Performance of the Leucaena leucocephala–Megathyrsus maximus cv Mombasa system and local range grazed by pelibuey ewe-lambs

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Key words: Daily weight gain; silvopastoral system; leucaena density; forage quality

Abstract

Mombasa grass and leucaena have shown an excellent agronomic performance grown in tropical semi-arid ranges, the objective of this study was to compare the agronomic performance of Leucaena-Mombasa grown as a silvopastoral system at two leucaena plant densities (10000 and 15000 plants ha-1) and of Pelibuey ewe-lambs grazing it against native unimproved tropical semi-arid range of the state of Morelos, México. Experimental design was a completely random with two replications. Unimproved native range was mainly deciduous shrubs and mixed herbaceous plants (Poaceae and Asteraceae). Stocking rate was the same across treatments and grazing lasted all rainy season. Of the agronomic variables determined, both Leucaena-Mombasa systems showed the same ($p>0.05$) forage on-offer total and expressed as herbage-allowance but 29 and 15% higher ($p\leq0.05$) respectively than the unimproved native range. Leucaena-Mombasa at the highest leucaena density showed the highest harvest rate, 22 and 50% higher ($p\leq0.05$) than the registered at the lower density and unimproved native range, respectively. Unimproved native range herbaceous layer showed 40% higher ($p\leq0.05$) crude protein content than the layer at both Leucaena-Mombasa systems; tree fodder was only different ($p<0.05$) in in vitro dry matter digestibility, tree fodder from both Leucaena-Mombasa systems was 32% higher ($p\leq0.05$) than that of unimproved native range. Ewe-lambs grazing any of the Leucaena-Mombasa systems showed a daily weight gain 1.5 times higher ($p<0.05$) than those grazing the unimproved native range. It was concluded that Leucaena-Mombasa system is an option to improve agronomic and animal performances compare to unimproved tropical native range.

Introduction

Silvopastoral systems of *Leucaena leucocephala* and tropical grasses have been shown to be effective to improve animal production under tropical and grazing conditions compared to other local alternatives for grazing livestock (Murgueitio et al., 2016). Trejo (2016) pointed out that *L. leucocephala* density is an agronomic variable that should be tested for specific sites to validate plant densities that provide the best association of this tree with tropical grasses in terms of agronomic and animal performance. Small-holders relay on the grazing of unimproved native semi-arid tropical ranges to feed their sheep herds that show rather low animal performance parameters.

The objective of the study was to compare the agronomic performance of Leucaena-Mombasa grown as a silvopastoral system at two leucaena plant densities (10000 and 15000 plants ha^{-1}) and of Pelibuey ewe-lambs grazing it against native unimproved tropical semi-arid range of the state of Morelos, México.

Methods and Study Site

Study site was in a semi-arid tropical area of the state of Morelos, Mexico with a mean annual rainfall of 900 mm and a dry season of 7 to 8 months. Treatments were: *L. leucocephala*-Mombasa at 10000 plants of leucaena ha^{-1}, leucaena low-density (LL); *L. leucocephala*-Mombasa at 15000 plants of leucaena ha^{-1}, leucaena high-density (HL); and, native range (NR). A complete random experimental design with three field replications was used. Experimental unit was a $190m^2$ plot.

Planting of Leaucaena and grass seeding were done a year before experimental grazing started. Leucaena plants were grown for two months in a nursery and then planted at the beginning of the rainy season in rows 2m apart, within rows plants were spaced every 50 and 33 cm for the low and high leucaena density, respectively. After leucaena planting, grass seeding was done in rows 1m apart within rows of leucaena, seeding rate was 8 kg of seed ha^{-1}. A plant inventory was done on the unimproved native range plots to determine plant families and species.

Experimental grazing lasted four months (2017 rainy season), stocking density of 158 ewe-lambs ha^{-1}, 14 d grazing period and from 28 d resting period. Variables were: forage on-offer, herbaceous, Mombasa grass in LL and HL, and all species in NR, and browse leucaena and all shrub species in NR, and residual forage only on herbaceous in all three systems (Haydock & Shaw, 1975); *in vitro* dry matter digestibility (Barnes, 1969); crude protein (AOAC, 1984); daily forage allowance and forage harvested (Hodgson, 1979); forage disappearance rate (Stuth *et al*.,1981); and, ewe-lamb daily live-weight gain, as the difference in live-weight at the end minus at the start of each grazing period. Statistical analysis wasa by analysis of variance using Proc GLM (SAS, 2012).

Results

Herbaceous forage on-offer and browse on-offer were 25 and 40% higher ($p<0.05$) in both leaucaena systems than in NR, respectively, with no difference ($p>0.05$) in any between leucaena systems. Residual herbaceous were similar ($p>0.05$) across all three systems (Table 1).

