DOI: 10.5433/1679-0359.2019v40n5Supl1p2319

Average time of dispersal and germination of Fabaceae seeds retrieved from goat feces

Tempo médio de dispersão e germinação de sementes de Fabáceas recuperadas em fezes de caprinos

Tatiana Oliveira da Silva[1]; Henrique Duarte Vieira[2]; Bruno Borges Deminicis[3]*; Norberto Silva Rocha[1]; Renata Vianna Lima[2]; Leonardo Siqueira Glória[2]

Abstract

This study aimed to evaluate the viability of seeds of butterfly pea, stylosanthes cv. Campo Grande, tropical kudzu and archer after passage through the gastrointestinal tract (GIT) of goats; and to evaluate these animals as dispersing agents. Fifty grams of seeds of each plant were mixed with the concentrate and given to 20 goats, whose feces were collected up to 102 hours after ingestion for seed retrieval and subsequent germination test. This was a completely randomized design in a factorial arrangement: 4 Fabaceae plants x 17 sampling times with five replicates. The percentage of seed retrieval ranged from 16.9 to 70.9%; butterfly pea and archer, respectively. The passage through the GIT positively affected the germination of kudzu seeds; which presented the highest germination average (45%), and negatively the seeds of stylosanthes and butterfly pea, which presented respectively, 15 and 13%. The period of highest seed dispersal was 24 - 42 hours, peaking in 36 hours. Under these conditions, goats may be considered as legitimate seed dispersers.

Key words: Liquid organic fertilizer. *Brachiaria brizantha*. Urea.

Resumo

Objetivou-se avaliar a viabilidade de sementes de cunhã, estilosantes Campo Grande, kudzu e macrotiloma após a passagem pelo trato gastrintestinal (TGI) de caprinos; assim como estes animais como agentes dispersores. Cinquenta gramas de sementes de cada fabácea foram misturados ao concentrado e oferecidos a 20 cabritos, cujas fezes foram recolhidas até 102 horas após a ingestão para a recuperação das sementes e posterior teste de germinação. Foi utilizado delineamento inteiramente casualizado, em esquema fatorial: 4 fabáceas x 17 tempos de coleta, com cinco repetições. A porcentagem de recuperação de sementes variou de 16,9 a 70,9%; para cunhã e macrotiloma, respectivamente. A passagem pelo TGI afetou positivamente a germinação de sementes de kudzu; que apresentou a maior média de germinação (45%) frente às demais espécies, e negativamente as sementes de estilosantes e cunhã, que apresentaram respectivamente 15 e 13%. O período de maior dispersão de sementes foi de 24 a 42 horas, com pico em 36 horas. Nestas condições os caprinos podem ser considerados legítimos agentes dispersores.

Palavras-chave: Adubação orgânica líquida. *Brachiaria brizantha*. Uréia.

[1] Profs., Faculdade de Ciências da Saúde de Unaí, FACISA, Unaí, Minas Gerais, Brasil. E-mail: tatiana.zoo@gmail.com; nsrocha@gmail.com

[2] Profs., Universidade Estadual do Norte Fluminense Darcy Ribeiro, UENF, Campos dos Goytacazes, RJ, Brasil. E-mail: henrique@uenf.br; renataviannalima2005@yahoo.com.br; leonardogloria@uenf.br

[3] Prof., Universidade Federal do Sul da Bahia, UFSB, Ilhéus, BA, Brasil. E-mail brunodeminicis@gmail.com

* Author for correspondence

Received: Aug. 11, 2017 - Approved: June 24, 2019

Introduction

In natural grazing conditions, germination of forage seeds is controlled by factors such as light, temperature, pH and soil moisture (SOUZA FILHO et al., 1998). In addition to these factors, animals consuming the seeds can positively or negatively affect the germination. Endozoochory was extensively studied in the past, and has recently gained new momentum. Thus, animals also function as dispersal agents. Dispersal is the transportation of seeds away from the mother plant, contributing to the perpetuation of species, reaching new environments (JANZEN, 1970; GARDENER et al., 1993).

