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FORAGE YIELD AND COMPOSITION OF *Avena strigosa* Schreb AT DIFFERENT HARVESTING FREQUENCIES AND INTENSITIES

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ABSTRACT

Harvesting frequency and intensity are management criteria in forage plants and their choices affect herbage yield and quality. The objectives of the study were to evaluate herbage yields of morphological components and chemical composition (crude protein, neutral detergent fiber and acid detergent fiber) of Saia oats (*Avena strigosa* Schreb) at three harvest frequencies (40, 50 and 60 cm sward height) and three harvest intensities (8, 14 and 20 cm residual foliage). The design was completely randomized with a factorial arrangement (3 × 3) of treatments and four replications. The factors were sward height (AD) and harvest intensity (IC). The experimental units were 36 plots of 12 m^2. Forage yield increased linearly (p = 0.007) with the increase in sward height (35 kg DM cm^{-1}, R^2 = 0.91). Leaf blade yield decreased (-33 kg DM cm^{-1}, R^2 = 0.99, p = 0.001) and pseudo stem plus stem yield increased (46 kg DM cm^{-1}, R^2 = 0.98, p = 0.001) with increasing sward height. Harvest intensity did not affect foliage yield (p > 0.05); however, leaf blade yield was higher at high harvest intensity (8 cm residual herbage, p < 0.05). Crude protein (CP) showed linear decrease (p = 0.001) as sward height increased (-0.22 % cm^{-1}, R^2 = 0.99), and neutral detergent fibre (NDF) was higher (51.2 %) at 60-14 and lower (41.9 %) at 40-8. Forage with higher proportion of leaf blades and lower NDF content was harvested at 40 cm sward height, in combination with moderate harvest intensities (8 and 14 cm residual foliage height).

Keywords: Saia oats, sward height, harvest frequency, residual foliage.

INTRODUCTION

In the temperate zone of Mexico, the use of common oats (*Avena sativa* L.) as an annual forage crop has been highlighted (Espitia *et al*., 2012), to counteract the deficit in forage supply that perennial grasslands have during winter (Rojas-García *et al*., 2017). However, in common oats it is common to perform a single forage harvest when the plants are mature, because in different varieties of common oats it has been found that forage yield is high in reproductive stages (Espitia *et al*., 2012). However, harvesting at reproductive stages decreases the regrowth capacity of the tillers, because the probability of cutting the apical meristem increases (Gastal and Lemaire, 2015). Another annual winter forage option is Saia oats (*Avena strigosa* Schreb); in Mexico, it has stood out for its higher yield compared to common oat varieties (Sánchez *et al*., 2014). Even when harvested during vegetative growth at moderate harvest intensities, forage can be obtained in more than one harvest (Quiroz-Pérez *et al*., 2016).

However, in forage plant management it is important to know when forage yield (foliage) and crude protein (CP) contents are high and neutral detergent fibre (NDF) and acid detergent fibre (ADF) contents are low. Different harvest frequency criteria have been evaluated to define the time of harvest. Such as, harvesting at a fixed number of days (Tonato *et a*l., 2014), at a fixed number of leaves harvested per tiller (Solomon *et al*., 2017) at a given sward height and a predefined level of light interception by the sward (Da Silva *et al*., 2015). In Mexico, the recommendation is to harvest based on fixed days, in Orchard grass (*Dactylis glomerata* L.) every 35 d (Hernández-Guzmán *et al*., 2015) and for Mulato grass (*Urochloa* híbrido) cv. Mulato grass every 28 d with light grazing during the rainy season (Cruz-Hernández *et al*., 2017).

Harvesting in fixed number of days may not be an entirely convenient criterion, because variations in temperature and rainfall between years affect yield and foliage composition, as it was highlighted by Solomon *et al.* (2017) in the case of annual ryegrass (*Lolium multiflorum* Lam. var. westerwoldicum). Another negative consequence of using fixed days as a harvest criterion is that the intervals between defoliations may be too short or too long and compromise forage yield or nutritional value. In this context, Salgado *et al.* (2010) reported that yield of *Avena strigosa* Schreb increased with the increase in harvest intervals from 30 to 45 or 60 d, while digestibility and CP and metabolizable energy (ME) content decreased. Light interception by sward (forage) and its height (Da Silva *et al*., 2015) or the number of leaves per tiller (Solomon *et al*., 2017) are more convenient harvesting criteria in terms of forage yield and composition, because they allow detecting the moment when leaf yield is higher than stems and dead material.