Table 1. Forage on-offer (FO) and residual (RF) in kg MS $ha^{-1,}$ in three silvopastoral systems

Silvopastoral system	FO herbaceous	FO browse	FO total	RF herbaceous
LL*	3088± 254^{ab}	1662 ± 254^{a}	4751 ± 508^{a}	2095± 254^{a}
HL*	3662± 254 ^{a}	1846 ± 254^{a}	5508± 508^{a}	1724 ± 254^{a}
NR*	2717 ± 254^{b}	1253 ± 440^{b}	3971± 695^{b}	1784± 254^{a}

* LL, low leucaena density (10000 ha^{-1}); HL, high leucaena density (15000 ha^{-1}); NR, native range. Means within columns with one letter in common are not different ($p\leq0.05$).

DFA was 15% higher ($p<0.05$) in leucaena systems compared to NR, along with this higher forage allowance ewe-lambs in both leucaena systems showed a maintained positive live-weight gain while ewe-lambs in NR showed a net weight loss of almost 40 g per day. Leucaena systems showed similar ($p>0.05$) results in both of these variables. High density leucaena system showed a FDR 43% higher ($p<0.05$) than the mean of de LL and NR, which showed no difference ($p>0.05$) between them (Table 2).

Table 2. Daily forage allowance (DFA), forage harvested (FH), forage disappearance rate (FDR) and daily live-weight gain (DLG) in three silvopastoral systems

Silvopastoral system	DFA (kg MS 100 kg LV^{-1} d^{-1})	FH (%)	FDR (kg MS 100 kg LV^{-1} d^{-1})	DLG (g ewe^{-1} d^{-1})
LL*	14.0 ± 0.6^{a}	57.3 ± 10.3^{a}	7.8 ± 1.1^{b}	22.7 ± 15.0^{a}
HL*	15.5 ± 0.6^{a}	70.4 ± 10.3^{a}	10.6 ± 1.1^{a}	30.3 ± 15.0^{a}
NR*	12.8 ± 0.6^{b}	57.6 ± 10.3^{a}	7.0 ± 1.1^{b}	-39.9 ± 15.0^{b}

* LL, low leucaena density (10000 h^{-1}); HL, high leucaena density (15000 ha^{-1}); NR, native range. Means within columns with one letter in common are not different ($p\leq0.05$).

Native range offered an herbaceous vegetation with up to 37% higher ($p<0.05$) crude protein than the Mombasa grass found in the leucaena systems, even in the herbaceous residual forage the NR system showed a crude protein 44% higher ($p<0.05$) than in the mombasa grass of the leucaena systems. The leucaena systems showed a better browse than the NR only in terms of IVDMD with similar crude protein, in the former leucaena systems provided a browse with 32% higher ($p<0.05$) IVDMD (Table 3).

Table 3. *In vitro* dry matter digestibility (IVDMD) and crude protein (PC) in herbaceous and browse forage on offer (FO) and residual herbaceous forage (RF) in three silvopastoral systems.

Forage quality measurement	Silvopastoral system		
	LL*	HL*	NR
IVDMD, FO herbaceous (%)	67.5 ± 2.4[a]	63.9 ± 2.4[a]	64.1 ± 2.4[a]
IVDMD, FO browse (%)	54.9 ± 2.4[a]	52.3 ± 2.4[a]	40.5 ± 4.1[b]
IVDMD, FR (%)	67.4 ± 2.4[a]	67.1 ± 2.9[a]	66.6 ± 2.7[a]
PC, FO herbaceous (%)	13.1 ± 0.6[b]	12.4 ± 0.6[b]	17.5 ± 0.6[a]
PC, FO browse (%)	19.1 ± 0.6[b]	21.3 ± 0.6[a]	20.9 ± 1.0[ab]
PC, FR (%)	9.8 ± 0.7[b]	9.5 ± 0.8[b]	13.9 ± 0.7[a]

* LL, low leucaena density (10000 h^{-1}); HL, high leucaena density (15000 ha^{-1}); NR, native range. Means within rows with one letter in common are not different ($p \leq 0.05$).

Discussion

The range of leucaena density tested showed no influence on the amount of forage on-offer of the associated Mombasa grass, this agrees with the finding of Trejo (2016) who stated that influence of leucaena density should be evident at very high densities and/or as leucaena planting is allowed to increase in aerial cover, then light competence could come to be an important factor on the associated grass.

The planned arrangement of leucaena plants against the rather random arrangement of the shrubs in the native range could explain the higher browse available for ewe-lambs in the leucaena systems compared to the native range. Anguiano *et al.* (2012) found this trend also, and pointed out that the arrangement of the fodder trees in a silvopastoral systems the plantation provides a better light use and then the higher browse on-offer.

The better ewe-lamb performance reflected on the higher daily live-weight in the leucaena systems than in the native range could be explained based on both a better agronomic performance of the leucaena systems that provided more feed in addition to a forage of higher quality.

It was concluded that in a semi-arid tropical environment planned leucaena-tropical grass silvopastoral systems are an option to improve livestock performance under grazing condition compared to native range. The influence of leucaena density on agronomic and livestock performances of tropical silvopastoral systems is still to be elucidated.

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