The effective seed dispersal by animals on pasture involves a number of stages, including the ingestion of seeds, passage through the gastrointestinal tract (GIT), germination, development, establishment and survival of seedlings (JOLAOSHO et al., 2006). However, after ingestion of seed damage caused by mastication and digestion. The percentage of seeds damaged by the animal is related to the size, shape and hardness of the coating, the proportion of seeds in the diet, the animal species, the quality of diet consumed and the time of permanence in the GIT (JONES; SIMÃO NETO, 1987). Seed dispersal by animals can be influenced by the reproductive success of plants due to the effect on seed germination capacity, dispersion desirable to grazing areas and proportion of seedlings originated (FLEMING; SOSA, 1994). Figueroa and Castro (2002), considered as a legitimate disperser of certain species, when it does not cause reduction in the germination of the dispersed seeds.

The passage of some types of seeds through the ruminant GIT allows chemical scarification, gas exchange and/or deletion of germination inhibitors present in the seed. Furthermore, this process facilitates water absorption and reactivation of metabolic processes (METIVIER, 1986; TRAVESET; VERDU, 2002). Machado et al. (1997) stated that the passage through the GIT possibly causes changes in longevity and dormancy, as well as the percentage and speed of germination and early seedling growth. The dispersal of forage seeds by ruminants can be used especially in situations where sowing by conventional methods is difficult in mountainous areas. It has been documented that goats can disperse the seeds of shrub species in arid and semiarid regions of Mexico (BARAZA; VALIENTE-BANUET, 2008; GIORDANI, 2015), various herbaceous species in New Zealand and in the United States (Harrington et al., 2011; Lacey et al., 1992) and in Spain (ROBLES et al., 2005; MANCILLA-LEYTÓN et al., 2011; GRANDE et al., 2013).

The aims of this study were to evaluate the goats as dispersers, and the viability of seeds of four tropical forages of the family Fabaceae. The plants used were *Clitorea ternatea, Stylosanthes capitata* x *Stylosanthes macrocephala, Pueraria phaseoloides* and *Macrotyloma axillare* retrieved from feces of goats, as well as the average time of dispersing seeds after eating.

Material and Methods

This study used 20 castrated Saanen x Alpine goats with an average weight of 60 kg, breeds popular for milk production. The animals were stabled individually and used Bags for feces collection. There was an adjustment period of seven days for both individual housing and for the use of collection bags. The feeding was carried out individually and followed a forage: concentrate ratio of 60:40, with 800g.day^{-1} concentrate and 5kg. day^{-1} chopped elephant grass (amounts divided in two daily meals) and water *ad libitum*.

The animals were randomly divided into four groups of five animals eacj. Each group received a different of Fabaceae species seeds. 50 grams of seeds of each Fabaceae species were mixed with 400g concentrate supplied in the morning, to facilitate the intake. This amount corresponds to approximately

1,000 seed butterfly pea, 17,500 Sstylosanthes, 4,850 tropical kudzu and 4,900 Aarcher, all in Fresh (without scarification). A sample of seeds evaluated in this assay was measured using a digital caliper, obtaining the average size. The butterfly pea seeds are on average 6.62 mm long, 4.62 mm wide and 2.80 mm thick.

Archer has seeds with an average of 3.45 mm long, 2.64 mm wide and 1.42 mm thick. kudzu seeds have an average size of 2.66 mm long, 2.46 mm wide and 2.19 mm thick. The Sstylosanthes has seeds with an average of 2.50 mm long, 1.71 mm wide and 0.99 mm thick.

The seeds were given only on the first day of the experiment, at 6 o'clock. At 6 pm on the same day (12 hours after seed supply) the faeces of the animals were collected at 6-hour intervals, extending the collection up to 102 hours after the meal, as, during this period, the seeds, if present, would be degraded. The samples were collected at 6, 12, 18, 24, 30, 36, 42, 48, 54, 60, 66, 72, 78, 84, 90, 96 and 102 hours.

