CHANGES IN THE DISTRIBUTION OF CARBOHYDRATES DUE TO WATER STRESS AND ROOT-SHOOT RATIO AS AN INDEX OF DROUGHT RESISTANCE IN ECOTYPES OF *ADESMIA BICOLOR* (POIR.) D.C.

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ABSTRACT
The genera *Adesmia*, is found in the "El Plata" area. *Adesmia bicolor* (Poir). D.C. is one of the most common species in Uruguay that belongs to this genera. In this study, three ecotypes were collected from different kinds of environments. Ecotypes 016, 2316 and 7017, came from superficial-soil, clay-soil and sandy soil, respectively. The ecotypes of *Adesmia bicolor* (Poir.) DC. were studied under water-stress conditions (two levels), during two stages: vegetative phase and beginning of blossom. In both stages, leaf-water potential (LWP), leaf-relative-water content (LRWC), leaf-dry matter (LDM), stem-dry matter (SDM) and root-dry matter (RDM) were measured, while root-shoot ratio [RSR=RDM/(LDM+SDM)] was calculated. During the first stage, ecotype 2316 was more affected by water stress (LWP = -2.238 MPa, LRWC = 49.248 %), while ecotypes 016 and 7017 were more tolerant to water stress (LWP = -1.600 MPa, LRWC = 82.120 % and LWP= -1.628 MPa, LRWC = 73.407 %, respectively). At this time we noticed a differential partition between LDM and SDM, without affecting the root-shoot ratio. Ecotype 016 under water stress, sent more carbohydrates to the stem rather than to the leaves, while in the ecotypes 2316 and 7017 there could not be found any difference in the partition associated with water stress. On the second stage, all the plants showed better hydric conditions; ecotype 2316 was the most sensitive ecotype (LRWC = 78.098 %) and ecotype 7017 was the least sensitive (LRWC = 89.448 %). However, ecotype 2316 showed good leaf and stem yields for both stages, even under the first water-stress cycle; while ecotype 016 was the least productive ecotype. Root-shoot ratio was associated with differences in the water stress resistance between ecotypes. On the first stage, RSR for ecotypes 016, 7017 and 2316 were 0.263, 0.224 and 0.197 respectively; on the second stage, ecotype 7017 showed the highest RSR (0.333). It is suggested that root-shoot ratio could be used as an index of selection towards drought resistance among those ecotypes. This ratio would not be influenced by temporary water stress conditions.

KEYWORDS
Adesmia bicolor, ecotype, root and shoot ratio, legume, forage, water stress, partition.

INTRODUCTION
One of the problems that limits beef cattle production in Uruguay is the low availability of forage. There were some attempts to amend this limiting factor by incorporating exotic species but they have problems with their survival abilities. While most of the native pastures are affected by periods of drought (Millot et al., 1987), *Adesmia bicolor* (Poir.) De Candolle is well adapted to Uruguayan ecological conditions (soil, climate and grazing) (Burkart, 1966; Cabrera, 1953; Burkart et al., 1987). Moreover it has a high nutritional value: 78 % digestibility and 18 % crude protein (Coll and Zarza, 1992). Since Uruguay represents a center of diversification of this species (Davyt and Izaguirre, 1992), we could detect ecotypes that were adapted to water shortage yet produced good dry matter yields. On the other hand, it is interesting to study the effect of "hardening" under stress conditions and this would be done evaluating *Adesmia bicolor* during vegetative and beginning of flowering stages . The present work intends to determine adequate methods for the evaluation of stress tolerance and productivity as part of an effort to develop improved varieties of *Adesmia bicolor*. Even through there exists a wide background on plant physiology and plant water stress, the references that consider the study of legume pastures are sparse. The lack of references to native species is even more accentuated.

MATERIALS AND METHODS
Plant Material**:** Three ecotypes of *Adesmia bicolor* (Poir.) D.C. (016, 7017 and 2316) were collected from the Lavalleja (superficial soil), Cerro Largo (sandy soil) and Canelones (clay soil) provinces of Uruguay respectively. Those ecotypes were exposed to water stress and were analyzed at two stages. First stage (FS), at the time of the vegetative phase and second stage(SS), during the beginning of blossom. The control plants were identified with HL_0 (hydric level 0) and the stress-plants with HL_1 (hydric level 1). The seeds were unscarified with NaClO (0.5 %) and washed three times with regular water before seeding. The plants were grown in PVC pots (34 cm height x 12 cm diameter) containing a mixture of clay-sandy soil fertilized with super-phosphate. The pots were placed in a greenhouse during the first and second stress cycle, where the environmental conditions were: 15ºC/28ºC (Tmin/max)- 60%/80% (RHmin/max) and 18ºC/30ºC - 50%/70%, respectively.

