Algarroba Effects on Behavior and Dairy Production of Grazing Cows II. Rainy Season

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ABSTRACT

The influence of arborization with algarroba (*Prosopis juliflora* SW) on behavior and dairy production of grazing cows was evaluated. The trial was made in the rainy season, and six enclosures per arborization treatment were used (low arborization, with 1-7 trees/ha; mid-arborization, with 12-16 trees/ha; and high arborization, with 20-27 trees/ha). Activities were observed every ten minutes during the mornings and afternoons. The number of animals, and each animal´s activity time was recorded. The dairy production data were collected and compared through a randomized design with six repetitions (ANOVA). Significant differences were observed ($P < 0.05$) to more arborization in grazing (155-173 min), and the monthly values observed were similar. In fields with low arborization, the cows ate less grass, whereas fields with mid and high arborization, the cows grazed longer, and produced more milk (11.2 and 12.59 kg/c/day).

Keywords:*natural shade, rainy season, bovines, forages, milk*

INTRODUCTION

Forest-grazing systems used as forage banks, and the trees in the grazing fields, are adaptation tools of grazing systems to climate change. Tree-based grazing systems provide foliage and fruits that can complement nutrition from pastures, and can have a positive effect on edible dry matter availability and quality (García, 2003; Lamela *et al.*,Ulf, 2010). Trujillo (2009) notes that tree shade reduces the caloric burden absorbed by animals, as the soil temperature is 2-3º C lower than in open spaces, due to heat disipation by evaporation.

Pérez (2010) noted that in the presence of high temperatures, dairy cows only consume 60 % of the total feed consumed when there is no high-temperature stress. As a result consumption decline, milk production and composition are affected. Dairy yields decrease from 50 to 75 % at temperatures above 26.5° C (Holstein); and higher than 29.5° C (Jersey and Swiss Brown). The critical temperature for dairy production decline ranged between 21 and 26.5° C for Holstein and Jersey. In addition to reduction of production, milk composition varied too.

This practice also had a very adverse effect on tropical ecosystem soils in Cuba, which led to other negative phenomena, affecting also pratense coverage. Fortunately, this process has been somehow reverted in several locations of Tropical Latin America (Pérez Infante; 2010; Guevara *et al*., 2015). Flemenbaum (2008) said that if environmental tropical temperatures are above 26º C, failure is produced in the heat-regulated systems, causing a decrease in feed consumption, with ensuing milk yield decreases and changes in composition.

The purpose of this paper was to evaluate the influence of arborization on the behavior and dairy production of grazing cows in cattle rasing systems in Manabí, Ecuador, over the rainy season.

MATERIALS AND METHODS

Location of the study

This research was done in a teaching, research and association unit of Pastures and Forages, and

in Bovine Herds, respectively, at Manuel Félix López Higher Polytechnical School of Agriculture, in Manabi, 15 m above sea level, at El Limón, Calceta Parrish, Bolívar, Province of Manabi (00°49'23" south latitude, 80° 11' 01" west longitude. The soils in the location are brown, without carbonates (Hernández *et al*., 2006), with medium fertility, and a nearby underground water supply, and mean acid content, with interchangeable organic matter and phosphorous.

The climatic conditions of the location show 881.4 mm of annual rainfall, mean temperature of 25° C, the relative humidity vectors are 87 % annually, and sun radiation is 1 325.4 h/year, as reported by the ESPAM MFL weather station in their data collection report on 2013 and first half of 2014.

Length of the study

The research lasted 4 months (December 2013-March 2014), marking the beginning of the rainy season with elevated heat burden. Six enclosures were used in the arborization treatment (low arborization, with 1-7 trees/ha; mid-arborization, with 12-16 trees/ha; and high arborization, with 20-27 trees/ha).

The tree criterion used was algarroba plants (Prosopis juliflora, SW), *above 2* m high, considering their contribution with leaves to the soil, used as tree forage in that stage, which the animal consumes while grazing. It was based on criteria by Febles and Ruiz (2001), on arborescent and arboreal ecotype evaluations while grazing, to measure the negative effects caused by the animals, where the species grazed.

The enclosures were 0.20 - 0.25 ha, and were generally covered with African Bermuda grass (*Cynodon nlemfuensis),* guinea grass (*Panicum máximum,* Jacq*),* ranging between 63-86 %, and native legumes of Centrosema, Desmodium, Macroptilium, Rynchosia and Desmanthus genuses; the latter to a lesser extent. Rational grazing was performed. Pasture resting times were 21-28 days in the dry stage.

