Effect of Algarroba on Grazing Cow Behavior and Milk Production. I. Dry Season

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ABSTRACT

The effect of algarroba (*Prosopis juliflora* SW) arborization on grazing cow behavior and milk production was assessed. The trial was made in the rainy season, and six enclosures were used per arborization treatment (low arborization, 1-7 trees/ha; mid arborization, 12-16 trees/ha; high arborization, 20-27 trees/ha). Rational grazing was performed. The grass rested for 21-28 days, and sprinklers were used for irrigation. The animals' activity time and the number of animals were registered. Milk production values were compared using ANOVA, following a randomized design with six replicas. No significant differences were observed in the morning grazing (118-203 min), but there were significant differences ($P < 0.05$) in the afternoon, in favor of more arborization (103-125 min), whereas in lands with mid and high arborization, cows ruminated longer, with higher water consumption and milk production, and values between11.85-13.76 kg/v/day.

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

INTRODUCTION

Besides natural shade and advantages to animal wellbeing, 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.*, 2010).

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 of feed consumption decline, milk production and composition are affected. Dairy yields decrease from 50 to 70 % at temperatures above 26.5° C (Holstein); and higher than 29.5° C (Jersey and Swiss Brown). The critical temperature for dairy production decline ranges between 21 and 26.5° C for Holstein and Jersey.

The same problems are observed in Colombian locations (Serrano, 2013; Polanía and Mora, 2013), where arborization has been indicated as a way to fight back these effects on the animals, and ensure grazing mobility properly.

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

MATERIALS AND METHODS

Location of the study

This research was made in a teaching, research and association unit of Pastures and Forages, and in Bovine Herds, respectively, at Manuel Félix López Higher Polytechnic 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 contents of interchangeable organic matter and phosphorous.

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

Length of the study

The research took four months (August-November, 2013), during the dry season in the area near the coast. 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 had 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 active legumes of *Centrosema*, *Desmodium*, *Macroptilium*, *Rynchosia* and *Desmanthus* genuses. Rational grazing was performed. Pasture resting times were 21-28 days in this stage. Scheduled sprinkler irrigation was used every 15 days, according to field use and water supply needs.

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) equals 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 summed to make the total time of the activity. Activities were observed every ten minutes, in the mornings and afternoons. No measurements 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 was used for comparison through simple ANOVA and the Tukey test. The cows used in this stage accounted for 25-28 dairy cows in production, with a lactation variation between 61-89 days at the beginning, and a mean of 3.4 calving/cow. The animals belong to the teaching-research-vocational unitat the Bovine Herd (ESPAM-MFL). The animals were Brown Swiss-Zebu hybrids, and Holstein-Zebu and Girolando. No separate measurements were made due to the complexity of the test and difficulties with the testers. A completely random design was used; SPSS 11.5 was used for statistics.

RESULTS AND DISCUSSION

Grazing cows indicator

At the onset of cattle raising in Latin America, the same technologies used in the temperate European climate, whose principle was the elimination of trees in the grazing areas, were applied. This practice had a negative effect on the soils of tropical ecosystems, and other ensuing adverse processes occurred as a result. Accordingly, Roca (2011) suggests that in order to avoid such effects forest-grazing systems should be implemented, to provide shade and forages from the leaves and fruits.

Uribe *et al.* (2011) and Ibrahim (2011) referred to advantages to animals stricken by heat, increasing in 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. The results show that in the fields with a low number of trees during the warmest days, the cows halted pasture consumption; but in the fields with mid and high arborization, the cows spent most of the time consuming grass and ruminating. It coincides with other papers on tropical areas (Pérez, 2010), that report efficient cattle raising; as well as results by Serrano (2013) and Kilgour *et al.*(2012) for grazing trials in Latin America and South east Asia, respectively.

These results coincide with research done by Martínez (2006), who noted that the goal of reducing feed consumption is linked to lowering the high temperatures produced by fermentation and physical activity (walk to troughs, chew, and ruminate).