Handling**:** the weight of the experimental unit (plant-pot) was calculated until Field Capacity (FC) according to the formula: water weight / soil dry weight * 100 (for this type of soil a water content value at FC is 20%).120 days after seeding (AS), water was added to all the pots until FC was reached. Day 127 AS, the stress plants were left in 75% FC, while the control plants were maintained at FC. Day 141 AS, watering was stopped for the stress plants while the control plants were maintained at FC. Day 144 A.S, the first stage was settled and the next variables were measured and calculated: leaf water potential (LWP) (by Scholander pressure chamber), leaf relative water content (LRWC), leaf dry matter (LDM), stem dry matter (SDM), root dry matter (RDM), total dry matter (TDM=LDM+SDM+RDM) and root-shoot ratio [RSR=RDM/(LDM+SDM)]. The stressed plants destined to the second stage of sampling were left to recover until the second cycle of hydric stress was imposed, which proceeded similar to the first one. The statistical model applied was a randomized complete blocks in a factorial arrangement. Each treatment consisted of the combination of ecotypes with two hydric levels and for two stages.

RESULTS AND DISCUSSION
It was found interaction between hydric levels and ecotypes for LWP, LRWC, LDM, SDM and TDM at the first stage, it means that there was a different behaviour between ecotypes under water stress. While at the second stage it was not detected this interaction in any of the variables. During the first stage of stress, all the hydric parameters showed a worst condition (Table 1). Under these situations, that occurred during the vegetative cycle, a slight reduction in the LDM took place. Since the SDM and RDM were not seriously affected, the RSR was incremented but it was not found statistically significant. When the second stress cycle was imposed, during blossom initiation, all the plant organs were affected, but the shoot (leaves and stems) was more affected than the roots (Table 1). Hence the RSR showed

a slight increase. We therefore conclude that the RSR is not influenced by temporary water stress. This ratio could be slightly affected while having a previous history of water shortage. Ecotype 016 combined more tolerance to drought (Table 2) and less shoot productivity. During the first stage the LDM and the SDM of control plants were 1.010 g and 0.193 g respectively. While the stress-plants showed values of LDM and SDM of 1.723 g and 0.765 g respectively. Furthermore its RWC did not suffer any change between stages and under water deficit. Ecotype 2316 had a good productivity of shoots even under water shortage, however its hydric condition was the most affected in relation to the other ecotypes. At the first stage the LDM and the SDM of control plants were 3.851g and 1.646 g; while the stress-plants those were 3.573 g and 1.593 g respectively. Ecotype 7017 showed at the first stage a LDM of 4.096 g and a SDM of 1.436 g and for the stress-plants LDM was 2.413 g and SDM was 0.840 g. This ecotype could respond better to a previous history of stress without affecting its RWC (92%, 73.41% for control and stress plants at first stage respectively and 92%, 89.45% for control and stress plants at the second stage respectively). In addition, during the first stress cycle, ecotype 016 showed a differential partition between LDM and SDM, without changing the RDM. This ecotype under water stress sent more carbohydrates to the stem rather than to the leaves. During the first stage it was detected in control plants that LDM was 67% and SDM was 13% of the total dry matter. However plants under stress destined 57% to the LDM and 23% to the SDM. While in the ecotypes 2316 and 7017 could not be found any difference in the partition of carbohydrates. Since high values of RWC in the ecotypes were associated with elevated RSR values, during the two moments of stress imposed (Table 2), we therefore suggest that the RSR could be used as an index of drought resistance, which means that higher ratios could be correlated with better water stress resistance. The RWC allowed us to detect even the smallest variations of the hydric condition (Table 2), in consideration of that we believe that is a better parameter than LHP.

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Table 1
Average values in the First and Second Stage

First Stage

Hydric Level	HP_1	RWC_1	LDM_1	SDM_1	RDM_1	TDM_1	RSR_1
0	-1.375*	87.879*	3.191*	1.200	0.819	5.283	0.200
1	-1.848*	67.020*	2.741*	1.120	0.829	4.694	0.220

Second Stage

Hydric Level	HP_2	RWC_2	LDM_2	SDM_2	RDM_2	TDM_2	RSR_2
0	-1.373*	86.84*	9.554*	6.839*	3.278*	19.671	0.200
1	-1.721*	80.74*	6.998*	5.156*	2.743*	14.896	0.230

(*) Those values are significant at the shown level: HP_1 (0.0046), RWC_1 (0.0001), LDM_1 (0.1618),

Table 2
RSR and RWC in the First and Second Stage

	RSR(**)		RWC (%)(**)		LWP(MpA)(**)
Ecotype	$FS^{(++)}$	$SS^{(+)}$	$FS^{(+)}$	$SS^{(+)}$	$FS^{(+)}$
2316	0.197b	0.191A	49.25b	78.09A	-2.238b
7017	0.224ab	0.333B	73.14a	89.45B	-1.628a
016	0.263a	0.218A	82.12a	82.68A	-1.600a

(**) different letters mean values that are significant at the 1%(++) and 10%(+) levels.

Note: The RWC and LWP dats, belong to stress-plants. There was not found any significant difference between ecotypes in the SS for LWP.