Original Article

PRODUCTIVITY AND MORPHOLOGICAL CHARACTERISTICS OF BUFFEL GRASS INTERCROPPED WITH BUTTERFLY PEA UNDER SHADE CONDITIONS

CARACTERÍSTICAS MORFOLÓGICAS E PRODUTIVAS DO CAPIM BUFFEL EM CONSÓRCIO COM CUNHÃ SOB SOMBREAMENTO

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ABSTRACT: Forage production in the Brazilian semiarid region can be enhanced by irrigation and shading to maximize water use. We evaluated the productivity and morphological characteristics of buffel grass (*Cenchrus ciliaris*) intercropped with butterfly pea (*Clitoria ternatea*) under shade conditions using an irrigated area with an artificial shading system (26, 39, 55%, or full sunlight). Butterfly pea was implemented in half of the land parcels in a randomized block using a split plot design with three replications. One hundred twenty days after planting was designated as the uniformity cut and the cutting was performed every 45 days for four consecutive cycles. The morphological analysis was performed during the first and fourth cycle, and the herbage mass was determined. The shadow had a quadratic effect on the leaf appearance rate in the first cycle, while shading had a quadratic deviation effect on the leaf elongation rate in the second cycle and an increased linear effect on the length of the sheet in the first cycle. Shading had a quadratic effect on the herbage mass in the third cycle and decreased linearity in the fourth cycle. The highest percentage of buffel grass was found in the single system in the first and second cycles. In addition, we observed a decreased linear effect of shade in the first cycle and the quadratic deviation effect of shade in the second cycle. A quadratic effect of shade was observed in the third and fourth cycles. The survival of the butterfly pea had a quadratic effect with a minimum rate level of 21% shading. The crude protein content showed a system effect in four cycles with higher crude protein in the intercropping system in the first and second cycles. There was also a quadratic effect of shade in the third cycle and linear increase in the fourth cycle. In conclusion, shading increased the leaf appearance rates and elongation at intermediate levels. In addition, a high level of shading increased the leaf length and survival of butterfly pea while it decreased the mass of the forage produced.

KEYWORDS: *Cenchrus ciliaris.* · *Clitoria ternatea.* · Leaf appearance rate. · Luminosity. · Tropical legume.

INTRODUCTION

According to Marshall et al., (2012), buffel grass constitutes a considerable proportion of the pool of grass plants in the arid regions of Brazil. In addition, this forage is often used in the semiarid region because of its low crude protein (CP) values due to low availability of water and fertilization at certain times of the year. An alternative strategy for the producers of this Brazilian region could be to intercrop this forage with legumes. These legumes act as a nitrogen source and thereby mitigate the negative effects of long periods of drought in pastures associated with irrigation in areas not only for direct grazing, but also conserved as a forage supply.

The importance of an alternative nitrogen source is evidenced by the commercial value of this input, which is one of the most expensive in the production system (MASCLAUX-DAUBRESSE et al., 2010). Furthermore, this is a limiting factor in the development and growth of plants (SANTI et al., 2013), in addition to the quality of the produced forage (FORNARA; TILMAN, 2008) due to symbiosis with bacteria of the genus *Rhizobium* (MIRANDA et al., 2003).

Among the group of potential forage legumes, the butterfly pea (*Clitoria ternatea*), a perennial plant that is tolerant to drought and grown in locations with an annual rainfall as from 380 mm, has been highlighted (BARROS et al., 2004). This plant is resistant to competition from weeds, has production values ranging between 30.000 and 40.000 kg/ha, and provides a fixing rate of up to 1.200 kg/ha of soil N (COLLINS; GRUNDY, 2005).

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The competition for resources among plants in the consortium can provoke different responses in the species involved (WHIPPLE, 2011). This is because the grasses and legumes have developed different and complex environmental change detection mechanisms and adaptive responses, which increase their productivity (WHIPPLE, 2011). Therefore, the success of the combination of grass and legumes would depend on their compatibility, which varies according to the equivalent features and reconciles competitive abilities and their dissimilar characteristics that make them complementary (LUSCHER et al., 2014).

Accordingly, ecophysiological studies to identify and plan management strategies for forage to ensure its longevity, productivity, and sustainability have demonstrated that the morphogenesis of plants fit the environmental conditions (DEJONG et al., 2011). Thus, it was observed that in silvopastoral systems the presence of trees promotes the formation of microclimates with milder temperatures, lower levels of solar radiation, higher relative humidity, lower evapotranspiration rates, and increased soil moisture, as well as higher N content in shaded plants (PACIULLO et al., 2007). This observation indicates that shading is an additional alternative option for forage production optimization in semi-arid regions.

Therefore, the objective of this study was to determine the levels of shading in intercropping or single systems that improve the productivity and morphological characteristics of buffel grass (*Cenchrus ciliaris*) intercropped with butterfly pea (*C. ternatea*) in semi-arid regions. In addition, we determined the survival of the leguminous and botanical composition in four consecutive production cycles.