From individual analysis by grazing time (Fig. 1) in the morning, no significant differences were found in the treatments for low, mid and high arborization in the monthly analysis. The exception was November, with more grazing activity in the high arborization treatment, and significant differences (P < 0.05), in comparison with the other treatments.

Consequently, the effects of a denser shade and its contribution to reducing the higher temperatures that take place in this month had some responsibility. It could have somehow affected grazing, and reduced it in comparison with the August-October quarter, as observed in the values/month. Hence, in November, the treatment reduced the heat load in the nearby environment, and differences were defined in favor of more arborization.

This effect has been reported for arborized systems by Febles and Ruiz (2001) in dairy farms with forest-grazing systems, in Cuba; and by Petit (1972) for other tropical regions. As to afternoon grazing time in every month, the high arborization treatment showed the best significant grazing behavior (P < 0.05). It is related to the heat load in these areas, due to natural shading, in spite of temperature increases and radiation during the day. Petit (1972)said that under a tree shade, temperature is 2-3° C lower than the air temperature, thus reducing stress significantly in the animals.

It is noteworthy that every cattle breed and hybrid responds differently to heat. Indian breeds and hybrids seem better adapted than the European ones. The former increase grazing and have higher animal response (Pérez *et al*., 2008; Roca, 2011; Ulf, 2012).

Ruminating cows indicator

In the morning, the ruminating cows indicator (Fig. 2) had a better and more significant behavior (P < 0.05) in the mid and high arborization, compared with the low arborization treatment. As a result, the data gathered showed that shading had a positive effect in this indicator, which follows a circadian rate, after moving and direct grazing.

The circadian rate goes along with dissipation of heat and gases from the animal´s metabolism. In the tropical areas, with higher radiation and temperatures during the day, this process could be affected in locations with low arborization and poor natural shade and in the absence of cloudy and rainy days; it opposes the effects observed in the presence of trees with mid shading in the fields (Guerrero, 2009; Polanía, and Mora, 2013).

The above is an expression of better pasture quality and environment, in terms of less heat load, which according to Rincón and Herrera (2012) for Carora cows in Venezuela, and García Lópes (2003) and Pérez (2010), for Holstein x Zebu cows in tropical areas, are reflection of stress, whether it increases or declines.

In the afternoon, on the other hand, there was more ruminating in the areas with low arborization, according to the circadian rate (P < 0.05), than in the mid and high arborization, with a prevalence of grazing.

These data coincide with reports by Pérez (2010), and may have a favorable effect on milk yields for the next day of grazing, after examination of dairy yield records, when grazing took place in more arborized enclosures, with more time for ruminating.

Walking cows indicator

Walking (Fig. 3) implies energy consumption and better use of inner heat; it also means grazing, because the cow must move around to eat the grass, and choosing it in every direction. It ends only when the animal satisfies its need for feed in every working session. In the morning sessions of November, the high arborized enclosures had more walking (P < 0.05), though for a short time; grazing prevailed over all the other activities, though many times it implied moving.

In the afternoon there was less walking because of the heat and a reduction in pasture consumption; the priority was given to other activities like ruminating. Regardless of highly arborized enclosures, walking was higher (P < 0.05) only in October and November, than in the other treatments, due to a decline in the heat load, thanks to a larger area with natural shade, corroborating the positive effect of trees on the fields.

Cows consuming water indicator

Water consumption by grazing animals (Fig. 4) is not only linked to water usage from physical activity (walking and grazing), as well as heat dissipation in the natural shade, and water loss. It is also related to total feed consumption produced by a physical distention of the rumen, the animal´s heat-regulating process, which differs from results by Polanía and Mora (2013) in a study of arborized cattle systems in Colombia; and by Serrano (2013) for the same ecosystem.

In general terms, for the previous, the concepts of water need per milk liter produced, or increase of muscle tissue, and DM kg of consumed pasture, are set apart. As a result, in the morning, the number of animals consuming water was very low, with no differences among the arborization treatments. Tachid (2013) notes that bovines can withstand cold better than warm temperatures; therefore it is necessary to offer shade, and clear and fresh water *ad libitum*.