The initial 6 hours were disregarded, because in previous experiments no seeds were found in this period. During data collection, seed-containing faeces were softened in water in a 5L bucket, and then washed with tweezers and gloves in running water with low flow in fine mesh screens.

The seeds retrieved were taken to Seed Technology Sector and counted. After counting, germination tests were performed with seeds intact, constituting control (time 0 h) and with seeds retrieved in each collection time. Germination tests were based on the recommendation of Seed Analysis Rules (RAS) (BRASIL, 2009) with four replications of 50 seeds, when the number of seeds retrieved was enough in a photoperiod of 08/16 light/dark hours.

Tests with Sstylosanthes and kudzu were mounted on one layer of blotting paper in a gerbox and placed in a growth chamber at 20-35°C and 25°C, respectively, the first counting performed after 4 days and the final count on the 10th day for both species. The tests with the seeds of butterfly pea and Aarcher were mounted on germitest paper roll, and placed in germination chambers with alternating temperature of 20-300ºC and constant 25° C, respectively. The first and last counts were made after 7 and 14 days for butterfly pea seeds and after 4 and 10 days for Aarcher seeds. Germinated seeds were those that gave rise to normal seedlings, according to RAS (BRASIL, 2009).

The tetrazolium test was applied to four 20-seed replicates of each species collected from both pellets and from uneaten seeds (control), to determine the viability of the embryos (MACKAY, 1972). Seeds were kept in water for 16 h at a constant temperature of 25°C, and then submerged in a 1% aqueous solution of 2,3,5-triphenyl-tetrazolium chloride, pH 7, in darkness for 24 h at a constant temperature of 25°C. Seeds were dissected and embryo analyzed with a magnifying glass (BRADBEER, 1988).

This was a completely randomized design in a 4x17 (legumes and collection times) factorial arrangement with 5 replicates (animals). The results were tested by analysis of variance using the GLM procedure of SAS statistical software (Stastical Analysis System). The Scott- Knott test was applied for grouping means, at 5 % significance level, using the GENE program (CRUZ, 2009).

Results and Discussion

As for the number of seeds retrieved from the feces of goats, the kudzu and butterfly pea seeds showed no statistically significant difference between the dispersal times. As for Sstylosanthes and Aarcher, there was no significant difference between the samples collected ($P < 0.05$), being the highest result found in the collection performed at 36 hours for both species.

Table 1 shows that the highest recovery of butterfly pea seeds occurred between 24 and 30 hours. For kudzu, Sstylosanthes and Aarcher, it

lasted between 36 and 42 hours, and the dispersion peak was observed between 36 and 42 hours after the seed consumption, with 49.3% of kudzu seeds, 69.7% of butterfly pea seeds and more than 80% of Sstylosanthes and Aarcher seeds.

Table 1. Number (N) and Percent recovery (PR%) kudzu seeds, Sstylosanthes, Aarcher and Bbutterfly pea recovered in goats faeces, depending on the dispersion time.