MATERIALS AND METHODS

This study was conducted on the agricultural campus of the Federal University of São Francisco Valley, located in the city of Petrolina, Brazil with the following geographical coordinates: latitude 09° 23′55″ South, longitude 40° 30′03″ West Greenwich and an altitude of 376 m in an area of 864 m^2. The pasture area was previously established with a buffel grass cultivar Biloela for approximately 4 years and received artificial shading consisting of shading screens and raffia up to 1.5 m high that generated different radiation interceptions (26%, 39%, and 55% shading). These values were obtained using Quanta meter equipment (Li-Cor, USA).

A soil sample was collected at a depth of 0–20 cm, in accordance with chemical analysis data and using the Manual of Recommendations for the Use of Lime and Fertilizer in Minas Gerais State 5th approach (CFSEMG, 1999). This recommendation considers the clay phosphorus dose and, therefore, the medium technological level did not need liming. Moreover, 50 kg/ha each of phosphorus (114.5 kg/ha of P_2O_5) and nitrogen was required and applied in the form of single superphosphate (636 kg/ha) and urea(111 kg/ha), respectively, as well as 40 kg/ha of potassium (48.2 kg of K_2O) in the form of potassium chloride (80.3 kg/ha) and 30 kg/ha FTE 12 (micronutrients) per cycle.

The meteorological precipitation data, average temperature, and global radiation cycle (Table 1) were collected at the Federal University of São Francisco Valley (UNIVASF) Weather Bureau, considering the butterfly pea deployment of 120 days and four consecutive cycles of 45 days each totaling 300 days.

The area was irrigated using micro sprinklers installed at the height of 1 m with a spacing of 3 × 4 m and an average flow of 71.6 L/h applying a blade average of 5.62 mm/h, determined using the uniformity and flow test. For the irrigation blade setting, the data used was from the UNIVASF Weather Bureau with the following calculation: TI = ETo/Ea.Ia, where TI = irrigation time, ETo = average daily evapotranspiration during the period (mm), Ea = irrigation efficiency (80%) = IA application rate of the micro sprinkler mm/h, and Ia = average flow/irrigated area. This calculation allowed the application of a water depth of 313.3, 281.8, 226.1, and 240.2 mm for the periods assessed.

Table 1. Meteorological data from Federal University of São Francisco Valley (UNIVASF) Weather Bureau located on UNIVASF campus, Petrolina, Pernambuco State during the 300-day period

Meteorological parameter	Butterfly pea implantation 120 days	Cycle			
		1st	2nd	3rd	4th
Precipitation (mm/period)	206.2	61.4	104.6	46.5	0.5
Global radiation[1] (MJ/m².day)	25.0	23.7	22.1	18.4	17.3
Temperature[1] (°C)	26.7	26.7	27.4	24.8	24.1
Wind speed[1] at 2 m/s	2.2	1.7	1.6	1.7	3.6
ET0[1,2] mm	7.1	5.6	5.0	4.0	4.2

[1]mean/period, [2]ET0 = average evapotranspiration of reference in the period

The buffel grass was cut to 5 cm above the soil on the total area after the plots were marked with an area of 3.5 m × 4.0 m (border 1.0 m). This occurred after the butterfly pea were planted with a 25 cm × 25 cm spacing (CONWAY; COLLINS, 2005), totaling 160.000 plants per hectare with three seeds in each hole. Morphological and structural characteristics were evaluated every 3 days in the first and fourth cycles for 45 days each. For these evaluations, we selected three tillers/shares and marked them with colored ring wires with three basal tillers for each plant.

The plants were evaluated for the following morphological characteristics: leaf appearance rate (LAR), leaf elongation rate (LER), stem elongation rate (SER), and leaf senescence rate (LSR). Furthermore, the following structural characteristics were evaluated: total length of the expanded sheet (TLES), the total width of the expanded sheet (TWES), and the total number of emerged leaves (TEL). All variables analyzed were calculated as follows. The LAR (leaves/tiller/day) was obtained by determining the number of sheets that sprouted for each tiller during the evaluation period. The LER (mm/leaves/day) was calculated as the difference between the sum of the final leaf lengths and the leaf lengths at the beginning of the evaluation measured from the leaf ligules to the apex, divided by the number of days of growth. The SER (mm/day) was calculated by the difference between the initial and final lengths of the stem measured from ground level to the height of the youngest expanded leaf ligules including the sheath, divided by the number of days assessed. The LSR ($mm \cdot day^{-1} \cdot tiller^{-1}$) was calculated by dividing the final length of senescent tissue by the number of days.