Although no significant differences were observed for this indicator in the August-October period, the number of animals that used the trough did increase in November ($P < 0.05$), which was higher in the mid and high arborization treatments. This behavior explains the convenience of managing areas with animal access to grazing and water supplies, that contribute with proper physiological activities following the circadian rhythm of grazing cows.

Resting cows indicator

There were almost no animals resting in the morning, since grazing was made to a much larger extent; no differences were observed among the treatments. In the afternoon sessions, the shade indicators were high for all the treatments (Fig. 5), due to an increase in temperature, which reduced consumption. Naturally, with low arborization, the choices were fewer, and the values were lower ($P < 0.05$).

Tachid (2013) said that shade is important for grazing cows, especially in subtropical and tropical regions, and temperate countries like Chile or New Zealand. At certain times of the year (summer), temperatures can increase over 30° C, and the cows must access shaded areas. Schutz (2008) on preferences, determined that cows standing for long periods (12 h) were given the choice to lie down in the sun or stand in the shade, and they chose the latter, in temperatures higher than 25° C .

Milk production

The milk production values (Fig. 6) observed during the investigation time confirmed the results from several researchers who reported that on the days the cows underwent the highest heat stress on fields, with low arborization load, milk production declined (Pérez *et al.*, 2008; Trujillo, 2009). The data showed that a decrease in consumption and a reduced blood flow to the mammary gland can be observed, leading to less milk production (Pulido, 2011; Ramírez, 2012; Kilgour *et al.*, 2012).

Salvador (2013) refers that in elevated heat environments, bovines tend to reduce heat production through involuntary anorexia, thus leading to limited feed consumption. Accordingly, dairy yields declined from 50 to 75% at temperatures above 26.5° C in Holstein; and above 29.5° C in Jersey and Swiss Brown. Negative effects were also observed in Brahman at 32° C, leading to decreased milk production, and changes in fat composition.

Moreover, Guevara et al., (1994) in a study of crossbred cow behavior (Holstein X Zebu) in the mid-eastern province of Camaguey, Cuba; and Lamela et al., (2010), and Ruiz et al., (2011) in western Cuba, and Palma (2006), in the dry Pacific Mexican tropic, found positive responses concerning arborized systems as to grazing increase and highermilk production in graminaceae-only pastures without arborization.

CONCLUSIONS

In the dry season, with lower heat loads, high arborization helped improve grazing behavior in the afternoon sessions, and favored ruminating, moving, and water consumption, with a determining and significant effect on greater milk production, in comparison with the rest of the treatments.