Time (h)	Species							
	Kkudzu		Sstylosanthes		Aarcher		Bbutterfly pea	
	N	PR%	N	PR%	N	PR%	N	PR%
0	0.0 Aa	0.0 Aa	0.0 Ad	0.0 Aa	0.0 Ac	0.0 Ad	0.0 Aa	0.0 Aa
12	3.4 Aa	0.1 Aa	2.0 Ad	0.01 Aa	8.0 Ac	0.2 Ad	0.6 Aa	0.1 Aa
18	18.6 Aa	0.4 Ba	173.2Ad	1.0 Ba	286.4 Ac	5.8 Ac	9.2 Aa	0.9 Ba
24	104.8 Ba	2.2 Ba	611.8 Ac	3.5 Ba	631.4 Ab	12.9 Ab	33.4 Ba	3.3 Ba
30	103.6 Ba	2.1 Ba	575.2 Ac	3.3 Ba	509.6 Ab	10.4 Ab	31.4 Ba	3.1 Ba
36	150.8 Ca	3.1 Ca	1422.6 Aa	8.1 Ba	831.6 Ba	17.0 Aa	25.8 Ca	2.6 Ca
42	134.4 Ca	2.8 Ca	915 Ab	5.2 Ba	556.2 Bb	11.3 Ab	17.4 Ca	1.7 Ca
48	79.2 Ba	1.6 Ba	315.6 Ad	1.8 Ba	233.4 Ac	4.8 Ac	11.4 Ba	1.1 Ba
54	111.8 Aa	2.3 Aa	122.2 Ad	0.7 Aa	154.8 Ac	3.2 Ac	9.0 Aa	0.9 Aa
60	62.8 Aa	1.3 Aa	148.8 Ad	0.8 Aa	126 Ac	2.6 Ac	6.2 Aa	0.6 Aa
66	66.0 Aa	1.4 Aa	73.6 Ad	0.4 Aa	44.8 Ac	0.9 Ad	2.8 Aa	0.3 Aa
72	50.4 Aa	1.0 Aa	61.8 Ad	0.3 Aa	28.0 Ac	0.6 Ad	3.2 Aa	0.3 Aa
78	57.2 Aa	1.2 Aa	68.8 Ad	0.4 Aa	23.2 Ac	0.5 Ad	5.6 Aa	0.6 Aa
84	48.2 Aa	1 Aa	57 Ad	0.3 Aa	19.0 Ac	0.4 Ad	5.0 Aa	0.5 Aa
90	14.4 Aa	0.3 Aa	29Ad	0.2 Aa	11.0 Ac	0.2 Ad	4.2 Aa	0.4 Aa
96	16 Aa	0.3 Aa	19.2 Ad	0.1 Aa	5.2 Ac	0.1 Ad	1.4 Aa	0.1 Aa
102	24.4 Aa	0.5 Aa	18.8 Ad	0.1 Aa	4.6 Ac	0.1 Ad	2.0 Aa	0.2 Aa
Total	1005	21.6%	4.615	26.4%	3.473	70.9%	169	16.9%

* Means followed by the same uppercase and lowercase in the lines in columns (By studied variable) do not differ by the Scott-Knott test at 5 % probability.

As for the total number of retrieved seeds, Sstylosanthes presented the highest value (4,615), which represented 26% of total ingested by the animal. Despite the high number of retrieved seeds, Sstylosanthes presented low percentage of retrieval due to the number of seeds contained in 50g offered to animals (17,500). The highest percentage of retrieval obtained for Aarcher, 71% of 4,900 seeds ingested by the animal, corresponds to 3,473 seeds retrieved. For kudzu and butterfly pea, the number of seeds retrieved was 1,046 and 169, which correspond to 22 and 17% retrieved seeds, respectively (Table 1).

As for the first germination count showed no significant difference ($P<0.05$) for kudzu, Aarcher and butterfly pea, with the higher results in dispersal times of 102, 78 and 12 hours, respectively. The results of first germination, count, of Sstylosanthes seeds did not differ statistically between the dispersal times. In the period of greatest seed retrieval (36 hours), there was no significant difference in germination among species (Table 2).

Table 2. The first Germination count (1st G), Total Germination (TG) and Viability (V%) of kudzu seeds, Sstylosanthes, Aarcher and Bbutterfly pea recovered in the feces of goats, depending on the different collection times.