Leaves were considered senesced when they were more than 50% compromised by senescence process. The length of the expanded sheet was determined by measuring the length of the leaf apex and the ligules of the same sheet while its width was determined by the measurements made on the sheet at the point of greatest width. Furthermore, the total number of leaves per tiller was calculated considering all the leaves that emerged during the evaluation period. After the 120-day establishment of the legumes without intervention, an initial cut was made using pruning shears at a height of 15 cm, from which were four cuts were made (cycles) with a 45-day interval to collect materials and data. The total collected material was weighed, separated, and then the fractions were weighed (buffel grass, butterfly pea, and weeds) to determine the botanical composition. The forage mass and the percentage of the botanical components of each fraction were estimated for the four cycles.

The survival of the butterfly pea was determined based on the total number of pits initially sown minus the total pits that did not contain live plants at the end of the last cycle. The forage mass samples collected from each site in the four cycles were analyzed at the UNIVASF Laboratory of Food Science and Animal Nutrition where they were oven-dried and evaluated for CP according to the Association of Analytical Communities (AOAC, 2002).

The experiment was conducted in randomized blocks in a scheme split plot using four levels of shading (full, 26%, 39%, and 55% sunlight) and a subplot with two types of systems (single or intercropping) with three repetitions each, totaling eight treatments and 24 plots. The results were analyzed using the statistical analysis system (SAS, version 9.1, 2003), after verifying the normality of the data using the Shapiro-Wilk test (PROC UNIVARIATE) and the variances were compared using orthogonal contrasts at a significance level of 5% using the PROC generalized linear model (GLM). The shading levels were not equidistant and, therefore, we used the interactive matrix language (IML) PROC to generate the vectors of each contrast (linear, quadratic, and quadratic deviation). The subsequently analyzed contrasts that were significant were further evaluated to determine the parameters of the regression equations using

PROC REG. The survival of the butterfly pea crop was evaluated using a randomized block design.

RESULTS

The mean stem elongation rate (14.7 and 13.45 mm/day) and LSR (13.7 and 6.5 mm·day^{-1}·tiller^{-1}) of the variables in the first and fourth production cycle showed no shadowing effect or system interaction (Table 2). The structural analysis data revealed no shadow effect, and there was no system or shade versus interaction system effect (Table 2) for the width of the expanded leaf (0.6 and 0.6 cm), total numbers of emerged leaves (7.0 and 7.4 leaves emerged), or number of aerial tillers (8.5 and 7.5 tillers) for the first and fourth cycles, respectively.

Table 2. Shading and system effects and factor interaction of evaluated variables.

Variable	Shading Effect	System effect	Factor interaction
Leaf appearance rate (LAR)	*	*	Ns
Leaf elongation rate (LER)	*	Ns	Ns
Stem elongation rate (SER)	Ns	Ns	Ns
Leaf senescence rate (LSR)	Ns	Ns	Ns
Length of expanded leaf (cm)	*	Ns	Ns
Width of the expanded leaf (cm)	Ns	Ns	Ns
Number of emerged leaves	Ns	Ns	Ns
Number of aerial tillers	Ns	Ns	Ns
Forage mass (ton MS/ha)	*	Ns	Ns
Buffel grass (%)	*	*	Ns
Weeds (%)	Ns	Ns	*
Butterfly pea survival (%)	*	-	-

*Significant at the 0.05 probability level $P < 0.05$; ns = not significant

Figure 1 (A) illustrates that in the first cycle, the LAR showed ($P < 0.05$) system and quadratic shading effects, indicating that the LAR was higher in the mixed cultivation than in other systems. Furthermore, the maximum and minimum points (0.21 and 0.17 leaves/tiller^{-}/day^{-1}, respectively) of the LAR were at the 25% level of shading and 35% level of single shading systems.

LER showed no effect of system; the two system values were statistically equivalent and presented a quadratic deviation shading effect (Figure 1 B) with maximum and minimum values of 41.99 and 18.16 at the 15% and 51% shading levels, respectively. In the third cycle, the length of the expanded leaf (Figure 1C) showed no system effect and an increasing linear effect of shading. This observation demonstrates that regardless of the cropping system the expanded leaf length increased as the brightness decreased. The first and second cycles showed no system or shadow effects ($P > 0.05$), indicating that the first cycle forage mass remained stable regardless of the shade level and farming system, with averages of 3.22 and 3.23 tons of dry matter (DM)/ha, respectively.