The intensity of harvesting or degree of severity with which cutting is performed (Gastal and Lemaire, 2015) also impacts forage yield and composition. Harvest intensity has been evaluated based on residual foliage height. Brink *et al*. (2013) harvested more foliage in *Festuca pratensis* Huds., *Dactylis glomerata* L., *Elymus repens* L. Gould, and *Phalaris arundinacea* L. when defoliated in vegetative state at higher than at lower harvest intensity (2 or 8 cm vs. 16 cm residual foliage). Solomon *et al*. (2017) found in annual ryegrass a tendency for higher forage yield at higher than at lower harvest intensity (5 cm vs. 10 cm residual foliage), and with higher NDF content. However, Schmitt *et al.* (2019) found in *Pennisetum purpureum* Schum. cv. Pioneiro and *Pennisetum clandestinum* Hochst. ex Chiov that forage composition was the same in the upper half of the sward (equivalent to a harvest intensity of half the sward height).

In Mexico, Saia oats has been evaluated in reproductive stages in a single crop (Espitia *et al*., 2012; Sánchez *et al*., 2014). However, different alternatives of harvesting frequency and intensity have effects on forage yield and composition. It was hypothesized that by harvesting more than once, the combination of high harvesting frequencies (lower sward height) with moderate defoliation intensities (8 to 20 cm of residual foliage) will allow a higher proportion of leaf blades, higher CP concentration and lower NDF content. The objective of the study was to evaluate forage yields and morphological components, as well as chemical composition (CP, NDF and ADF) of Saia oats harvested with combinations of three harvesting frequencies (40, 50 and 60 cm sward height) and three harvesting intensities (8, 14 and 20 cm residual foliage height).

MATERIALS AND METHODS

The research was conducted at the Autonomous University of Chapingo, Mexico (19° 29′ N, 98° 54′ W, 2240 m altitude) between April and June 2017 (first experiment) and 2018 (second experiment). The climate is sub-humid temperate with summer rains. Monthly average temperatures in both evaluations were similar and ranged from 16.8 to 19.2 °C (Figure 1). Total cumulative precipitation during the 2017 and 2018 evaluations was 254 and 264 mm, but the monthly distribution differed between years (Figure 1). It was low in April 2017 and high in June 2018. The soil of the experimental site was analysed with the following results, medium texture (clay loam), pH 7.5, 2.6 % organic matter, 35.6 mg kg^{-1} of N-NO_3, 14.1 mg kg^{-1} of P-Bray and 455 mg kg^{-1} of K. Crops were fertilized at sowing with 18 kg N ha^{-1} and 46 kg P_2O_5 ha^{-1}; other 60 kg N ha^{-1} were applied at the beginning of the tillering.

The experimental design was completely randomized with four replications. Treatments resulted from the factorial combination of three sward heights (40, 50 and 60 cm) and three harvest intensities (8, 14 and 20 cm residual foliage height). The experimental units were 12 m² plots, separated by 0.5 m wide strips. Sowing was