Time (h)	Species											
	Kkudzu			Sstylosanthes			Aarcher			Bbutterfly pea		
	1st G	GT	V%	1st G	GT	V%	1st G	GT	V%	1st G	GT	V%
0	NG	33.5 Ab		24.4 Aa	36.8 Aa	65.3a	NG	24.4 Aa	92.3a	22.0 Ac	47.6 Ab	82.0a
12	NG	61.9 Aa		16.7 Ba	16.7 Bb	64.4a	NG	19.9 Ba	92.4a	75.0 Aa	75.0 Aa	82.1a
18	NG	48.4 Ab		5.3 Ba	9.7 Bb	63.1a	7.4 Bb	19.2 Ba	92.1a	33.2 Ab	33.2 Ab	82.0a
24	NG	44.4 Ab		4.9 Ba	8.8 Bb	35.1b	2.2 Bb	18.7 Ba	91.1b	28.6 Ab	31.1 Ab	80.1b
30	NG	42.1 Ab		3.7 Ba	6.6 Bb	35.2b	0.1 Bb	16.8 Ba	90.4b	41.1 Ab	44.6 Ab	81.0b
36	12.5 Ac	56.6 Aa		5.3 Aa	6.6 Bb	35.5b	9.4 Ab	20.4 Ba	90.6b	16.3 Ac	24.8 Bc	81.0b
42	17.1 Ac	49.5 Ab		6.4 Aa	12.5 Bb	35.7b	17.9 Aa	22.1 Ba	90.4b	13.4 Ac	16.4 Bc	80.0b
48	9.4 Ac	42.1 Ab		4.4 Aa	6.3 Bb	35.9b	17.5 Aa	22.5 Ba	90.2b	0.6 Ad	10.4 Bc	80.7b
54	11.4 Ac	36.2 Ab	NS	6.9 Aa	12.1 Bb	34.2b	14.0 Aa	19.1 Ba	90.2b	2.0 Ad	5.43 Bc	80.1b
60	27.1 Ab	37.4 Ab		8.6 Ba	14.7 Bb	34.6b	21.9 Aa	25.8 Aa	91.4b	12.9 Bc	12.9 Bc	81.0b
66	15.2 Ac	62.8 Aa		10.1 Aa	24 Ba	34.1b	6.0 Ab	17.7 Ba	90.3b	NG	NG	81.0b
72	7.2 Ac	47.5 Ab		11.1 Aa	23.3 Ba	34.6b	0.4 Ab	23.9 Ba	90.1b	NG	NG	80.0b
78	12.5 Bc	34.9 Ab		13.7 Ba	29.7 Aa	33.3b	28.8 Aa	35.1 Aa	90.3b	1.9 Bd	8.0 Bc	80.7b
84	17.4 Ac	37.2 Ab		6.7 Aa	20.3 Ba	33.7b	10.9 Ab	13.9 Ba	90.7b	NG	5.0 Bc	80.1b
90	24.4 Ab	54.6 Aa		7.0 Ba	20.7 Ba	33.8b	14.6 Aa	16.7 Ba	89.9b	NG	13.1 Bc	80.4b
96	13.7 Ac	31.9 Ab		4.2 Aa	26.0 Aa	33,3b	15.7 Aa	21.4 Aa	89,8b	NG	10.0 Ac	81.0b
102	47.5 Aa	65.2 Aa		4.6 Ba	19.2 Ba	33,8b	8.6 Bb	8.6 Ba	89,8b	NG	NG	80.1b
Average	13.0%	46.0%		8.0%	17.0%		10.0%	20.0%		15.0%	20.0%	

* Means followed by the same uppercase and lowercase in the lines in columns (By studied variable) do not differ by the Scott-Knott test at 5 % probability. NG: not germinated. NS: not significant.

For total germination, there was no significant difference ($P < 0.05$) between the dispersal times for kudzu, Sstylosanthes and Bbutterfly pea. Higher germination was observed at times 0, 66, 72, 78, 84, 90, 96 and 102 hours after ingestion of Sstylosanthes seeds; the collection of 12, 36, 66, 90 and 102 hours for the seeds of kudzu; and 12 hours for Bbutterfly pea seeds. At 36 hours (dispersion spray), the germination of kudzu seeds (56.6 %) was significantly higher than the germination of Bbutterfly pea seeds (24.8%), Aarcher (20.4%) and Sstylosanthes (6.6%) (Table 2).

