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Hyparrhenia variabilis a potential invasive exotic weed at Mexico

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Abstract

The genus *Hyparrhenia* Andersson ex E.Fourn. is native to Africa, but presents in several countries and many parts of the world. Mexico is one of the countries, where *Hyparrhenia rufa* (Nees) Stapf (Poaceae) is found. However, it is classified as a highly invasive exotic species; therefore, is on the list of invasive species in Mexico. In recent years, the presence of *Hyparrhenia cymbaria* (L.) Stapfand and *Hyparrhenia variabilis* Stapf (Poacear) has been reported, while *H. variabilis* has been observed in the state at Morelos, Michoacán, and Jalisco. *H. variabilis* has been particularly identified in the municipality of Tepatitlan, Jalisco, Mexico. It has been observed that it grows densely and displaces native vegetation. Some studies mention that there are biotypes that have the ability to inhibit nitrogen-fixing bacteria, so it is necessary to study its biology and its inhibition capabilities around nitrogen fixation and seek strategies to stop its spread. The objective of this research was to review the information that exists on the species *H. variabilis* and its control. Apparently, there is a lack of information on this specie. However, there are some studies on other species of the genus such as *H. rufa*, which classified as highly invasive and some management reports can be used for *H. variabilis*. Therefore, it is necessary to develop management for the species based on literature available on *H. rufa*.

Keywords: *Hyparrenia variabilis*, invasive species, Change biodiversity, nitrogen fixation inhibition, quick adaptation

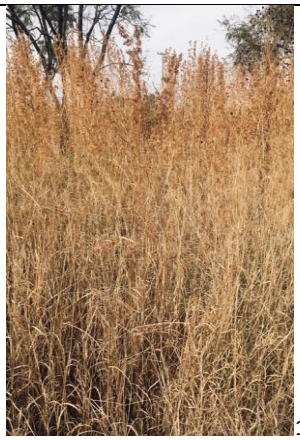
Introduction

Hyparrhenia is native to southern tropical Africa and has around 50 species, including *H. rufa, Hyparrhenia hirta* (L.) Stapf*, H. cimbaria* and*, H. variabilis* (Clayton, 1975; Vibrans *et al.,* 2014). Some species of the genus were introduced at tropical America and Asia regions. It is distributed throughout the tropics around the world and there are reports of its presence from sea level to 1820 m altitude. Its presence is currently reported in the United States, Mexico, and Australia (Chejara et al*.,* 2012; Vibrans et al*.,* 2014). In Africa it has been used to build roofs, for which it has been given the name "roof grass" (Vibrans et al*.,* 2014). *H. rufa* and *H. hirta* have been found as part of the diet of *Phacochoerus africanus* Gmelin (Suidae) (Edossa et al*.,* 2021), while in some other countries, they have been introduced as fodder but it is also used as hay and silage.

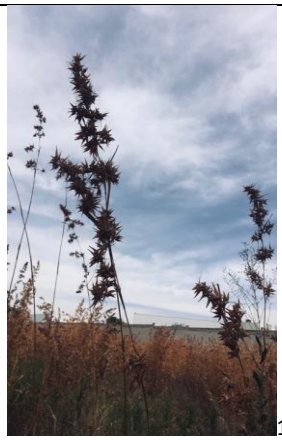
The nutritional content of *H. rufa* is acceptable at Mexico (Table 1). The characteristics that pushed in *H. rufa* by human to Mexico were its ease of adaptation, fast growth, resistance to drought, and the high productivity of biomass, for which its introduction was with a dual purpose, fodder for the industry livestock, and erosion control, slope restoration, as well as roadside stabilization (López et al., 2019). "*Hyparrhenia hirta, H. rufa, H. cymbaria and H. variabilis*, have been found in Mexico for some time, the first two have been in the country for several decades", in the case of *H. cymbaria* and *H. variabilis* approximately a decade. However, despite its benefits as a genus, several of its members are labeled as invasive.

