACT

Shade in house gardens is one of the problems that hinder the growth of lawn and its distribution in the soil, where the types of lawns differ in their durability and adaptation to shade. The research aims to know the resistance of some species of lawn plants to shade and to know the appropriate fertilization procedures that can be followed to reduce the negative effects. The study was conducted in the Amiriya district of Baghdad in a house garden. Three varieties of lawn plants Bermuda, Gazon, and Trifoglio were planted. Five fertilization treatments (contained N and P elements) and the control were used. The sunlight density with the temperature of the study field locations were estimated using the AMT-300 and the vegetation coverage percentage was measured by the Conape program. The results showed a significant difference in the coverage percentage and its area of Bermuda compared with Gazon and Trifoglio, where the average coverage percentage at the end of period of 97.4%, due to the appropriate temperature and its ability to extending rhizomes. The treatment (Dap + Urea + Humic DUH) had a higher coverage rate with a significant difference from other treatments. The results showed a significant increase in the available P in the soil (101 - 146%) and the higher increase rate was in the DU treatment with a slight decrease in available N in the control and DUH treatment. According to the results, humic acid had a role in maintaining the availability of the nutrient and improving its absorption by the plant. The sunlight density level in the house garden is more suitable for Trifoglio and Gazon, thus the two classes could be inserted into mixtures cultivated after the growth of Bermuda in periods of cold weather.
***Keywords*:** Response, humic acid, Bermud, Gazon, Trifolium, AMT-300

Introduction

Lawns are those areas of land cultivated with a group of close and contiguous herbaceous plants, and when they are cut, their branches grow profusely creeping so that the ground is covered as a green compress (Mahmood and Amin, 1989). Lawns play a high role in drawing an aesthetic image of the local environment, adjusting its surroundings, preventing pollution, and ensuring safety (Bernieh, 2010). The selection of appropriate plant for green landscape requires the knowledge of several things and the most important are: the nature of growth, and procedures for maintenance and preservation. Species must be able to tolerate agricultural treatments for lawns such as cutting, irrigation, fertilization, and weed control (Al-Bayati, 2008). One of the most important things that characterizing lawns plants is their tolerance for crushing and walking on. Most of lawns plants belong to the Gramineae family (Poaceae) and others belong to other families that share some morphological characteristics making them able to tolerate agricultural treatments (Mahmood and Amin, 1989). There are many types of lawns plants used in Iraq including those suitable for warm areas such as Bermudagrass (*Cynodon dactylon*), Dichondra (*Dichondra micrantha*), Zoysiagrass (*Zoysio* spp.), etc. and those suitable for cold areas such as Colonial bentgrass (*Agrostis tenuis*) and Perennial ryegrass (*Lolium perenne*), known as Gazon (Al-Bayati, 2008; Rasool, 1988) as well as Trifoglio (*Trifolium repens*) which follows the leguminous family.

Sunlight is one of the most important factors for the growth of lawns because of its effectiveness in the photosynthesis process, tissue formation, and other biological processes. Lawns absorb high levels of red, orange, purple, and blue radiations (extreme ends of the optical spectrum), thus the duration of lighting is one of the determining factors. Generally, lawns require intense lighting for several hours during the day (Bernieh, 2010). On the other hand, shade affects photosynthesis leading to weak vegetative and root, rhizomes, and extended stems growth, thereby reducing the plant's ability to resist external factors (Turgeon, 1980). The intensity of light is measured in lux unit (lumens.m-2). Most plants need to light within a range of 2500 - 7500 lux to maintain a 14-hour light period (Navvab, 2000; IESNA 1994). The optimum energy needs for plants equals at least 753 to 1077 lux for 12 hours a day (Navvab, 2000). The level of 4000 lux is sufficient to equate the rate of photosynthesis with the rate of respiration, while the next level (over 4000 lux), in which increasing light intensity does not lead to increase photosynthesis, is called light saturation. The upper leaf saturation is at around 32,000 lux, however, due to the shading of lower leaves, light levels of about 100,000 lux maybe necessary for the entire plant to be saturated with light. Different crops prefer different lighting levels. While many indoor plants will tolerate a low light intensity from 25,000 to 30,000 Lux, the amount of light should reach most crops to the maximum (Parker, 1999). (McWhorter and Jordan, 1976) found that Johnsongrass grass grew from 4 – 40 ºC at a light intensity of 9000-19000 Lux. Some legumes grew in a temperature and optical density range from 16 – 32 °C and 6500 - 12900 Lux (Gist and Mott, 1957). While Bermuda requires about 4 hours for direct sunlight or an entire day of high-quality and pure sunlight (McCurdy, 2015). Direct sunlight is characterized by very high strength and continuous movement, the light produced on the surface of the earth may exceed 100000 Lux, and most herbs, even that tolerate the shade, requires some direct sunlight every day for healthy growth and survival (Kurtz, 1975).