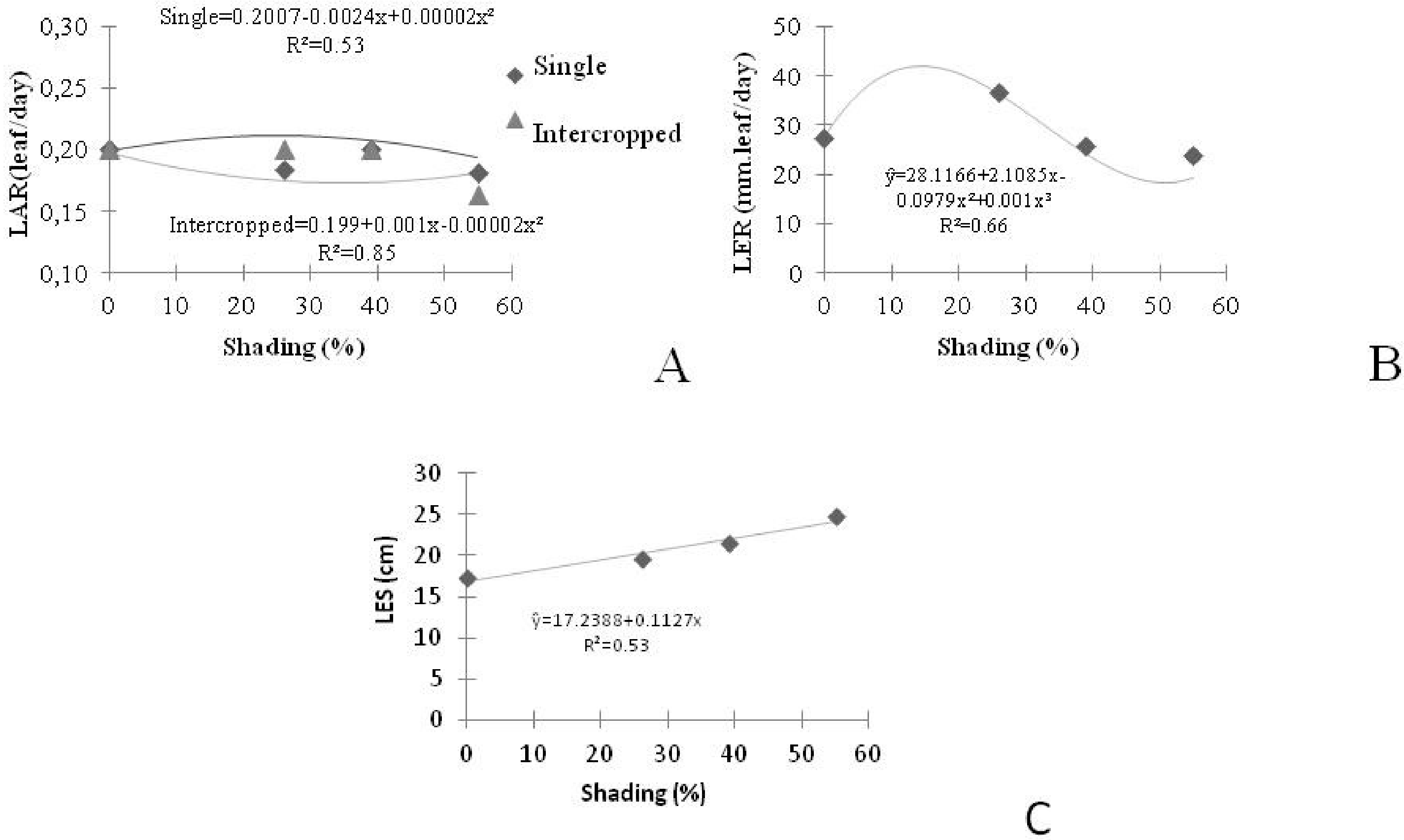

Figure 1. (A) Leaf appearance rate (LAR, leaves/tiller/day) in first cycle, (B), leaf elongation rate (LER, mm/leaves/day) in fourth cycle, and (C) length of expanded sheet in first cycle for buffel grass cultivated under shade levels (0, 26, 39, or 55%) in single or intercropping systems with butterfly pea.

There was a quadratic effect ($P < 0.05$) of shading and no effect ($P > 0.05$) of system in the third and fourth cycles (Figure 2). These results was based on the observation of a minimum of 2.81 and 2.25 tons of DM/ha at 51% and 41% shade for the third and fourth cycles, respectively. The analysis of the intercropping system showed 8.3, 12.1, 6.58, and 3.5% butterfly pea in the first, second, third, and fourth cycles, respectively.

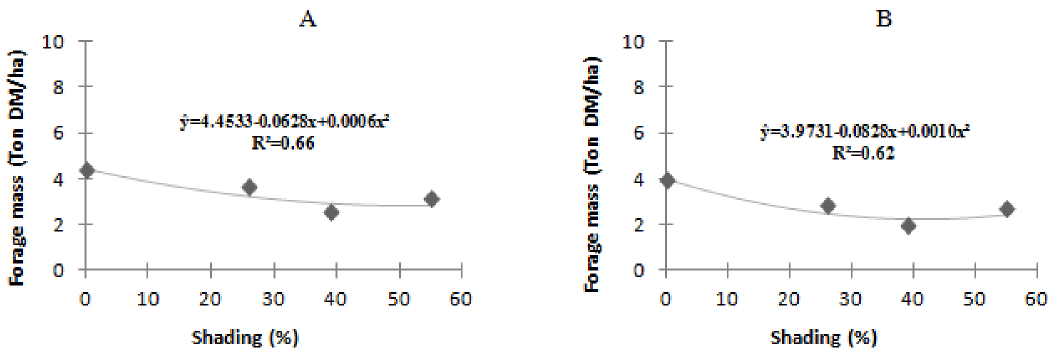

Figure 2. Forage mass (ton of DM/ha) in (A) third and (B) fourth cycle for buffel grass cultivated under 0, 26, 39, or 55% shade levels in single or intercropping systems with butterfly pea.