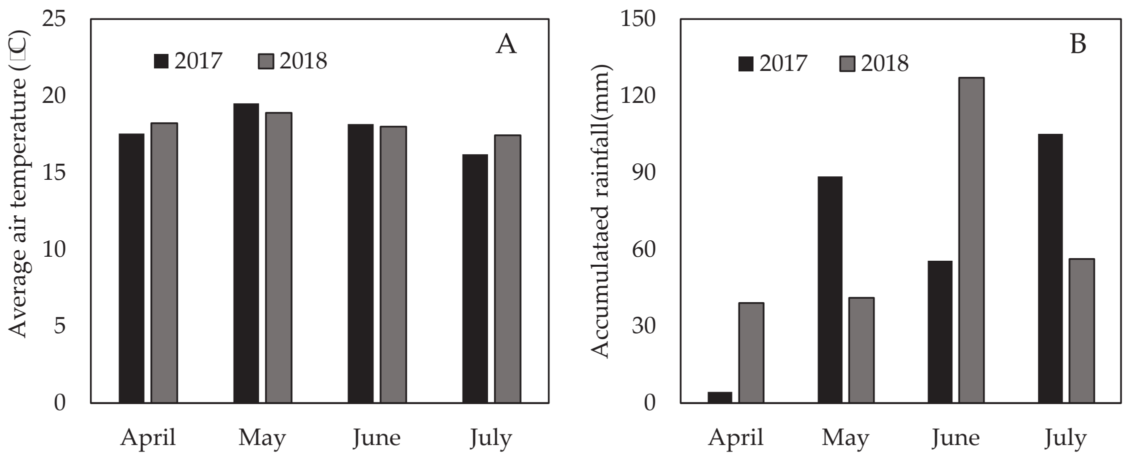

Figure 1. A: average air temperature and B: monthly cumulative precipitation from April to July 2017 and 2018 in Chapingo, Mexico.

carried out on March 31, 2017 (first experiment) and April 26, 2018 (second experiment), with a hand seeder 120 kg of pure germinable seed per ha were applied. During the experiments, sprinkler irrigations of approximately 50 mm each were made every two weeks. A total of 10 irrigations were completed in 2017 and four in 2018. The less amount of irrigations during 2018 was due to later sowing in 2018 and to the delayed start of the rainy season in 2017 (Figure 1). After crop emergence, 2-4-D herbicide (Hierbamina®, 1.5 L ha^{-1}) was applied to control broadleaf weeds.

The sward height of each plot was measured on a weekly basis, but when the average height approached the goals of each treatment, measurements were taken every two days. For this purpose, 15 measurements were taken within each plot with a graduated stick, an adaptation of the sward stick. Average sward heights obtained during the experiments were 40.2 ± 0.7 cm, 51 ± 0.7 cm, 61 ± 1.5 cm in 2017 and 43.8 ± 0.4 cm, 53 ± 1 cm, 63 ± 2 cm in 2018 (on average, 5 % deviation from height goals). The study variables were forage yields and morphological components; leaf blade, pseudo stem plus stem, inflorescence, dead material and herbs. As well as the chemical composition of the forage crude protein, neutral detergent fibre and acid detergent fibre (CP, NDF and ADF).

Forage yield was evaluated from the sum of dry matter (DM) yields obtained in the harvests made in each treatment (Table 3). To estimate forage yield per harvest, within each experimental unit, three foliage-mass samples were cut with scissors, at the harvest intensity of each treatment, in fixed sampling units of 0.32 m2 (0.8 m × 0.4 m). Before collecting the samples in each sampling unit, a metal rectangle was placed and slid on four graduated poles, which allowed to obtain the samples at the residual foliage height per each treatment. Afterwards, the fresh weight of forage per sample was recorded. Then, for the determination of DM content, a composite sample of approximately 400 g of foliage was taken and dried at 55 °C to constant weight in an oven with forced air circulation. To meet the harvest intensities in each treatment, immediately following the cutting of the foliage samples, the remaining forage in each plot was cut with a mower (Model UT44110, Homelite®, USA) up to the residual foliage height defined for each treatment.

In order to quantify the morphological components of each experimental unit, a subsample composed of approximately 200 g of forage, was cut in each sampling unit. Next, all the forage in the subsample was classified as oat components and herbs. Afterwards, the morphological components of oat were separated, and each of them was dried at 100 °C up to constant weight in an oven with forced air circulation, based on the dry weight, the proportion of each component was calculated. The yield of the morphological components was obtained by multiplying forage yield by the proportion (0-1) of each morphological component; this calculation was made for each harvest of all treatments.

The chemical composition (CP, NDF and ADF) of the forage was evaluated in the 2018 experiment. For this purpose, the same samples obtained to estimate the DM content of each plot were used. Forage samples were ground in a mill (Thomas Model

4, Wiley®, USA) with a 1 mm mesh. In the laboratory, the CP content was estimated from the N content (N * 6.25) determined by the Kjeldahl method. NDF and ADF contents were obtained sequentially with the use of filter bags (Model F57, Ankom®, USA) with porosity of 25 microns (McRoberts and Cherney, 2014) and a fibre analyser (Model A200, Ankom®, USA).