Lawn plants differ in their tolerance to temperatures some had no ability to tolerate high, but low temperatures and vice versa for others. Generally, 15 – 30 °C is the best for overall growth, 26 – 35 °C for warm-climate plants, and 15 – 25 °C for cold climate plants (Al-Dujwi, 2004).

(Kurtz, 1975) mentioned that fertilization of grasses under shade should be reduced to prevent plant stimulation by nitrogen, and grass should be fertilized 3-4 times per year with a complete fertilizer (N, P, K) to fertilize both grass and trees.

Than the above, shade in home gardens is one of the problems that hinder the growth of lawn and its distribution on the ground, and the types of lawn plants differ in their tolerate and adaptation to shade. The research aims to know the resistance of some types of lawn plants to shade and the appropriate fertilization procedures that can assist to reduce the negative effects of low lighting and natural growth of lawn in the house garden.

Materials and Methods

The study was conducted in Al-Amiriya district in Baghdad, at latitude 33.30 north, longitude 44.3 east, and an altitude of 40 m above sea level in a home garden. After preparing the soil for planting, the field was divided into blocks with dimensions of (50 x 50 cm) 0.25 m^2 area and planted with three varieties of lawn plants**:**

Bermuda grass (*Cynodon dactylon*):

It follows the Gramineae family, from warm regions types, and most prevalent in the tropics and subtropics. This species (native to Africa) produces a vigorous, good-growth tolerate to the cutting, and had a high density and tolerance to both walking on and drought stress. Bermuda grew rapidly and spread by vegetative Propagation, on ground (stolons) or/and underground (rhizomes). Bermuda grew best under full sun conditions as most are intolerant for shade (Brosnan and Deputy, 2008).

Gazon (*Lolium perenne*):

It follows the Gramineae family, cold regions types, not affected by shade or cold, but affected by the summer heat. (Mitchel, 1953) found that high light intensity and hypothermia increase the branching of rye class (Gazon).

Trifoglio (*Trifolium repens*):

It follows the legume family, a cold region, short plant, and had circular and thick leaves with bright green color, no need for large amounts of water, and had a low resistance for low temperatures**.**

Five fertilization treatments were used with control (Control, Dap + Urea + Humic DUH, Dap + Humic DH, Urea + Humic UH, Dap + Urea DU) with 3 replicates. The number of treatments as below**:**

3 Classes * 5 levels of Fertilization * 3 Replicates = 45 treatments

Fertilizer combinations containing only N and P nutrients were used (Goh, 1987). DAP was used as a source of N and P (18% N, 46% P_2O_5) and urea fertilizer as a supplement to the nitrogen component (46% N), (Table 1). Some of the chemical and physical soil properties of the study soil were analyzed as shown in (Table 2).

Table 1 : Weights of fertilizing treatments added for the experimental units

	DAP		Urea		Analysis	Humic Acid	
Treatment	**gm/unit**	**kg/donum**	**gm/unit**	**kg/donum**	**N-P_2O_5-K_2O**	**gm/unit**	**kg/donum**
Control	0	0	0	0	0-0-0	0	0
DUH	12	120	10	100	30.7-25.1-0	0.3	3
DH	12	120	0	0	18-46-0	0.3	3
UH	0	0	10	100	46-0-0	0.3	3
DU	12	120	10	100	30.7-25.1-0	0	0

Table 2 : Soil chemical and physical properties

Property	Value	Property	Value
EC	0.7 $ds.m^{-1}$	Mg^{+2} soluble	1.5 $meq.L^{-1}$
p H	7.13	Na^{+2} soluble	1.33 $meq.L^{-1}$
N available	24 $mg.kg^{-1}$	HCO_3^{-1} soluble	0.81
P available	3.17 $mg.kg^{-1}$	Cl^{-1} soluble	11.5
K available	125.11 $mg.kg^{-1}$	K^{+1} soluble	0.8
O.M	0.73 $gm.kg^{-1}$	Texture	Sandy Clay Loam
$CaCO_3$	23.71 $gm.kg^{-1}$	Hydraulic Conductivity	0.085 $cm.hur^{-1}$
Ca^{+2} soluble	3.11 $meq.L^{-1}$	Cumulative Infiltration	1.97 cm for 1 hur