Measurements of grazing animal behavior

These data were collected through observation of animals grazing, standing, lying and ruminating, in the shade, in the sun, defecating-urinating, walking, and drinking water. The test was made through the Petit (1972) method, in which the time used by the animal in each activity (T) equaled the multiplication of the number of animals in the activity, in each measurement, by the measurement interval (min). The result was divided by the total number of animals in the test, and the values (min) were added to make the total time of the activity. Observations were made every ten minutes in the morningns and afternoons. No readings were made at night, when the animals grazed until the 5:00 am milking. During that period, the animals were given 0.46 kg of supplement/cow, starting from the fifth kilogram of milk produced.

The milk production data from enclosures with the three arborization levels were collected during that period. A random design with 6 repetitions was used for comparison through simple ANOVA and the Tukey test for significance. The number of cows used varied from 25 to 26, depending on the amount of grazing animals at the moment, averaging 3-4 calvings each, and instant lactation between 65 and 109 days. The animals belonged to the research center at the ESPAM-MFL Bovine Farm (hybrid Brwon-Swiss-Zebu, and Holstein-Zebu and Giroland). A complete random designed was used, and SSPS 11.5 was used for statistical analysis.

RESULTS AND DISCUSSION

Grazing cows indicator

The importance of bovine behavior analyses in tropical grasslands lies on the search of new strategies for handling and feeding that ensures heat stress reduction; such as forest-grazing models to provide microclimate features, strategic natural shading spots in the fields, and the use of genotypes that adapt well to the location´s climatic conditions (Polanía and Mora, 2013; Roca, 2011; Guevara *et al*., 2015).

Uribe *et al*. (2011) and Ibrahim (2011) mentioned advantages of arborization with semi open toplegumes, like Gliricidia, Prosopis, Leucaena and Albizia for bovines, which increase grazing time and milk production. The trees in the fields are located on strips or rows, and they offer reduction of direct radiation effects, better than grasslands without trees,to animals stricken by heat, and contributes to increased grazing activities, and the milk producing response from grazing cows in fields with trees on them, or arborescent systems planted on stripes or roads, which help reduce radiations received in fields without trees.

Differential grazing time analysis (Table 1) in the morning showed significant differences ($P < 0.05$) among low, mid and high arborization for monthly analysis of both morning and afternoon. Grazing time was greater for the high arborization treatment, which might mean lower effect of heat burden (more disipation), due to the presence of trees, and improved animal comfort near the tree tops. A great tree concentration in the field probably had a positive influence on grazing (Ramírez, 2012; Polanía and Mora, 2013; Guevara *et al*., 2015).

Ruminating had a similar behavior in the morning session within the different arborization degrees, except in December, a transition month. Hence, it could have caused more ruminating under broader arborization; and in the afternoon, with more heat burden for the first two months ($P < 0.05$), when animal activity is increased. No differences were observed in February and March. It was possible because of the compensation effect for these two months between ruminating and grazing, very high in the morning.

Ruminating cows indicator

A positive effect of shading was observed for this indicator, that follows the circadian rate as post locomotion and direct grazing ativities. It goes along with the animal´s metabolic heat and gas disipation over the periods of highest radiation and temperatures during the day in the tropics. This process can be affected in low arborization, which can be paliated with the presence of trees with mid shading in the fields (Guerrero, 2009; Ramírez, 2012; Serrano, 2013).

According to Rincón and Herrera (2012), for Carora cows in Venezuela, and reports by García López (2003), and Pérez Infant (2010), for crossbred cows (Holstein x Zebu) in tropical areas, they indicate the streess levels (increasing or decreasing). It coincides with reports by Pérez Infante (2010), on examining dairy yield records in cows that grazed in more arborized enclosures, with better ruminating time values.

Walking cows indicator

Walking (Table 2) implies energy consumption and better use of inner heat; it also means grazing, because the cow must move around to eat the grass, choosing it, in every working session. In the morning sessions of March improved walking activity toward highly arborized enclosures was observed ($P < 0.05$).

It coincides with results reported by Guevara *et al*., (1994) on rational grazing cow behavior tests in Cuba (June, July, December and March), without behavioral differences. Pérez Infante (2010) also reported similar results on the moving behavior by the animal while exploring the grassland (vertically and horizontally), and moving to search for water. Less walking activity was observed in the afternoon, due to less heat burden and a reduction in grass consumption, to favor ruminating.

Cows consuming water indicator

Water consumption by grazing animals (Table 2) is not only linked to water loss caused by physical activity (walking and grazing), and heat dissipation and water loss; it is also related to a overall feed consumption due to rumen physical distention condition, feed degradation, and the kind of feed. Often, the need of water per milk liter, or muscle tissue increase, and per DM kg of consumed grass. No significant differences were observed for this indicator in the afternoon.