Statistical analysis was performed using the GLM procedure of SAS/STAT® (SAS Institute, Inc., 2017). The statistical model to evaluate forage yield (sum of the yields of each harvest) and of each morphological component included fixed effects of sward height (AD), harvest intensity (IC), year and their respective interactions. The model to evaluate chemical composition included fixed effects of AD, IC and their interaction. Means (LSMEANS) were compared with the Student *t*-test (a = 5 %). In addition, the responses of each variable to AD and IC were evaluated with the use of orthogonal polynomial contrasts.

RESULTS AND DISCUSSION

Forage yield (Table 1) showed linear increase (p = 0.007) with the increase in AD (35 kg DM cm^{-1}, R^2 = 0.91), but was altered ($p > 0.05$) by IC (average 6334 kg DM ha^{-1}). In 2017, it was 28 % higher than in 2018 ($p \leq 0.001$). Leaf blade yield decreased linearly (p = 0.001) with the increase in AD (-33 kg DM cm^{-1}, R^2 = 0.99). The interaction between year and IC had an effect on this variable (p = 0.04), since in 2017 it was 10 % higher (p < 0.05) with the highest IC (8 cm residual forage); but in 2018 IC did not affect it (p >

Table 1. Effects of harvest frequencies (sward heights) and year on forage yields and morphological components of Saia oats (*Avena strigosa* Schreb).

Component (kg DM ha^{-1})	Sward height (cm)			EEM†	p¶	Contrast
	40	50	60			Linear
Forage yield	6048 b§	6204 b	6746 a	174	0.017	0.007
Foliar blade	3446 a	3097 b	2784 c	77	0.001	0.001
Pseudo stem + stem	2191 c	2547 b	3104 a	111	0.001	0.001
Dead material	11 b	13 b	85 a	12	0.001	0.001
Inflorescence	249 b	295 b	510 a	27	0.001	0.001
Herbs	151	252	263	59	0.345	0.186
	Year					
	2017	2018				
Forage yield	7110 a	5557 b		142	0.001	
Foliar blade	3491 a	2727 b		63	0.001	
Pseudo stem + stem	2950 a	2278 b		91	0.001	
Dead material	74 a	0 b		10	0.001	
Inflorescence	562 a	141 b		22	0.001	
Herbs	33 b	411 a		48	0.001	

†EEM: standard error of the mean; ¶p: probability of difference; §Means with different letter between columns indicate statistical difference ($p \leq 0.05$).

0.05). Pseudo stem plus stem yield (Table 1) increased linearly ($p \leq 0.001$) with increase in AD (46 kg DM cm^{-1}, $R^2 = 0.98$), but was not affected ($p > 0.05$) by IC (average 2614 kg DM ha^{-1}); in 2017 it was 29 % higher than in 2018 ($p \leq 0.001$).

Due to the effect of the interaction AD * IC * year ($p < 0.006$), the amount of dead material in 2017 was higher with 60-8 (347 kg DM ha^{-1}) and with 60-14 (127 kg DM ha^{-1}) than with the average of the other treatments (27 kg DM ha^{-1}). Inflorescence quantity was affected by the AD * IC interaction ($p \leq 0.001$); it was more than three times higher with 60-14 (704 kg DM ha^{-1}) than with the average of the treatments with lower inflorescence yield (40-8, 40-14, 50-8 and 50-14; 193 kg DM ha^{-1}). It was also affected by the IC * year interaction ($p \leq 0.002$) so that in 2017 the harvested inflorescence was higher with decreasing IC, whereas in 2018 that happened with IC of 14 and 20 cm residual forage (Figure 2). The amount of herbs biomass harvested was higher ($p \leq 0.001$) in 2018 than in 2017 (Table 1).