Cultivation carried out on 7/4/2019. Sprinkler irrigation was applied according to the needs of plant (15 mm / hour). The first batch of fertilizer treatments was added at 20 days after planting after grass lengths reaching higher than 3 cm. The first batch of humic acid fertilizer was added by spraying on the leaves at a concentration of 0.6 $gm.L^{-1}$ according to the recommendation of the producing company (Eden Modern Agriculture, 2016) at 0.5 liters per experimental unit a week after adding chemical fertilizer. Plants were cut (after reaching more than 6 cm length) and the second batch of fertilizers was added. The percentage of vegetation coverage was measured by the Conape program. After entering the image of the experimental block into the program, it gives a percentage of the vegetation on the block **.**Sunlight intensity was estimated with study field environment temperature using AMT-300 device. The device includes levels of solar radiation intensity from 500 Lux to less than 120,000 Lux. Four months readings were taken; in each month, two groups of readings were taken: the first group started at the beginning of the month and the second group in the middle of the month, and each group had 13 reading hours starting from 5 a.m. until the end of 5 p.m. taken from three different sites of the study field. The data were inserted into the statistical analysis according to the global factorial experiments using the complete random design by 13-time x 4-month x 3 replicates with a total of 156 readings.

At end of the experiment, the available content of elements N, P, and k was estimated for comparison with their content at the beginning of the experiment, and the cumulative infiltration and unsaturated hydraulic conductivity of the experimental units were estimated using Mini Disk Infiltrometer device.

Results and Discussion

Table 3 showed that the best times of sunlight density for all study months are between 11:00 am until the beginning of 3 pm, (i.e. a period of high (HGH) and normal (NOR), which density was estimated between 60000-100000 Lux) was not exceeded 2-4 hours per day, and the highest density was in July (HGH was just two hours), and this period represented the direct sunlight which should not be less than 4 hours per day (McCurdy, 2015). Also, the table showed that the sunlight density was close to most variable treatment, as it fell within the level of LOW + (slightly low) most of the time (20000-40000 Lux) due to the presence of trees and buildings surrounding the study area, and this level of light intensity is suitable for leguminous Trifoglio class according to (Gist And Mott, 1957), noting that readings were carried out in natural climatic conditions.

Table 3 : The times of sunlight density for study months

Time	April	May	June	July
05:00	LOW	LOW	LOW	LOW
06:00	LOW^-	LOW^-	LOW	LOW
07:00	LOW	LOW	LOW^+	LOW^+
08:00	LOW	LOW^+	LOW	LOW
09:00	LOW^+	LOW^+	NOR	LOW^+
10:00	LOW^+	LOW^+	NOR^-	LOW
11:00	NOR^+	NOR	NOR^-	LOW^+
12:00	HGH^-	NOR^+	NOR	HGH^-
13:00	NOR^-	NOR	NOR	HGH
14:00	NOR^-	NOR^-	LOW^+	LOW^+
15:00	NOR	LOW^+	LOW	LOW
16:00	LOW^+	LOW^+	LOW	LOW
17:00	LOW	LOW	LOW	LOW

Table 4 showed that the average temperature during study time ranged between 14 - 36 ° C within the best range for lawn growth, especially Bermodagrass, but their height above 25 degrees is not suitable for cold climate plants such as Gazon and Trifoglio.