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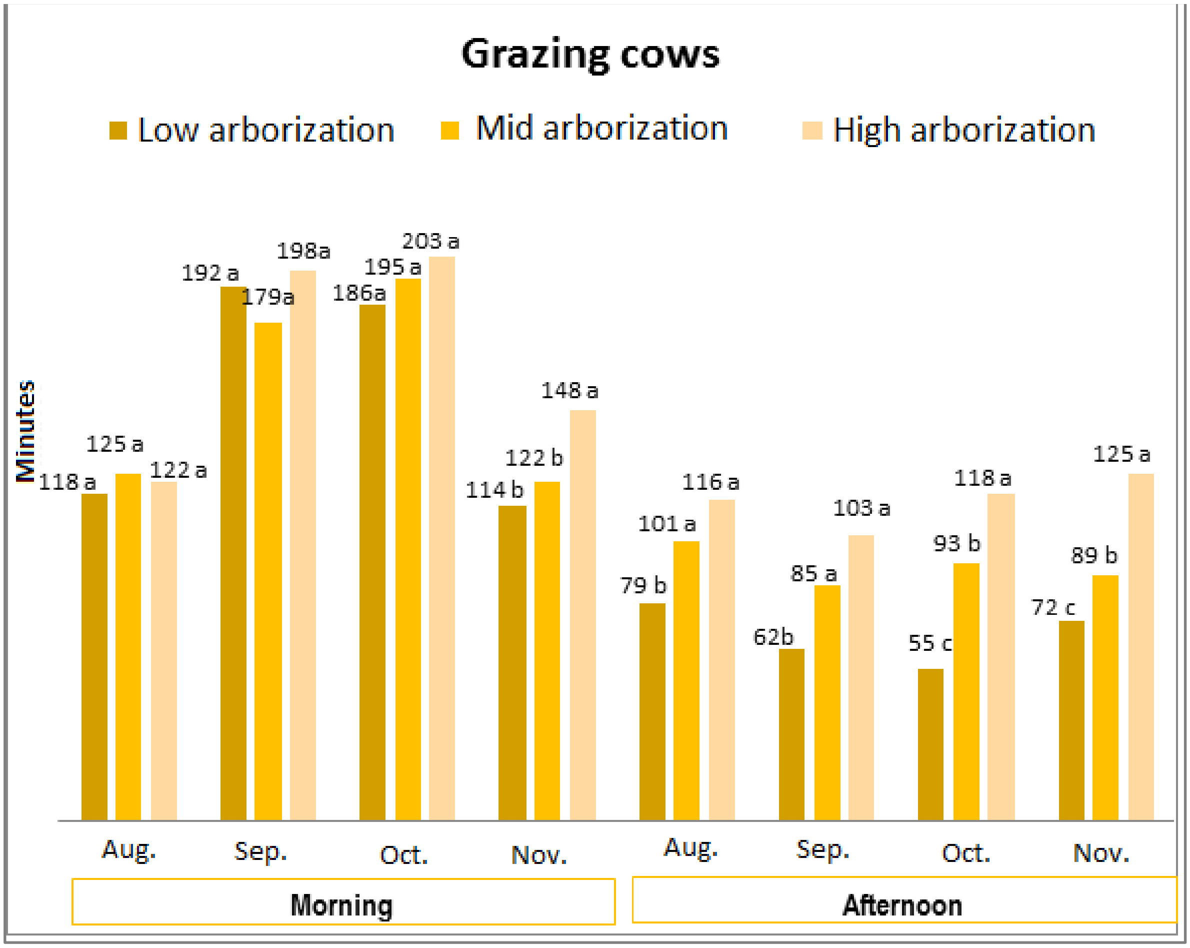

Fig. 1. Arborization effect (trees/ha) with algarroba (*Prosopis juliflora)* on grazing cow time (min) distribution in the August-November (2013) period

a, b and c: different letters among treatments differ for P < 0.05 (Duncan, 1995)