Biological invasions were recognized in the last two decades of the last century. Since 1992, the Convention on Biological Diversity identifies them as a "problem" since it states that

Table 1. Nutrient content of *H. rufa*, "jaragua grass"			
Fresh plant	%	Hay	%
Water	80.0	Water	19.0
Crude protein	2.0	Crude protein	5.8
Carbohydrates	6.5	Carbohydrates	31.0
Fiber	9.0	Fiber	33.8
Fats	0.5	Fats	1.0
Ashes	2.0	Ashes	9.4

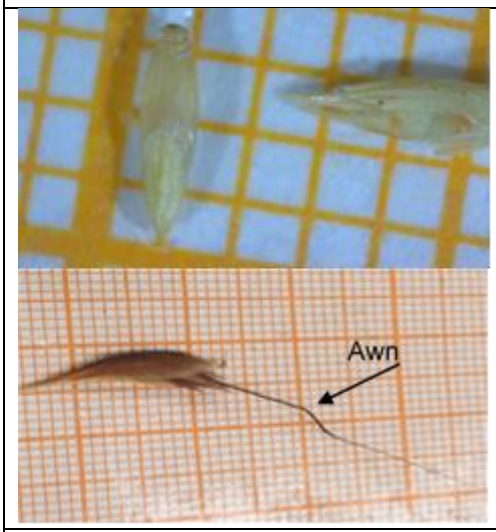


1a



1b

Figure 1. Characteristics of *Hyparrhenia variabilis*. a)Dense populations and *b)* Spikes or bunches of *Hyparrhenia variabilis*



b

c)

a)

Figure 2. Reproductive structures of *Hyparrhenia variabilis*. a) Bunches, b) seed, c) pair or spikelets

"they will prevent the introduction, control or eradication of exotic species that threaten ecosystems, habitats or species" (Art. 8, paragraph h), which urges the signing parties to commit to it. Invasive species are then defined as "exotic species that have become established in natural or semi-natural habitats, as agents of change, threatening native biodiversity (Ley General de Silvestre, 2000). In this context, *H. hirta* and *H. rufa* have been reported to change native biodiversity due to high competition. In Australia, *H. hirta* (coolatai grass) has been reported as invasive to such an extent that it is destroying the ecosystem of a group of rare native plants, since it begins to invade and ends up dominating plant populations. From 1890, it was introduced to Australia for forage and then rapidly spread and naturalized (CCR for Australian Weed Management, 2008).

Invasiveness of *Hyparrenia*

As an invasive plant, some species of *Hyparrenia* have the ability to grow quickly after being, burned, cut, or crushed. In addition, its growth rate increases with heat, it adapts easily and displaces native species, changing the diversity of the invaded sites, as well as the structure and the fire regime. It is easy to naturalize as it reproduces outside its natural distribution range, rapidly increasing the number of individuals forming dense populations. It is highly resistant to drought and low humidity, its seeds germinate quickly, which gives it an advantage when it comes to capturing moisture from the soil.

Therefore, it is important to eradicate invasive exotic species such as some species of the *Hyparrhenia* genus to favor the succession ecological process of native species, which is generally slower than the development and naturalization of this type of species aggressive.

In 2011, a proposal was made to classify weeds, according to their reproduction and establishment characteristics, where at least two aggressive species of Hyparrhenia are at level "E" under which a completely invasive population is described, with individuals that disperse, survive and reproduce in multiple sites throughout their range of presence and a more or less broad spectrum of habitats (Blackburn et al., 2011). Hence, efforts are already being made to control these species in places where it is already a problem.