Table 4 : Average soil temperatures during study time

Time	Month			
	April	May	June	July
5:00	14	18	27	27
6:00	15	20	27	24
7:00	17	19	26	25
8:00	17	21	27	25
9:00	18	21	27	27
10:00	20	21	27	28
11:00	22	24	28	29
12:00	23	27	29	33
13:00	27	26	31	36
14:00	28	25	33	33
15:00	27	24	32	28
16:00	23	23	33	32
17:00	21	22	32	32

Figure (1) showed a significant superiority of the Bermuda compared to Gazon and Trifoglio in the study period (April 15 - August 15), in which the average coverage ratio, at the end of period, reached 97.4%, and the plant continued to grow and extend rhizomes even after the end of period. The superiority of Bermuda was due to the temperature during the study period (14 - 36 ° C), which was appropriate for the growth of this class as a category of warm regions, although not being exposed to direct sunlight by a sufficient period, while the maximum percentage of Gazon class was 52.1% at the end of the period with a difference of 86.95% from Bermuda, and showed no development in the summer months from the beginning of June until the end of the study period on August 15. The coverage rate in the Trifoglio reached a maximum level of 55.6% in June, growth began to deteriorate in mid-July due to the high temperature (more than 25 ° C) and the end of the growing season for this variety.

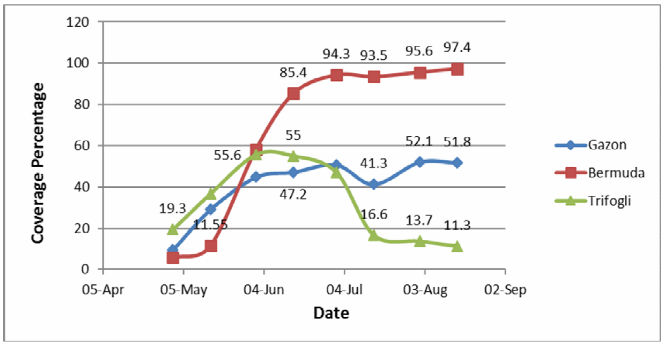

Fig. 1 : Effect of lawn class on plant coverage ratio of an experimental unit

Figure 2 showed an insignificant superiority of DU fertilizer treatment in the middle of the study period with a coverage rate of 72.4%. At the end of the study period, control treatment reached the lowest coverage rate of 41.3%, with an insignificant difference of 25.72% at the highest coverage rate DUH treatment with very small differences among other treatments. The low coverage percentage at the end of the study period was due to the stop of growth in Gazon and Trifoglio classes because of increasing temperature. This result reflected the role of humic acid in increasing fertilizer retention until the end of the experiment (Sultan, 2016).

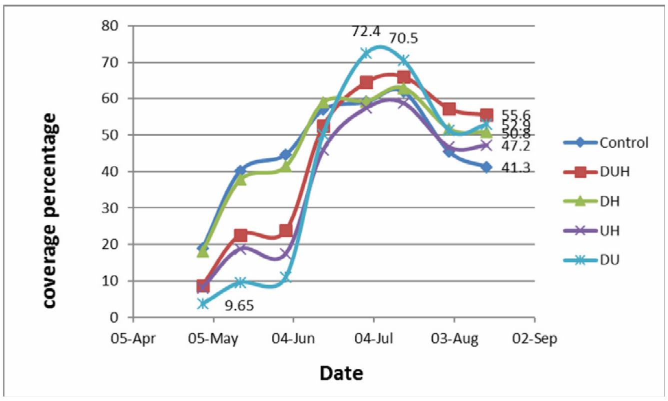

Fig. 2 : Effect of fertilizer treatment on plant coverage percentage of an experimental unit

Table 3 showed that the highest coverage rate of 98.1% in DUH and DH treatment added to the Bermuda class in July and August, whereas the highest DU treatment for Trifogli class of 71.9% at the beginning of July, and the DUH for Gazon class increased by 67.7% at the end of the study period. The statistical analysis showed no significant differences in treatment among lawn classes and fertilization treatments.

Table 3: Percentage of vegetation coverage for interference between lawn class and fertilization treatment