The results presented in Table 1 are similar to those reported by Gardener et al (1993), who studied the passage of eight poaceae species seeds through the bovine GIT, and observed in feces increased retrieval between 24 and 36 hours after eating the seeds.

The 36-hour period corresponded to the peak of seed retrieval (dispersal) for the evaluated species, except for Bbutterfly pea. In this period, Sstylosanthes was significantly superior to other species considering the number of retrieved seeds (1423), followed by Aarcher (832); the lowest value was found for kudzu (151). The retrieval of seeds reduced from 36 hours in accordance with the increase of time after ingestion, agreeing with the results found by Gökbulak (2006), in which the retrieval of seed reduced when the time increased from one to 4 days after ingestion thereof.

Even considering the homogeneity of animals used in this study (age, weight, sex and management), seed retrieval from the feces showed large variations. Lisboa et al. (2009) also observed this behavior. Thus, Studies on seed dispersal by animal feces should consider the greater homogeneity of the Study animals, and as many repetitions as possible for the animal effect has less influence on the results. However, this variation is not an impediment for the use of this dispersal technique.

Ramos et al. (2006) showed 50% retrieval of seeds of five species of the family Cistaceae after passage through the GIT of sheep. The authors attributed this high retrieval to the small size and hardness of the integument of these seeds, which protect them from damage during chewing and rumination.

Considering that the number of seeds of each species offered to the animals was known, as the number of seeds recovered, it can be inferred that the difference is equivalent to the numbers of seeds degraded by the digestive tract in the animals. After ingestion of the seeds, the damage is caused by the chewing and digestion processes by the animal. A study on the recovery of seeds of fodder species, in feces of different animal species, pointed to different damages caused by ingestion and passage through the digestive tract of goats.

Although the seeds of kudzu and Sstylosanthes have different sizes, and the seed kudzu three times, the retrieval percentages of these from the feces was similar (21.6 and 26.4 %, respectively). This suggests that the seeds suffered similar damage caused by ingestion and passage through the GIT of goats. This result is related to seed size and seed coat strength. These results are consistent with those reported by Nakao and Cardoso (2010), which assessed seeds of pigeonpea, leucena and calopo and obtained low retrieval from cattle feces for all species, regardless of the size of the seeds.

By contrast, the low retrieval of Bbutterfly pea seeds can probably be explained by their larger size, which leads to strong chewing by the goats. In corroboration, Simão Neto et al. (1987) stated that large seeds are more prone to damage by chewing, as a small crack in the seed coat is enough to expose them to attack by rumen microorganisms and other effects of digestion.

Os resultados deste estudo e os valores encontrados por Deminicis et al. (2009), quando avaliada a germinação de sementes de Bbutterfly pea nas fezes de bovinos, mostram as diferenças entre ovinos e bovinos, apesar das duas especies serem ruminantes. These authors observed 30 %

Bbutterfly pea seedlings in the cattle feces, higher than seeds retrieved from the feces of goats in this study (17%). In a study on the chewing efficiency of herbivores, Fritz et al. (2009) reported that the particle size ingested should be proportional to the body mass of the animal; thus, the goat has a higher intensity of chewing compared to cattle. In this case, it is assumed that the higher intensity of chewing observed in goats is the most important factor to decrease the number of butterfly pea seeds retrieved from the feces of these animals.

Considering all the factors cited by Jones and Simão Neto (1987) as responsible for the degradation of the seeds as they passed through the GIT (animal, diet quality, seed size, length of stay in the GIT, etc.), the highest percentage of retrieval of Aarcher seeds should be associated with the hardness of integument. These authors also pointed out that seeds with hard seed coat resist better the damage caused by the pressure of the teeth during chewing, as well as the attack of ruminal microorganisms and other processes related to digestion.