The increase in forage yield obtained with the increase in AD is a frequent response that occurs with the advancing growth of forage plants, including common oats (Espitia *et al*., 2012) and Saia oats (Salgado *et al*., 2010). It is a product of photosynthetically active solar radiation intercepted by the leaf blades as the grasses develop (Gastal and Lemaire, 2015).

The opposite response obtained between the amounts of leaf blade (decreased) and pseudo stem plus stem (increased) with the increase of AD is due to the fact that, with the phenological development of the plants, the structure of the sward changes (Lemaire and Belanger, 2020). In this regard, Bommert and Whipple (2018) reported that the transition from the vegetative to the reproductive stage involves the transformation of the vegetative apical meristem into a reproductive meristem (it

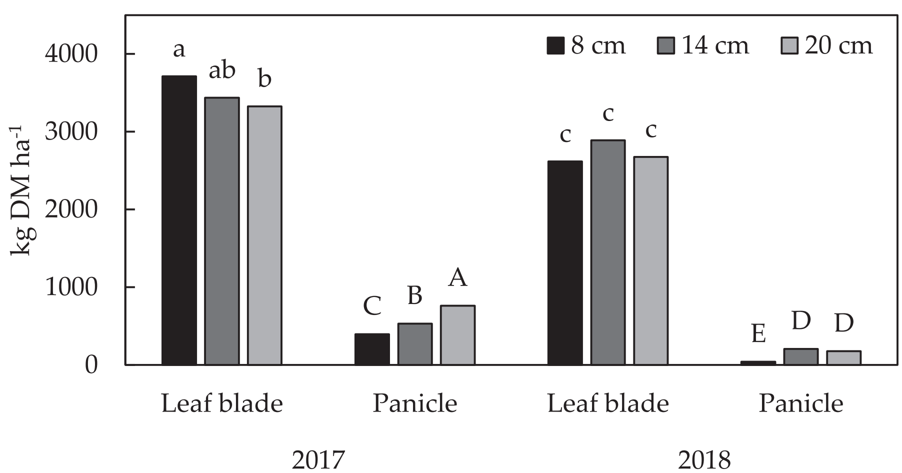

Figure 2. Leaf blade and inflorescence yields of Saia oats (*Avena strigosa* Schreb) with different harvest intensities (residual foliage height) in two years of evaluation. Bars with lowercase letters different between years indicate statistical difference ($p \leq 0.05$) in leaf blade. Bars with different capital letters between years indicate statistical difference ($p \leq 0.05$) in inflorescence yield.

stops producing leaf primordia), along with the elongation of internodes (Gastal and Lemaire, 2015) and consequently there is a higher proportion of pseudo stems and stems. Bommert and Whipple (2018) indicated that in tillers whose stems elongate, with the change to reproductive phase, inflorescences and seeds are produced. This is the reason why a higher number of inflorescences was found in 60-14.

Shorter harvest frequencies associated with lower AD delayed the transition to the reproductive stage and consequently forage with more leaf blades than stems could be harvested. Gastal and Lemaire (2015) highlighted that with stem elongation, the probability of apical meristem removal at harvest also increases, leading to lower tiller survival and affecting plant regrowth capacity. Perhaps for this reason, with higher AD and IC (60-8 and 60-14), fewer harvests were obtained.

Regarding IC effects, the higher leaf sheet yield obtained with higher IC (8 cm residual forage) can be attributed to the delay in stem elongation (Lemaire and Belanger, 2020), which coincides with the increase in inflorescences found with lower ICs (higher residual forage height) and which allowed plants to continue their phenological development. Also, the higher amounts of dead material resulting in the 60-8 and 60-14 treatments (low frequency and higher harvest intensity) were attributed to older leaves being shaded with stem elongation, which accelerates their senescence and causes the accumulation of dead material at the base of the sward (Da Silva *et al*., 2015).

Contents DM, CP and ADF were not affected by the AD * IC interaction ($p > 0.05$). The DM content was similar ($p \leq 0.05$) among AD (average 17.1 %, Table 2); but with linear increase ($p = 0.007$) with decreasing IC (average 0.23 % cm^{-1} reduction in residual herbage height, $R^2 = 0.96$). In contrast, NDF content (Figure 3) was higher ($p < 0.05$) at 60-14 (51.2 %) and lower at 40-8 (42.0 %); while that of ADF tended ($p = 0.086$) to be 8 % higher at 60 cm AD than the average at 40 and 50 cm (25.9 %, Table 2), but was similar

Table 2. Main effects of harvesting frequencies and intensities (sward and residual forage heights) on the chemical composition of the forage from Saia oats (*Avena strigosa* Schreb).