Date		Control	DUH	DH	UH	DU	Max.
1 May	Gazon	15.5	5.6	15.7	4.1	6	15.7
	Bermuda	9.6	5.6	9.3	2.7	2.5	9.6
	Trifogli	31.6	15.1	29.4	17.5	2.8	31.6
15 May	Gazon	44.1	24.6	41.7	23.3	6	44.1
	Bermuda	9.6	5.6	9.3	2.7	1.8	9.6
	Trifogli	53.1	34.2	51	34.3	17.1	53.1
1 June	Gazon	53.5	24.9	43.3	18.7	11.4	53.5
	Bermuda	21.5	17.1	34.9	9.4	3.8	34.9
	Trifogli	59.1	29.4	45.9	24.1	17.8	59.1
15 June	Gazon	55.8	44	56.7	31.6	36	56.7
	Bermuda	49.2	58.6	70	61.6	52.3	70
	Trifogli	66.1	55	49.9	44.4	62.7	66.1
1 July	Gazon	34.9	48.5	57.5	36	59.1	59.1
	Bermuda	75.9	91.6	84.8	88.5	86.3	91.6
	Trifogli	66.5	53.3	35.5	47.7	71.9	71.9
15 July	Gazon	35.7	51.8	64.9	39.3	62	64.9
	Bermuda	92.4	98.1	93.8	97.9	89.6	98.1
	Trifogli	57.9	48.4	29.9	39	60	60
1 August	Gazon	30.4	52.1	48.9	25.4	49.8	52.1
	Bermuda	91	94.8	95.4	96.5	89.9	96.5
	Trifogli	15	25	10.7	18.1	14.1	25
15 August	Gazon	29.6	67.7	63.7	36.4	63	67.7
	Bermuda	96.2	97.9	98.1	96.7	89.4	98.1
	Trifogli	14.8	16.6	10	14.2	13	16.6
Max.		96.2	98.1	98.1	97.9	89.9	98.1

Figure 3 showed that there was a significant effect of lawn class on an area of vegetation coverage, where Bermuda cultivar significantly had a superiority of Gazon and Trifoglio cultivars by 279.4 and 222.68%, respectively, due to the efficiency of class in extending rhizomes, which led to exceeding the experimental unit area by 150.4%.

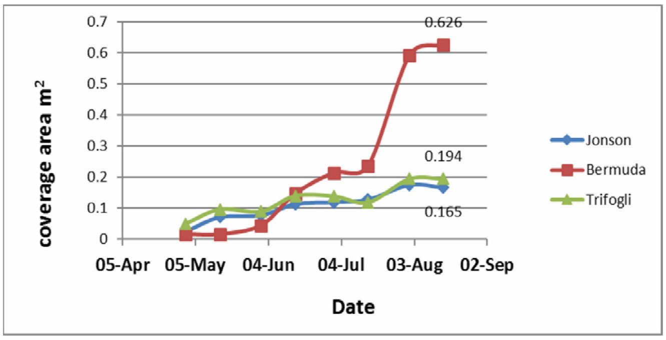

Fig. 3: Effect of lawn class in the coverage area

Figure 4 showed an insignificant superiority of fertilizer treatment (DH) in coverage area at the end of the study period at a rate of 0.398 m^2 with an increase of 59.2% over the experimental unit area, while control treatment reached the lowest coverage area at a rate of 0.263 m^2 and a difference of 65.14% for (DH) treatment with slightly differences between other treatments. Also, the figure showed that all treatments exceeded the area of the experimental unit, and the use of humic acid with a compound fertilizer of phosphorous and nitrogen elements was better for lawn growth than using with nitrogen fertilizers only (NH) or the use of phosphorous and nitrogen only (NP), this may be due to the role of humic acid in increasing the available phosphorous available for plant, then increasing plant growth.

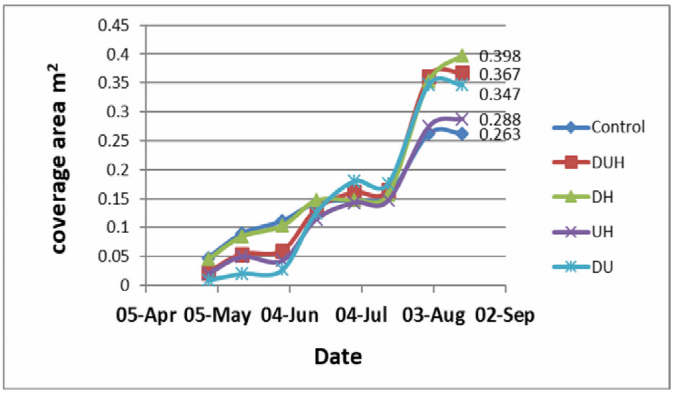

Fig. 4: Effect of fertilizer treatment on the vegetation coverage area

Table 4 showed the available content and increase ratios of N, P, and K nutrients in the soil at the beginning and end of the experiment. Also, the table showed a significant increase P availability, where the rate of increment ranged between 101 - 146% and the highest rate of increment was in DU treatment, where the content of available-P reached 7.8 mg. Kg^{-1} with an increment of 146% over soil content at beginning of the experiment (Table 2 and Table 4). Table 4 showed that the available P was higher in Control and DU treatments (which had no addition of humic acid) due to the role of humic acid in improving plant absorption of nutrients (Sultan, 2016). The plant absorbed part of available P, the indicator was the high coverage ratios of these treatments (Figure 2 and Table 3). The table also showed a slight decrement in available N in control and DUH treatment due to lack of N addition in the control treatment and improvement of nitrogen absorption by a plant in DUH treatment. An increase in available potassium was observed at rates ranging between 21 - 50% and the highest availability was DU treatment.