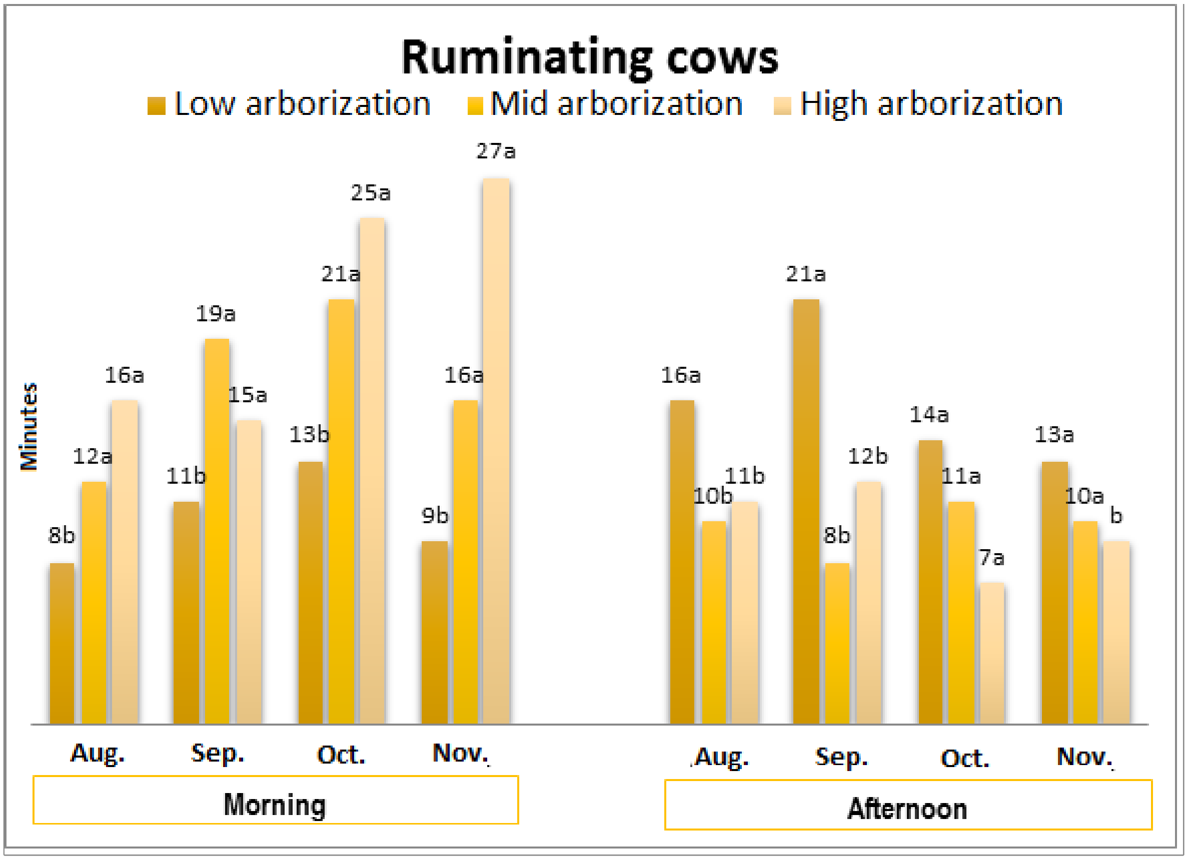

Fig. 2 Arborization effect (trees/ha) with algarroba arborization effect (trees/ha) with algarroba (Prosopis juliflora) ***on ruminating cow time (min) distribution in the August-November (2013) period***