Compared to the percentage composition of the buffel grass (Figure 3) in the four cycles, that of the first cycle presented a system effect. There was a greater proportion of buffel grass ($P < 0.05$) in the single system than there was in the intercropping system and a decreased linear effect of shading. This observation indicates that higher shading levels led to a lower percentage of buffel grass in the botanical composition.

The second cycle showed no system effect with the largest percentage ($P < 0.05$) in the single system, and shading presented a quadratic deviation effect. This observation indicated that the variation in the botanical composition contributed to the maximum and minimum values of 99.8 and 78.9% for full sunlight conditions (0% shading) and 55% shading, respectively in the single system, and maximum and minimum values of 90.6 and 67.1% for 35% and 55% shading, respectively in the intercropping system.

In addition, a system effect was observed in the third and fourth cycle for the buffel percentage, indicating that even in the single system, the contribution of buffel grass to the total plant composition was not higher ($P < 0.05$) than that of the consortium system. However, it can be seen that shading showed a quadratic effect with a peak at 13% in both cycles, which was calculated as 99.3 and 99.7% respectively from the derivative of the equation (Figure 3C and D). Furthermore, the minimum point of the buffel grass percentage in all vegetative cycles was observed at the maximum level of shading (55%) evaluated in this study.

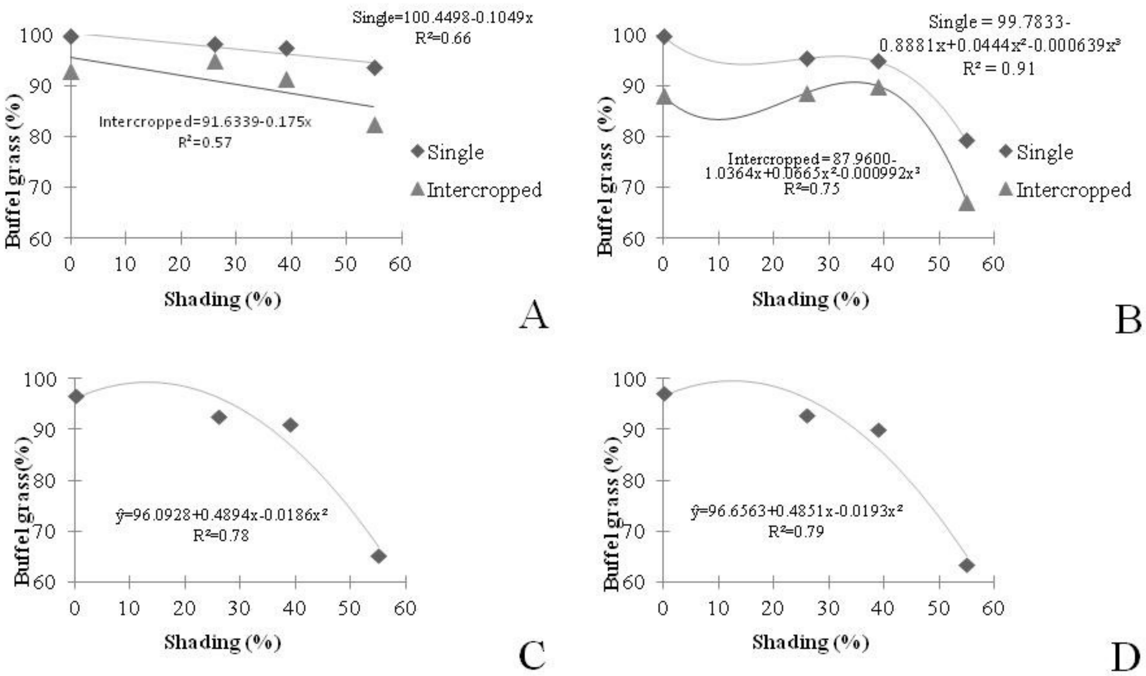

Figure 3. Percentage wet forage mass in (A) first, (B) second, (C) third, and (D) fourth cycles for buffel grass cultivated under 0, 26, 39, or 55% shade levels in single or intercropping systems with butterfly pea.