Component (%)	Sward height (cm)			EEM[†]	p[¶]	Contrast Linear
	40	50	60			
Dry matter	17.0	16.8	17.4	0.6	0.797	0.639
Crude protein	27.5 a[§]	25.7 b	23.2 c	0.6	0.001	0.001
Neutral detergent fibre	43.3 c	45.0 b	48.4a	0.6	0.001	0.001
Acid detergent fibre	27.2	24.6	27.9	1.0	0.086	0.607
	Residual forage height (cm)					
	8	14	20			
Dry matter	15.5 b	17.4a	18.3a	0.6	0.007	0.002
Crude protein	25.3	24.8	26.4	0.6	0.081	0.198
Neutral detergent fibre	45.5 ab	46.9a	44.4 b	0.6	0.005	0.214
Acid detergent fibre	27.1	27.1	25.5	1.0	0.380	0.289

[†]EEM: standard error of the mean; [¶]p: probability of difference; [§]Means with different letter between columns indicate statistical difference ($p \leq 0.05$).

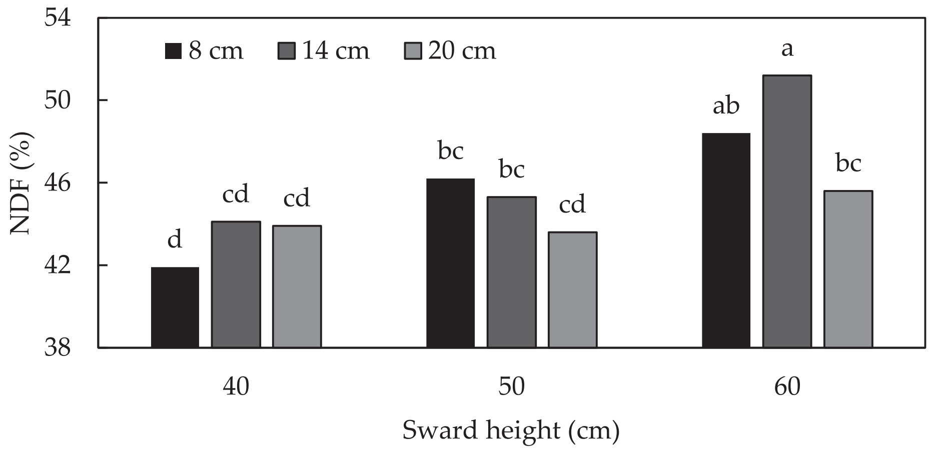

Figure 3. Neutral detergent fibre (NDF) content in Saia oat (*Avena strigosa* Schreb.) forage at different combinations of harvesting frequencies (sward heights) and harvesting intensities (residual forage height). Bars with different letter indicate statistical difference ($p \leq 0.05$).

($p > 0.05$) among IC (average 26.6 %). The content of CP decreased linearly (p = 0.001) with the increase in AD (-0.22 % cm^{-1}, $R^2 = 0.99$). Furthermore, it tended (p = 0.081) to be 5 % greater at 20 cm residual forage height than the average of 8 and 14 cm (25 %). Although forage yield was higher with the increase in AD, an inverse relationship was found between forage quality and quantity. The decrease in forage quality (lower CP and higher NDF and ADF content) with the increase in AD was attributed to the fact that leaves have a better nutritional composition than stems. Arzani *et al*. (2004) studying five C3 grasses, found that on average over three maturity stages the NDF and ADF contents of leaves were 16 and 23 % lower than those of stems, whereas the contents of CP and ME were 67 and 27 % higher in leaves than in stems. Coincidentally, Solomon *et al*. (2017) found that with the increase of harvest interval (defined by the number of leaves per tiller) in annual ryegrass (*Lolium multiflorum* Lam. var. westerwoldicum) the ratio of leaf blade decreased (in the cultivar Marshall) and simultaneously there was linear decrease in CP concentration; between 2 and 3 leaves per tiller the NDF and ADF contents were lower than those with the lower frequency of four leaves per tiller. Based on the above, the decrease in CP content in forage with the increase in AD was due to the deterioration by 0.8 percentage points in leaf blade content for each cm increase in AD ($R^2 = 0.65$, $p \leq 0.001$). The higher amount of leaf blade may also explain the lower NDF content in 40-8. Another factor explaining the reduction in forage quality with increased growth is the change in chemical composition of morphological components as plant maturity advances. In this regard, Arzani *et al.* (2004) reported that with the advancement of the phenological stage in grasses (vegetative, flowering and maturity), CP content decreased and NDF and ADF increased, which contributes to the explanation of why NDF and ADF contents were higher in forage with higher AD.