a and b different letters among treatments differ for P < 0.05

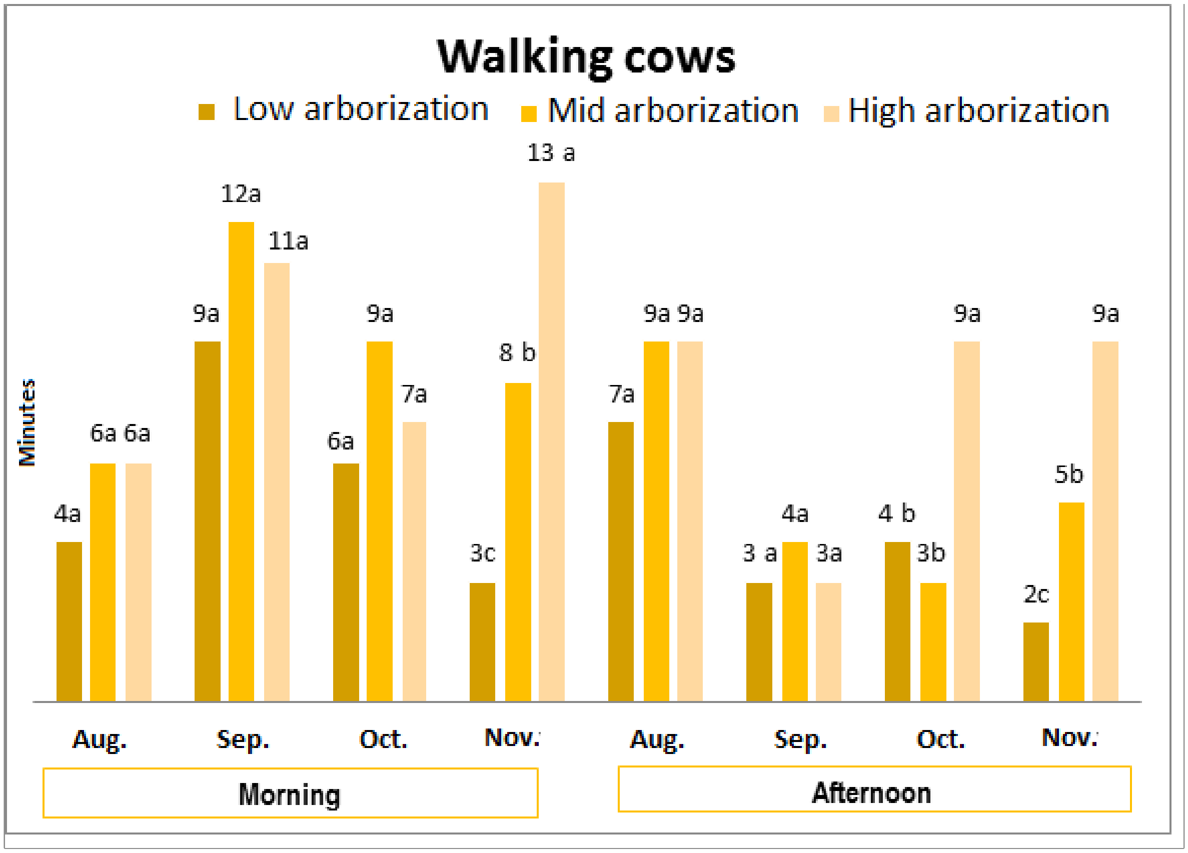

Fig. 3 Arborization effect (trees/ha) with algarroba arborization effect (trees/ha) with algarroba (Prosopis juliflora) on walking cow time (min) distribution in the August-November (2013) period
a, b and c: different letters among treatments differ for P < 0.05 (Duncan, 1995)