The butterfly pea survival during the crop establishment period and the four growing seasons, totaling 300 days, showed a quadratic effect ($P < 0.05$) of shading, which presented a minimum survival rate of 37.8% at the 21% shade level (Figure 4). Furthermore, we observed that the 55%

shade level was the most favorable for the Butterfly pea survival during the four cycles, with a median survival of 76.9% for the pits planted with at least one living plant.

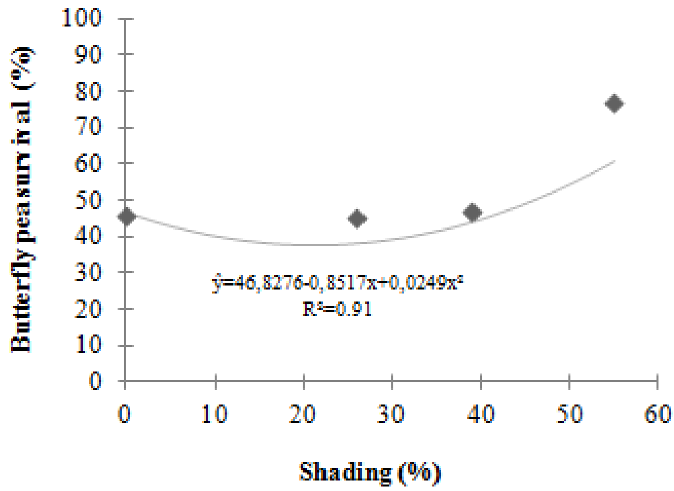

Figure 4. Survival (%) of butterfly pea intercropped with buffel grass cultivated under 0, 26, 39 or 55% shade levels during establishment period (120 days) and four growing seasons (45 days each) totaling 300 days.

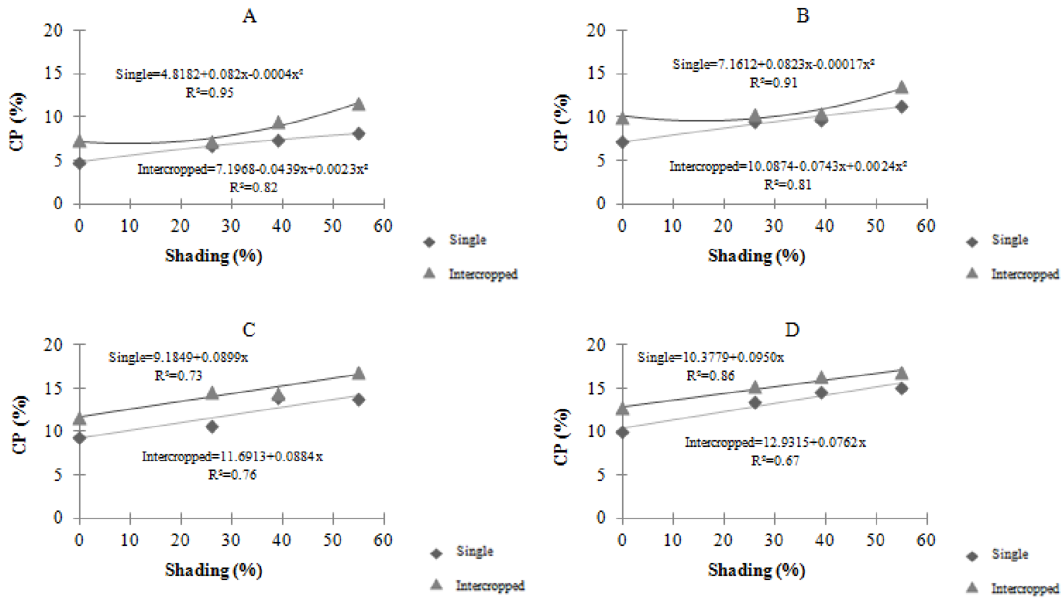

Figure 5. Crude protein (CP) content in (A) first, (B) second, (C) third, and (D) fourth cycles of buffel grass under 0, 26, 39, or 55% shade levels cultivated single or intercropped with Butterfly pea

The CP content showed a quadratic effect (P < 0.05) in the first and second cycles (Fig. 5 A and B) of shading and system. The estimated regression equations for both factors revealed that the intercropped system had the lowest level of protein (6.98%) found at the 10% level of shading in the first cycle while in the second cycle the lowest level (9.51%) was at the 16% shading level. In the third and fourth cycles (Fig. 5 C and D) a system effect was observed, indicating a higher CP percentage (P < 0.05) in the shaded grass. Moreover, there was a linear effect (P < 0.05) of shade, indicating a higher CP content with higher shading levels.