Table 4: Effect of fertilizer treatments on available content of N, P and K nutrients in soil

Nutrient	Before	After	control		DUH		DH		UH		DU	
	$mg.kg^{-1}$	$mg.kg^{-1}$	$mg.kg^{-1}$	Inc.%	$mg.kg^{-1}$	Inc.%	$mg.kg^{-1}$	Inc.%	$mg.kg^{-1}$	Inc.%	$mg.kg^{-1}$	Inc.%
N	24	N	23.9	-0.42	22.5	-6.25	26.2	9.17	25.3	5.42	28.6	19.17
P	3.17	P	7.4	133.44	6.5	105.05	6.5	105.05	6.4	101.89	7.8	146.06
K	125.11	K	156.4	25.01	150.7	20.45	152.8	22.13	165.6	32.36	187.6	49.95

The study soil was characterized by low cumulative infiltration and hydraulic conductivity of 1.97 cm and 0.085 $cm.hr^{-1}$, respectively (Table 2) it considered as a slow permeability (k <1mm.hr). Table 5 and 6 showed an improvement in values of cumulative infiltration and hydraulic conductivity after implementation of the experiment, with no significant differences for lawn class in the cumulative infiltration and hydraulic conductivity of soil, which ranged between 2.58-8.46 cm and 0.34-1.78 cm^{-1} hr, respectively, with a difference of 31% before implementation of experiment. While there were significant differences in the average water conductivity of the soil in the fertilizer treatments, where the highest average hydraulic conductivity was in UH treatment which reached 1.26 $cm.h^{-1}$, with a difference of 168% from the lowest value of H.C in the control treatment. This was due to the role of fertilization with humic acid with mineral fertilizers in improving the vegetation of the soil and strengthening the root zone then improving the physical and soil water properties.

Table 5: Effect of lawn classes and fertilizer treatments in soil cumulative infiltration (cm for an hour)

Infiltration cm	control	DUH	DH	UH	DU	Average
Bermoda	4.52	4.30	3.17	8.46	3.53	4.80
Gazon	2.67	6.01	3.04	4.70	3.78	4.04
Trifoglio	2.58	3.15	3.66	4.63	3.13	3.43
Average	3.25	4.49	3.29	5.93	3.48	4.09

Table 6: Effect of lawn classes and fertilizer treatments on soil hydraulic conductivity (cm.h^{-1})

H.C cm.hur^{-1}	Control	DUH	DH	UH	DU	Average
Bermoda	0.71	0.57	0.57	1.78	0.45	0.81
Gazon	0.37	1.33	0.59	0.96	0.68	0.79
Trifoglio	0.34	0.65	0.74	1.05	0.51	0.66
Average	0.47	0.85	0.63	1.26	0.55	0.75

Conclusions and recommendations

The superiority of the Bermuda class over the other two classes Gazon and Trifoglio is due to a period of experiment that was suitable for plants in warm regions, in addition to the nature of its expansion through rhizomes. Therefore, this class is suitable in warm periods and can be cultivated with care to fertilize it with nitrogenous and phosphorous fertilizers while using humic acid as an organic fertilizer that increases available nutrients for plants and makes it resistant to shade conditions. It appears that level of light density is more suitable for Trifoglio legumes and Gazon so that two classes can be inserted into mixtures cultivated after the growth of Bermuda stops in periods of cold climate (Rasool, 1988), with taking care of mineral and organic fertilization. Thus, we get a lawn covering the entire area in the low-sunlight areas of the house garden throughout the year. We recommend conducting other studies that take other classes with greater periods, including winter and summer season .

Fig. 5: Lawn classes cultivated in experimental units

Fig. 6 : Image on right for experimental units and image on the left for lawn state after adopting a mixture of classes used in the experiment

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