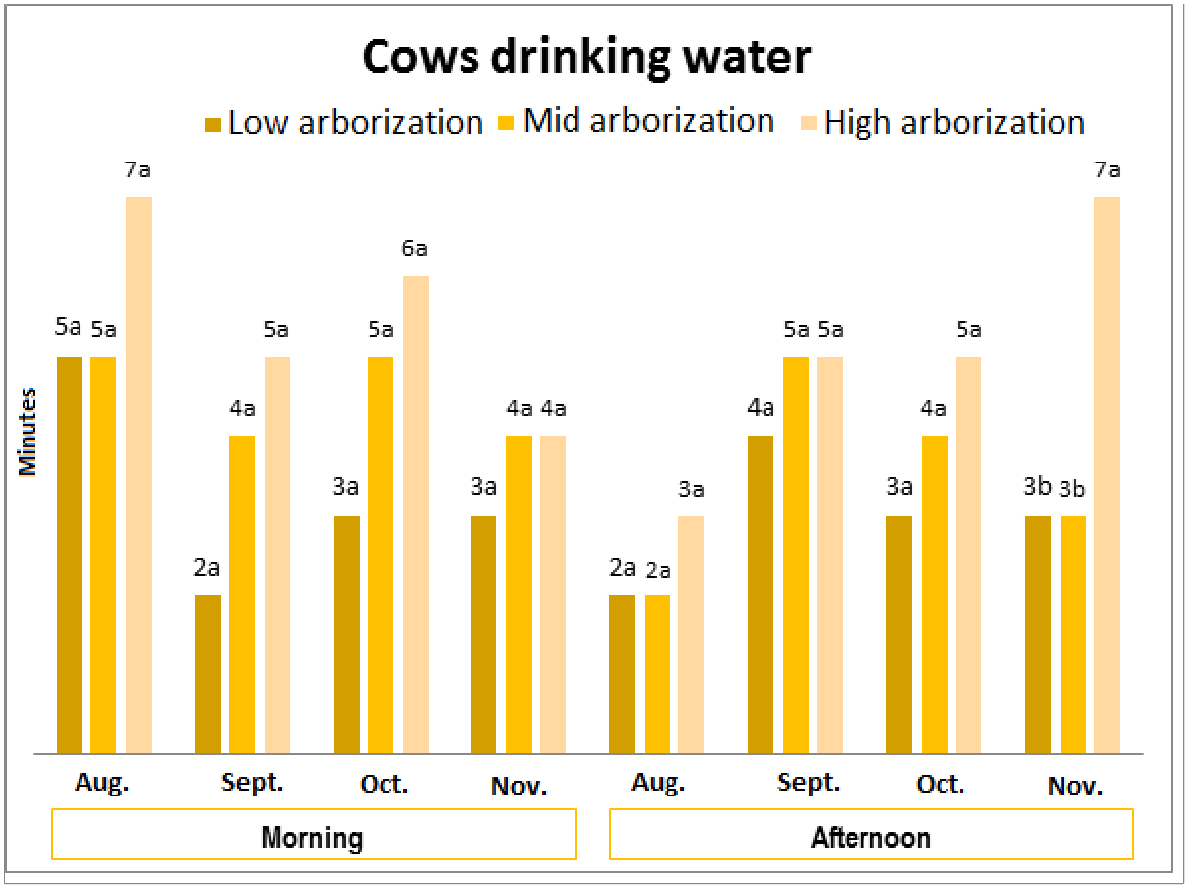

Fig. 4 Arborization effect (trees/ha) with algarroba (*Prosopis juliflora)* on cow drinking water time (min) distribution in the August-November (2013) period

a, and b: different letters among treatments differ for P < 0.05 (Duncan, 1995)

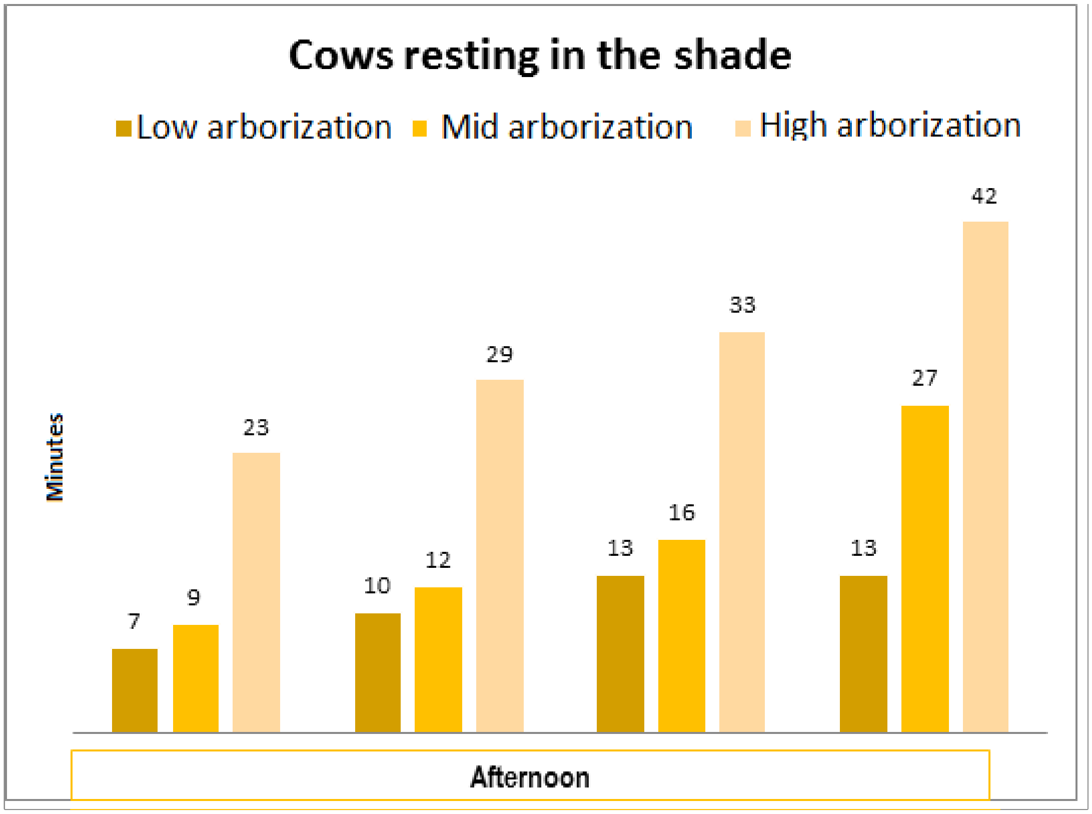

Fig. 5 Arborization effect (trees/ha) with algarroba (*Prosopis juliflora)* on cow resting time (min) distribution in the August-November (2013) period

a and b: different letters among treatments differ for P < 0.05 (Duncan, 1995)