Feeding cattle with high quality forages has productive implications. Salgado *et al.* (2013) published that dairy cows fed on a diet containing 38 % Saia oats (19.8 % CP and 2.36 Mcal kg DM^{-1} ME) were found to have 6 % higher milk yield than cows fed on a diet that did not include Saia oats. Forage harvested at 40 cm AD and 8 cm residual foliage may be a suitable management strategy to obtain high quality forage to feed dairy cows since the CP and ME content obtained with 40-8 were better than those reported by Salgado *et al.* (2013). Contents of 28.4 % CP and 2.54 Mcal kg DM^{-1} ME, calculated with the ME equation (Mcal kg DM^{-1}) = 3.412-0.0322 % ADF, applied on the 27.15 % ADF in the forage composition data reported by the NRC (2001), were achieved with 40 cm AD and 8 cm IC.

Harvest intervals in most treatments (except 50-8) were shorter in 2018 than in 2017, that difference ranged from three (40-20) to nine days (50-14). In treatments 40-14, 40-20 and 50-20, the harvest interval after the first harvest was on average 17 d shorter than in 40-8, 50-14 and 60-20 (on average 25 d); whereas in 50-8, 60-8 and 60-14, this interval was even longer (on average 38 d). Other consequences of the combinations between AD and IC were variations in the number of harvests (Table 3) and yield per

Table 3. Saia oat (*Avena strigosa* Schreb) harvest dates with different harvest frequencies (sward heights) and harvest intensities (residual forage heights).

	Harvest intervals								
AD[†]-AFR[¶]	40-8	40-14	40-20	50-8	50-14	50-20	60-8	60-14	60-20
Harvest	Harvest dates 2017								
1	20May	20May	20May	30May	30May	30May	07Jun	07Jun	07Jun
2	16Jun	12Jun	8Jun	04Jul	29Jun	21Jun	19Jul	19Jul	12Jul
3	15Jul	04Jul	23Jun	02Aug	26Jul	12Jul			02Aug
4		26Jul	07Jul			02Aug			
5			20Jul						
6			5Aug						
[§]DDS-1	50	50	50	60	60	60	68	68	68
[Þ]DEC	28	22	15	32	29	21	42	42	28
Harvest	Harvest dates 2018								
1	19Jun	19Jun	19Jun	25Jun	25Jun	25Jun	30Jun	30Jun	30Jun
2	10Jul	04Jul	29Jun	02Aug	15Jul	09Jul		04Aug	24Jul
3		20Jul	09Jul			28Jul			
4			24Jul						
DDS-1	54	54	54	60	60	60	65	65	65
DEC	21	16	12	38	20	17	-	35	24

[†]AD: Sward height; [¶]AFR: Residual forage height; [§]DDS-1: Days after sowing to first harvest; [Þ]DEC: Days between harvests after the first harvest.

harvest (Figure 4). In general, more intense defoliation (less residual foliage) resulted in fewer harvests, but higher forage yield per harvest. On the contrary, with less intense defoliation (more residual forage), a greater number of harvests were obtained, but with lower forage yield per harvest.