Milk production

On days when the cows underwent higher heat stress in fields with low arborization, milk production was decreased(Pérez *et al*.,2010; Trujillo, 2009; Polanía and Mora, 2013; Serrano, 2013).

Salvador (2008) notes that in high temperatures, bovines tend to reduce heat production through voluntary anorexia, with ensuing feed consumption. Dairy yields decline from 50 to 75 %, at temperatures above 26.5º C (Holstein), and higher than 29.5º C (Jersey and Brown Swiss).

These effects are responsible for decreased grazing activity and related dairy yields. Likewise, Apart from milk production, a change in composition and decline in fats was observed (Salvador, 2008; Ramírez, 2012).

Pulido (2011) mentions that the individual response of the animal to weather variations, aside from the heat burden, depend on several factors, like animal size, breed, color, skin complexion, individual heat tolerance, nutritional status, and the genetic potential for production. Pérez *et al*. (2010) in Chiapas,and Palma (2006) dry Mexican tropic; Lamela *et al*.(2010) and Ruiz *et al*. (2011) in Cuba,and Kilgour *et al*.(2012) present similar data. The greater the arborization of the fields, the higher production, only in fileds with young graminaceae.

CONCLUSIONS

The results claim that fields with low arborization, cows reduced grass consumption, standing in the sun, motionless, gasping, or in the shade. However, on the days they weremoved to fields with mid and high arborization, cows spent most of their time eating grass, and ruminating. Hence, milk production was higher.

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Tabla 1. Effect of arborization (trees/ha) with algarroba (*Prosopis juliflora*) on time distribution of cows grazing and ruminating (min) cows between December 2013 and March 2014

	Arborization	Morning				Afternoon			
		Dec.	Jan.	Feb.	Mar.	Dec.	Jan.	Feb.	Mar.
Grazing cows	Low	129[a]	136[a]	132[a]	134[a]	112[a]	66[a]	56[a]	82[a]
	Mid	145[b]	141[a]	155[b]	142[b]	113[a]	71[a]	58[a]	85[a]
	High	159[b]	163[b]	173[c]	155[c]	117[b]	95[b]	102[b]	118[b]
	E.S	4.31	2.09	5.51	3.17	5.22	6.19	3.06	2.18
	Sig.	*	*	*	*	*	*	*	*
Ruminating cows	Low	12[a]	11	13	12	8[a]	8[a]	10	11
	Mid	12[a]	13	14	13	10[a]	10[a]	12	9
	High	18[b]	13	14	14	15[b]	12[b]	12	10
	E.S	1.25	1.59	1.16	2.16	1.16	0.79	0.51	0.46
	Sig.	*	NS	NS	NS	*	*	NS	NS

a, b, c: different letters mean differences from P < 0.05

Tabla 2.ºEffect of arborization (trees/ha) with algarroba (*Prosopis juliflora, SW*) on time distribution of cows walking and drinking water (min) between December 2013 and March 2014

	Arborization	Morning				Afternoon			
		Dec.	Jan.	Feb.	Mar.	Dec.	Jan.	Feb.	Mar.
Walking cows	Low	5	9	6	6[a]	10	5	5	5
	Mid	6	10	7	8 [b]	10	4	5	5
	High	6	11	7	14[c]	11	5	5	6
	E.S	1.14	1.09	1.31	0.72	0.12	0.29	0.16	0.53
	Sig.	NS	NS	NS	*	NS	NS	NS	NS
Cows drinking water	Low	5	7	6	4	2	4	3	4
	Mid	5	7	6	5	2	5	4	3
	High	6	6	6	5	2	5	4	6
	E.S	0.06	0.11	0.28	0.09	0.19	0.51	0.34	0.16
	Sig.	NS	NS	NS	NS	NS	NS	NS	*

a, b, c: different letters mean differences from P < 0.05

Table 3. Effect of arborization (trees/ha) with algarroba (*Prosopis juliflora*) on milk production (kg/cow/day) cows between December 2013 and March 2014

Arborization	Dec	Jan	Feb	Mar
Low arborization	8.76[a]	7.05[a]	8.23[a]	9.16[a]
Mid arborization	10.08[b]	9.11[b]	10.96[b]	9.85[a]
High arborization	12.39[C]	12.50[c]	11.02[b]	12.44[b]
E.S	1.29	1.13	0.83	0.71
Sig	*	*	*	*

a,b,c:different letters mean differences from $P < 0.05$