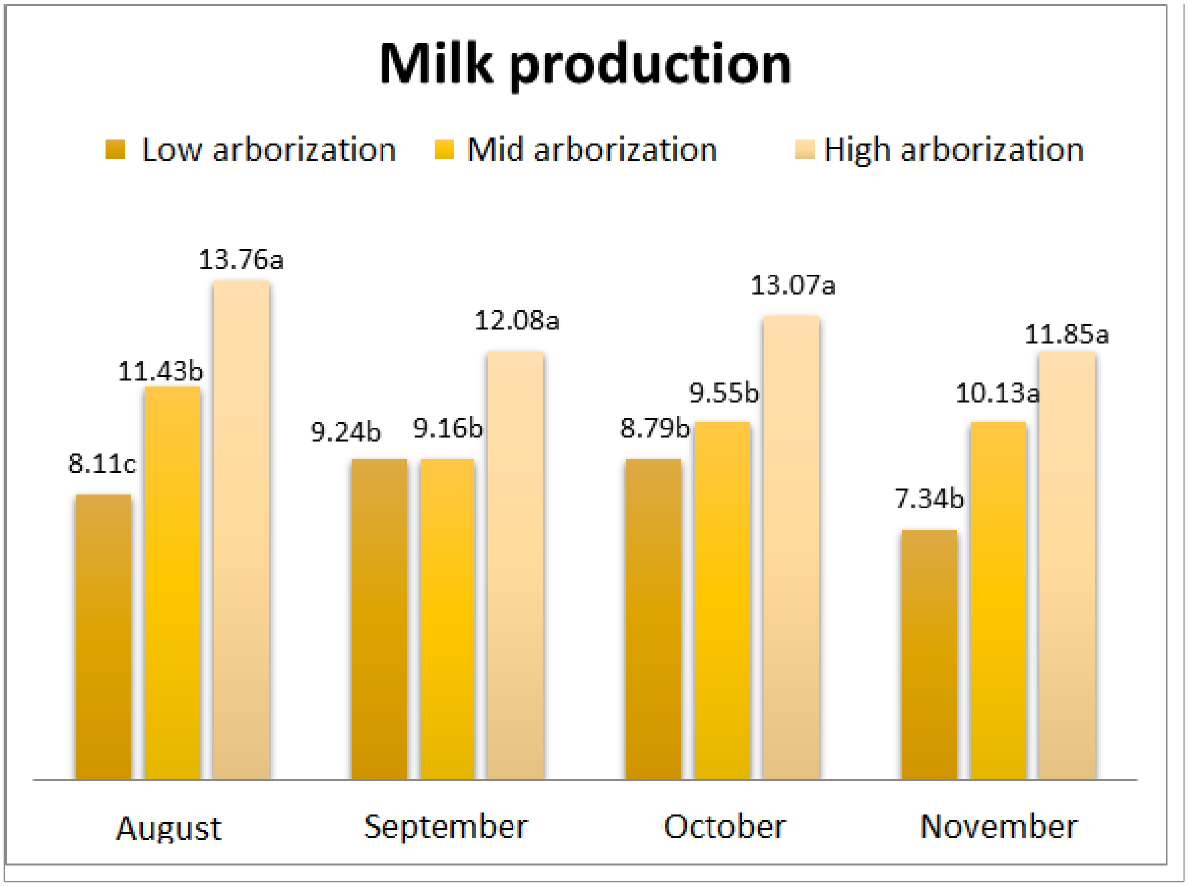

Fig. 6 Arborization effect (trees/ha) with algarroba (Prosopis juliflora) on milk production time (min) distribution in the August-November (2013) period

a, and b: different letters among treatments differ for P < 0.05 (Duncan, 1995)