The first germination count test identifies vigorous seeds as those that germinate in the shortest period of time (MARCOS FILHO, 2005). However, in this experiment, the at first germination count also represented overcoming dormancy by passing the seeds through the GIT of goats. The kudzu and Aarcher seeds showed positive effects with the passage through the GIT, since there was an acceleration in the germination treatment from 36 hours for kudzu (12.5%) and 48 hours for Aarcher (17.9 %) compared to the control (0 % for both).

Most of the species in the collection period between 12 and 30 hours showed that permanence in the digestive tract of goats improved the germination of the seeds. After this period, scarification due to stay in the GIT of goats caused damage to the seeds, with low in the first germination count.

The results of the first germination count may have been influenced by the seed size. Thus, contrary to Jones and Simão Neto (1987), which stated that large seeds are more susceptible to damage caused by the passage through the GIT of the animals, the lowest germination was obtained by Sstylosanthes (smaller size compared to the others) and the highest was obtained by Bbutterfly pea (larger size). These results suggest that, in addition to size, the cutaneous hardness can influence the viability of seeds by passing through the GIT of goats.

The kudzu seeds increased germination caused by the passage through the GIT of goats. In some periods, seeds reached significantly high levels of germination (56.6; 61.9; 62.8; 54.6 and 65.2 %) when compared to control (33.5%). This showed that scarification by the passage of seeds through the GIT of the animal was beneficial for this species in this experiment. These results are similar to those found by Gökbulak (2006), who observed higher germination of Sandberg bluegrass seeds three days after ingestion by cattle.

Low germination (average of 20 %) and high retrieval (70.9%) of Aarcher seeds, table 1, together with the high percentage of hard seeds at the end of TG (38%) confirm the cutaneous hardness of this species, corroborating the results of Paiva et al. (2006), who reported low germination of Aarcher seeds when not scarified.

The passage through the GIT of goats considerably reduced the percentage of germination of Sstylosanthes seeds. This result was similar to those reported by Rao et al. (2007), who observed a variation of 6 to 0.25% of germination of Sstylosanthes seeds when mixed with salt after passing through the digestive tract of cattle. Finally, the tetrazolium test showed no significant differences in the viability percentages between control seeds and kudzu seeds retrieved from goat feces . In the case of Sstylosanthes, Archer and Bbutterfly pea, control seeds were significantly more viable than defecated ones ($p \leq 0.05$) (Table 2).

The passage through the goat GIT did not soften Aarcher and Kkudzu seed coat, therefore it did not increase germination, neither caused damage to

the embryo, which would have adversely affected seed germination, as evidenced by the viability percentages of seeds obtained in the tetrazolium test (Table 2). On the contrary, the passage through the goat GIT softened the seed coat of butterfly pea, decreasing the viability of ingested seeds. It is assumed that these seeds suffered more intense damage during passage through the GIT of animals, since this species had a high percentage of dead seeds at the end of the germination test. This may be related to the fact that small seeds have higher specific surface, since the amount is greater because of the smaller size. Thus, small seeds suffer more the action of digestive acids. Disagreeing with Simão Neto et al. (1987), which emphasized that small seeds are more resistant to the damage mainly due to lower intensity of mastication and higher rate of passage through the GIT of animals.

The fact that goats have a higher chewing intensity compared to cattle may have caused more damage to the structure of the seeds that were not exposed to the acids in the animals' digestive tract. The seeds that spent more time in the digestive tract of the animals were more attacked and damaged, resulting in reduced germination values (Table 2). This result disagrees with the findings of Deminicis et al (2009), in which Bbutterfly pea seeds showed the highest percentage of germination in the cattle feces (30%), among the species studied. Gökbulak (2006) said it was difficult to compare the results of retrieval and germination of seeds dispersed by goats and sheep with the results for cattle, mainly by the difference in size of the mouthparts, which results in different levels of damage during chewing.

In a study on the dispersal of native plant seeds from Nigeria, Jolaosho et al. (2006) compared goats, sheep and cattle as dispersers of these seeds. These authors obtained higher germination of seeds in the feces of goats and sheep (32 and 28 %) compared to cattle (5 %). According to the authors, the lower germination of seeds from the cattle feces is due to the higher retention time in the rumen, although they did not test the viability of seeds that did not germinate.