DISCUSSION

According to Luscher et al., (2014), the LAR is important because of its relationship with the leaf mass accumulation due to the increase in the number ofphytomeres, the basic unit of the tiller comprising the node, internode, leaves, and axillary buds. This rate has a strong effect on photosynthesis, nutrient uptake, and the duration of phyllochron, which corresponds to the time necessary for the appearance of leaves, with time expressed in thermal units (°C/day) (XUE et al., 2004; STRECK et al., 2005). This may explain the low LAR in the environment with a high level of shading that may cause the plants to respond differently to the light conditions, temperature, and soil moisture (WILHELM; MCMASTER, 1995). During the study period, a marked decrease in global radiation and temperature was observed in the fourth cycle, justifying the lower LAR recorded at higher levels of shading.

The LER (Figure 1) showed no system effect, and the lowest point of leaf elongation was found under high-level shading, in contrast to the results of Castro et al., (2009), which indicated that the development of the leaf blade is an adaptive response of grasses to lower light conditions. In addition, in shaded environments, photosynthetic organs develop to a greater extent to compensate for the low light level, resulting in a higher leaf blade length and width than observed at high light levels.

The length of the expanded leaf observed in this study increased as the brightness decreased, independent of the farming system. This effect is observed with various species since the development of the photosynthetic system is influenced by light. This may be related to the increase in intracellular chlorophyll in shaded environments observed in expanding leaves. Studies with *Brachiaria decumbens* plants grown in the shade showed significantly higher leaf length than those grown in an unshaded environment (CASTRO et al., 2009).

The length of the leaf is determined by the number of cell divisions perpendicular to the midrib of each leaf and stretching of the cells. In environments where the leaves are shaded, the epidermis shows a greater number of cells in the longitudinal direction and greater length in than unshaded leaves grown exposed to full brightness (MITCHELL; SOPER, 1958).

The reduction of the LER in this study confirms the forage mass data of the last two cycles, which was lower at higher levels of shading. This may be explained by the high adaptability of buffel grass to high brightness levels, which decreases the production of forage mass in shaded environments. This phenomenon can be confirmed by the observation that the LER was lower at low light levels than it was at high levels. According to Carvalho et al. (1997), the decrease production of forage in shady environments is related to the low luminous radiation of shaded environment, which becomes lower than the point of luminal characteristic compensation of each species.

The data corroborate those of Soares et al. (2009) who evaluated the effect of light on 11 tropical cultivars and noted that in environments with high levels of shading, *Pinus taeda* with a 10-year spacing (15 m × 3 m and 9 m × 3 m) showed decreased DM production in all tested forages. Furthermore, that study reported a low production in denser crops caused by the low quality and quantity of radiation that reaches the canopy (SOARES et al., 2009). Martuscello et al. (2009), working with *B. decumbens* and *Brachiaria brizantha* 'Xaraés' and Marandu grass found a lower DM production ($P < 0.05$) in cultivars of *B. decumbens* and Xaraés grass exposed to 70% shading than in cultivars exposed to full sunlight and 50% shade, which had no effect on Marandu grass. Soares et al. (2009) reported that the radiation regimen was the main variable determining plant growth and its effects are associated with photosynthesis and other physiological processes such as perspiration and absorption of nutrients, which explains the decreased DM yield of the shaded plants.

The proportion of buffel grass showed a similar percentage forage mass in all growing seasons and the lowest percentage was found at the maximum tested shading level. This observation may be related to the fact that the buffel grass has a type C4 metabolism, which makes it a more efficient grass in energy production. Thus, this plant shows a maximum level of production in high-radiation environments and at high temperatures (RAVEN et al., 2001).

The system effect shown in the early cycles ($P < 0.05$) the higher percentage of buffel grass in the single system may be associated with the butterfly pea establishment period, since this plant butterfly pea likely became a more inserted component of the ecosystem and, therefore, competed for the nutrients and water available in the soil.

This effect was also observed in the second cycle; however, there was a more drastic decrease in the contribution of the buffel grass to the weight of the forage composition, which may be related to the positive influence of shading, irrigation, and the butterfly pea (in the case of intercropped system). This is because the absence of these factors could promote the overlapping of the buffel grass with ecosystem competitors because of its adaptability to stress conditions.

Regarding the last two cycles, no system effect was of the buffel grass percentage of the botanical composition was observed, which may be attributable to the development of invasive plants. According to Soares et al. (2009), plants grown under shaded conditions receive less radiation and temperature and, therefore, the accumulated degree days of the plant decrease affecting their phenology and morphogenesis. This is particularly applicable to forage species with a phenology that is heavily dependent on the sum thermal (such as C_4 plants). In this case, the plants tend to be in a vegetative stage for a longer period and bloom later or unevenly. This condition can be considered harmful when the goal is the production of seeds; however, it may be beneficial for forage mass production with a higher digestibility induced by shading periods that are longer than those of exposure to full sunlight.

