AN APPROACH TO DEFINE G x E INTERACTION IN A CORE COLLECTION OF *DESMODIUM OVALIFOLIUM*

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ABSTRACT
In searching for alternative forage legumes, there is a need for increased emphasis on understanding the influence of environment on quality and anti-quality factors. The tropical pasture legume *Desmodium ovalifolium* contains high levels of tannins, which, however, vary among accessions and seem to be influenced by environmental factors. A core collection of 18 accessions was selected based on geographic origin, and agronomic and quality parameters. A multilocational trial with this core collection was initiated in six contrasting environments in Colombia to identify soil fertility and climate effects on tannin contents. This is complemented by greenhouse trials and other research such as studies on tannin dynamics, genotype fingerprinting by isozymes, analysis of available *D. ovalifolium* database information, and GIS technology based data processing. The main output will be the identification of superior genotypes and environments with high potential for *D. ovalifolium*. The described approach and the results are also relevant to the evaluation of other tropical legumes with tannin contents.

KEYWORDS
Tropical legumes, quality, tannins, genetic diversity, multilocational trial, PAGE, GIS

INTRODUCTION

Current tropical forage research aims to identify and develop legume and grass germplasm for marginal conditions such as acid, low-fertility soils in the humid and subhumid tropics in order to contribute to increased livestock production and soil enhancement. To select legume germplasm for different environments and production systems, there is a need to define the influence of environmental factors on quality and anti-quality components like tannins and possible interactions with genotypes. Yet the knowledge about genotype x environment interactions on quality components of tropical legumes is limited. An important example for a tropical legume, whose quality seems to be influenced by the environment, is the Southeast Asian Desmodium heterocarpon DC. subsp. ovalifolium Ohashi, widely known under its earlier name "*Desmodium ovalifolium*" (Schultze-Kraft, 1992). In this paper, an approach to define G x E interactions in this species is presented.

The Species

Desmodium ovalifolium has, because of its stoloniferous growth habit and adaptation to low-fertility soils, a high potential not only as a pasture legume, but also for soil conservation and reclamation of degraded areas in the humid and subhumid tropics. However, livestock performance with this legume in association with grasses can be poor (CIAT, 1990), mainly because of low acceptability to grazing cattle (Schultze-Kraft *et al.*, 1989). Low forage quality in *D. ovalifolium* is associated with high tannin contents (Carulla, 1994; Lascano *et al.*, 1995), which are variable among accessions (Schultze-Kraft and Benavides, 1988), and influenced by edaphic and climatic factors (Sobrinho, 1982; Salinas and Lascano, 1983).

Identification of the Core Collection

A core collection intends to represent the genetic spectrum of an entire collection as well as to include as much as possible of its genetic diversity (Brown, 1989). On the basis of germplasm passport and evaluation data, Schultze-Kraft and Benavides (1988) proposed 28 genotypes for a core collection of *D. ovalifolium*. In the final selection, out of a total of 149 accessions held at CIAT, 18 accessions were included in the core collection, based on (1) their representativeness of the geographical distribution of the species, including density of collection sites in a given area (Figure 1); (2) environmental conditions at the collection sites; (3) agronomic performance; and (4) quality parameters (Table 1).

Field Experiment

The core collection was established in a multilocational trial in six contrasting environments, which are representative high-rainfall locations in Colombia: (1) well-drained savanna, hot (Carimagua, two sites with contrasting soil textures); (2) humid forest margins, hot (Caquetá, two sites with contrasting drainage conditions); (3) dry hillsides, cool (Cauca); and (4) humid hillsides, cool (Caldas). As in the selected locations temperature is confounded with soil acidity/fertility, a fertilization treatment with two levels (low/high), adjusted to the specific conditions of the location, was applied. Along with climatic data recording, the following measurements are carried out at each location:

(1) Morphological and production measurements every six and eight weeks in the periods of maximum and minimum rainfall, respectively; (2) quality analyses in leaves of a six and eight weeks-old regrowth for crude protein (CP), cell wall components (NDF, ADF), in vitro dry matter digestibility (IVDMD), condensed tannins (type and astringency), phosphorus, and sulphur; (3) acceptability to grazing cattle through cafeteria-type trials in order to determine relative palatability of genotypes, which will be correlated to quality data.

Greenhouse Trials and Other Research

Complementary trials are set up with selected genotypes under controlled greenhouse conditions to determine soil fertility effects on tannin content and to describe how tannins change with plant growth and development. In addition, the entire collection of *D. ovalifolium* held at CIAT is characterized by isozymes, utilizing polyamide gel electrophoresis (PAGE) in order to study both the species' patterns of diversity and the representativeness of the core collection. Finally, all available biological and agronomic information on *D. ovalifolium* is collected from accessible databases and submitted to appropriate statistical procedures; this includes multilocational agronomic evaluation data from Latin American and African networks. Geographic Information Systems (GIS) technology will be used to combine these data sets to generate maps of regions with potential for growing *D. ovalifolium*, and to identify areas in Southeast Asia with both high genetic diversity and potential to find new promising germplasm.

EXPECTED RESULTS

It is expected that results from this project will broaden the knowledge on the effects of soil fertility and climate on forage quality of legumes with high levels of tannins, in general. This is particularly relevant to the evaluation of multipurpose trees and shrubs. In addition, results should help in the identification of (1) superior genotypes of *D. ovalifolium* for the enviromental conditions as represented by the six selected locations, and (2) environments where the potential of *D. ovalifolium* is particularly high. Finally, the results should be helpful for setting regional priorities for future germplasm collection

missions. It is submitted that the proposed approach, which is based on (1) a large, well documented and adequately characterized germplasm collection; (2) its reduction to a representative and manageable core collection; (3) the multilocational evaluation of the core collection under contrasting environmental conditions; and (4) the linkage of evaluation results and other available information on the respective species by modern statistical procedures and GIS technology, is also suitable for other species where G x E interactions need to be studied.

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Figure 1
Natural distribution of *Desmodium ovalifolium* germplasm: Areas of collection site densities and origins of core collection accessions (based on Schultze-Kraft, 1990).

Table 1
Desmodium ovalifolium core collection (CIAT accession no.)

Origin (no.)	Environment			Agronomic performance			Quality				
	Origin[a]	High altitude	Low rainfall	Early flower	High seed	Quick establ.	High CP	High N_{sol}	Low tannin	High IVDMD	High palat.
Thailand (11)											
North	23618[b]	33058	(33058)[c]								
Southeast			13655		13647					13651	
South	13089		13086	3788		13125		3793		13030	
Malaysia (3)						13105	13305		13110		(13105) (13305)
Indonesia (3)											
Centr. Sumatra	23665										
South Sumatra	23195										
Sulawesi	23762										
Without information (1)	350[d]										
Total (18)	6	1	2	1	1	2	1	1	1	2	

a. Selected because of geographic origin only; b. From Laos, close to frontier of Thailand.
c. Accession numbers in parentheses were chosen by more than one selection criterion.
d. Commercial cultivar (origin unknown)