Retrieval percentage versus Germination percentage: four evaluated Fabaceae obtained different percentages of retrieval and germination, but all showed potential for this technique. However, in this experiment, Aarcher and kudzu seeds were more viable for use in this dispersal technique for presenting greater retrieval and germination, respectively (Table 1 and 2). These results are in agreement with those presented by Mouissie et al. (2005), who reported the survival of 25 different species used for the evaluation of endozoochory seed dispersal in deer. In this study, the authors obtained 50% retrieval of the seeds offered in up to 25 hours (range 13-38 hours).

For the species studied, the highest percentage of seeds recovered was concentrated in the period from 24 to 42 hours after ingestion of the seeds. During this period, were recovered 52%; 20.1%, 11% and 10%, respectively, of the total seeds of archer, Sstylosanthes, kudzu, and butterfly pea. As for the number of seeds retrieved in this period, the average values of germination percentage and hardness were, respectively, 48 and 20% for kudzu, 29 and 36.5 % for butterfly pea, and 19.5 and 33% for Aarcher. In turn, Sstylosanthes seeds retrieved showed, on average, 10% germination and 81.5 % dead seeds.

After scarification, germination of kudzu seeds increased from 46 to 55%. The increase in germination of kudzu seeds is related to the shape and texture of the integument. These seeds are spherical and with smooth integument, hindering the damage during mastication (SIMÃO NETO et al., 1987). These results are similar to those found by Machado et al. (1997), who reported minor damage on Lathyrus crassipes seeds after passage through the GIT of sheep.

In the case of Aarcher seeds, more species retrieved from feces of goats, germination increased from 20 to 51%, while the germination of Kkudzu seeds increased from 20 to 51%, confirming the

results obtained by Gardiner et al. (2012). These authors stated that the seeds which did not germinate in the first test remained viable after passing through the GIT of sheep.

Thus, in natural field conditions when the animals disperse the seeds of Aarcher and Kudzu, part of which will germinate readily, and some remain dormant in the feces. This is a way to perpetuate the forage pasture, and resist drought. The Dormancy will broke slowly; either by time, by fermentation of feces, or by the action of insects or fungi present in fecal matter and soil, allowing a new germination in the next period of favorable conditions of water, light and temperature.

Low germination of Sstylosanthes seeds can be explained by the high percentage of dead seeds verified in the tests. These results agree with those obtained by Rezende et al. (2007), who found that Stylosantes seeds mixed with mineral salt and ingested by the animals showed significantly lower germination percentage (5%) than seeds only mixed with salt (71%), which confirming the damage to Sstylosanthes seeds by passing through the GIT of the animals. Giordani et al. (2015) studied the dispersal of seeds of Mimosa luisana by domestic goats in México and observed that after passing through the goat GIT, 47.5% seeds germinated while only 5.83% of the undigested seeds germinated. In addition, they found that during the experiment, more than three quarters of the seeds (77%) passed through the intestine of goats between 8 and 24 hours after ingestion.

The endozoochory dispersal technique for Planting/Spreading Fabaceae in pastures is feasible, but this is a long-term process, since there is considerable loss in mastication and digestion, resulting in low seed viability at the end of the dispersal. Thus, there is a need to continuously supply seeds to the animals to achieve dispersion of the desired number of seeds in a given area. Aarcher has a higher percent retrieval from goat feces. The kudzu species had higher germination among the retrieved seeds. The period of seed dispersal is 24 - 42 hours after ingestion, with a peak within 36 hours. Goats can be considered legitimate seed dispersers of Fabaceae species evaluated in this study. Aarcher and kudzu are the species most suitable for goats by scattering technique, due to the greater retrieval from feces and good germination.

Acknowledgments

To FAPERJ and CAPES for financial support.

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