Studied on butterfly pea have shown that it is highly adaptable to stress resulting from cutting with a low range nodular mass due to its high capacity for regrowth, even after long periods of drought. These characteristics are related to the increased availability of reserve carbohydrates in its roots, as well as its robust root development and rapid recovery of nitrogenase. Nitrogenase is the main enzyme responsible for converting N_2 into ammonia (NH_3), which constitutes the main stage of atmospheric N fixation, and results in a high yield of N in plants (MENEZES et al., 2016). This legume also exhibits a high resistance against weed competition (CONWAY; COLLINS, 2005), which may also lead to a satisfactory survival level.

The protein levels were favored by shading, and showed increases in the single and intercropping systems of the first, second, third, and fourth cycles of 68.96% and 63.06%, 56.01% and 31.42%, 53.92% and 42.43%, and 50.29% and 32.4%, respectively compared to full sunlight and 55% shading.

Several studies have shown that the protein content increases more in plants exposed to shading than in those exposed to full sunlight (MOREIRA et al., 2009; SOARES et al., 2009; PACIULLO et al., 2007). In consortium mesquite and Buffel grass, Ribaski and Menezes (2002) observed superior microclimate conditions that provided higher levels of nitrogen, phosphorus, and potassium in the soil. A greater percentage of CP in the biomass of the intercropping system was also observed in all cycles (31.94, 17.78, 20.70, and 15.05% in the first, second, third, and fourth (largest) cycles, respectively, compared to the single system). This observation is likely related to the fact that the system, and possibly the presence of the butterfly pea, fixed nitrogen into the soil. Moreover, this is a plant with high levels of crude protein in the composition ranging from 14 to 20% (KALAMANI; MICHAEL GOMEZ, 2001).

All the cycles showed a higher percentage ($P < 0.05$) of CP at the highest level of shading tested, which is related to the fact that the butterfly pea has a major contribution to the botanical composition. Furthermore, the presence of butterfly pea enhances the plant survival (Fig. 4) at that level of shading, and lead to a higher proportion of CP content in the herbage mass.

Ribaski and Menezes (2002) also achieved a higher CP content in buffel grass when used in an intercropping system with mesquite, with a 27.1% increase in plants shaded by trees over those exposed to full sunlight. In this case, the largest increase was found to be related to nutrient cycling and improvements in soil fertility induced by natural shading.

CONCLUSION

Intermediate shading levels (25 and 15%) showed a higher LAR in the intercropping system and higher LER independent of the system. On the other hand, while high levels of shading (55%) increased the length of the sheet they decreased the mass of forage production and survival of legumes. In addition, 55% shading increased the CP by 49.8% over that observed under full sunlight, and the intercropping system showed a 21.3% CP increase in herbage mass compared to that of the single system.

RESUMO: A produção de forragem na região semiárida brasileira pode ser intensificada com a irrigação e o sombreamento, maximizando o uso da água. Com o objetivo de avaliar as características produtivas e morfológicas do Capim Buffel (*Cenchrus ciliaris*) consorciado com Cunhã (*Clitoria ternatea*), sob sombreamento, foi utilizada uma área irrigada com sistema de sombreamento artificial (26, 39, 55% ou pleno sol). Foi implantada Cunhã em metade das parcelas em delineamento de blocos casualizados em esquemas de parcelas subdivididas com três repetições. Após 120 dias foi realizado o corte de uniformização e a cada 45 dias foram realizados os cortes por quatro ciclos consecutivos, sendo realizadas análises morfológicas e determinada a massa de forragem no 1.º e 4º ciclos. Houve efeito quadrático para sombra na taxa de aparecimento foliar no 1º ciclo, efeito de desvio da quadrática para sombreamento na taxa de alongamento foliar no 2º ciclo e efeito linear crescente para sombreamento no comprimento da folha no 1º ciclo. A massa de forragem apresentou efeito quadrático para sombreamento no 3º ciclo e efeito linear decrescente no 4º ciclo. O maior percentual de Capim Buffel foi encontrado no sistema solteiro no 1º e 2º ciclos. Foi observado efeito linear decrescente para sombra no 1º ciclo e de desvio da quadrática para sombra no 2º ciclo. Já no 3º e 4º ciclos houve efeito quadrático para sombra. A sobrevivência da Cunhã apresentou efeito quadrático com taxa mínima em 21% de sombreamento. O teor de proteína bruta apresentou efeito de sistema nos quatro ciclos, sendo encontrados maiores teores de proteína bruta no sistema consorciado no 1º e 2º ciclos. Houve ainda efeito quadrático para sombra no 3º ciclo e efeito linear crescente no 4º ciclo. Conclui-se que o sombreamento promove aumento nas taxas de aparecimento e alongamento foliar em níveis intermediários. Além disso, alto nível o sombreamento promove aumento do comprimento foliar, eleva a sobrevivência da Cunhã e diminui a produção de massa de forragem.

PALAVRAS-CHAVE: *Cenchrus ciliaris. Clitoria ternatea.* Leguminosa tropical. Luminosidade. Taxa de aparecimento foliar

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