The absence of differences in forage yield when using different IC could result from the trade-offs between yield per harvest (Figure 4) and the number of harvests made in each treatment (Table 3). Because with low IC (40-14, 40-20 and 50-20) there were more harvests (four on average), but on the contrary, with high IC (50-8, 60-8 and 60-14) there were fewer harvests (two on average). Our results agree with that reported by Hamilton *et al.* (2013) in cutting experiment and Brink *et al.* (2013) in grazing experiment (both in temperate grasslands), they found lower and higher number of harvests with more and less intense harvest, respectively. Rapid forage growth during regrowth explains the reduction of the inter harvest interval with lower AD and lower IC since the first harvest onwards. This is because, in plants with lower IC the greater residual leaf area and the greater amount of organic reserves in the tillers favour photosynthesis and growth (Da Silva *et al*., 2015); however, a lower amount of forage is harvested (Hamilton *et al*., 2013).

Differences in forage yield between years are attributed to the higher number of harvests made in 2017 than in 2018 (Table 3), which was due to earlier sowings in the first year. Quiroz-Pérez *et al.* (2016) found at the same experimental site higher forage yields with earlier sowing dates (late spring *vs.* mid-fall) in associations of *Avena strigosa* with *Vicia* spp. Shorter harvest intervals since the first harvest in 2018 are attributed to a higher foliage growth rate during the months when harvests were made (June and July). In those months, there was higher average temperature and cumulative precipitation than in 2017 (Figure 1) which should have stimulated plant growth and allowed reaching AD targets in less time. In this regard, Hamilton *et al.* (2013) reported

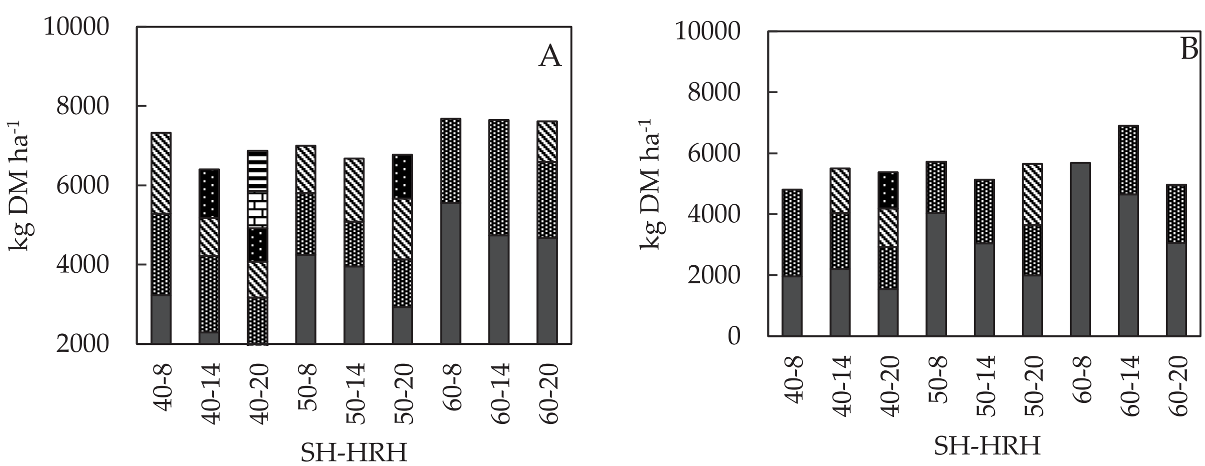

Figure 4. Forage yield per harvest in Saia oats (*Avena strigosa* Schreb) with different harvest frequencies (sward height, AD) and harvest intensities (residual forage height, AFR) in A: 2017 and B: 2018.

that longer intervals between harvests in English ryegrass (*Lolium perenne* L.) and tall fescue (*Festuca arundinacea* Schreb.) were partly due to slower growth.

CONCLUSIONS

Harvesting Saia oats at sward height of 40 cm (higher frequency) in combination with moderate harvest intensities (8 and 14 cm residual forage height) resulted in two to three harvests. This harvesting management allowed harvesting forage with higher amount of leaf blades and crude protein. The decrease in the crude protein content in forage, when harvested at a lower frequency (60 cm sward height), was due to the fewer number of leaf blades, but the higher content of pseudo stems and stems.

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