Control strategies for some known species of Hyparrenia

In some places where members of the genus are a problem, strategies have been proposed to control their dispersion and possible eradication. It includes chemical and mechanical control, application of fire and also biological control. Some of thesde methods had led to partial success. For example, in Puerto Rico studies have been carried out to find pathogens that affect *H. rufa, Curvularia* sp., *Fusarium* sp., *Phoma sorghina* and *Sphaeropsis* sp. were reported as possible controls for this species. Of these, Fusarium was the most virulent in field experiments (Rivera-Andújar et al., 2016). In Australia, specific management procedures were established to control *H. hirta*. It has been observed that management with the use of chemicals or herbicides is not enough to eliminate the common weeds. The earlier the control is carried out, the more efficient it would be, because the thick stems do not allow the herbicide to penetrate, so a single application may not be enough. A relative success is reported when the plants are young and mechanical control plus chemical application was carried out. Flupropanate and glyphosate are currently being used. However, the application might be targeted and requiring permit. In some countries application of these herbicides might be prohibited. Controlled burning is also carried out. However, it has been observed that this stimulates the germination of native species and could stimulate the germination of Hyparrhenia sp.

Another management with relatively high success has been reported in Coolatai grass (*Hyparrhenia hirta*). This consists of: (a) Cut or burn before flowering appears, in spring, if seeds are found, contain the seeds, avoid their dispersion, (b) Wait 4 to 6 weeks to grow (c) Look for native or autochthonous plants and protect them from herbicide application (d) Apply a spot spray of glyphosate + surfactant (e) wait for them to grow and repeat. A scan should be done after the next rain to make sure there was no germination and the problem is still there. In some regions of Australia Coolatai grass (*Hyparrhenia hirta*) has been classified as C3 (CCR for Australian Weed Management, 2088).

In Mexico there are two species of the Hyparrhenia genus on the list of invasive alien species: *H. hirta* and *H. rufa* (DOF, 2016). At the government level small actions are beginning to be taken with the implementation of projects or programs that generate actions aimed at controlling or eradicating their presence. A recent project has aimed at (1) Increase National Capacities for the Management of Invasive Alien Species (IAS) through the implementation of the National Strategy on IAS in Mexico and (2) Strengthen the effectiveness of management and resilience of "Protected Areas to protect biodiversity threatened by climate change". This project was carried out in the Cañón del Sumidero National Park in Chiapas. The result has proposed to apply controlled fire breaks and burning. Another action is to cut the large stems, leaving them to dry for about four days and applying glyphosate at 3% containing a dye that allows the technician to observe its correct application. Moreover, it is applied seven days after manual clearing to prevent new growth. On the other hand, the MERI methodology has been applied to *H. hirta*, finding a high risk of invasiveness. So *H. variabilis* would be expected to behave in the same way.

Hyparrhenia variabilis

It is another species of importance that presents in Mexico. Its presence is documented since 2010 by García Moya and reported by Vibrans (Vibrans et al., 2014) where its extensive and dense populations are documented in the states of Morelos, Jalisco, and Michoacán in similar agroecological environments and an altitude range that goes from 1,300 to 1,820 m (4,265 to 5971 ft.). There are no reports of damage, so it is important to carry out work in this direction, since the growth of dense populations (Fig. 1a, b), as already mentioned, suppresses the native flora.

In addition to its potential aggressiveness towards native plants, *H. variabilis* and biotypes of *H. diplandra* are known to exude secondary metabolites capable of inhibiting nitrogen fixation (Boughey, 1964; Vibrans et al., 2014). In Mexico, the producers of the Altos Sur region and La Barca in Jalisco report the presence of this species within the cultivation fields so the study of the biology of the present species becomes important, and also addresses the aspect of control or eradication. These species were identified by two of the authors and collated in the herbarium of INECOL (Figure 2a y 2b). For this species, the only biological control study that exists is *Cyperus rotundus* extract at the laboratory level in order to inhibit germination, obtaining interesting results with its inhibition (Mancilla-Margalli et al., 2016). However, the investigation must be continued urgently as fast as possible because the populations are on the rise.

Conclusions

The *Hyparrhenia variabilis* studies are important and urgent due to its faster dispersion and the consequent suppression of native populations, as well as the possibility that it can inhibit

nitrogen-fixing bacteria, affecting the crops. It should be noted that its biology and ecology are unknown, so it is imperative to address these issues.

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References

CCR for Australian Weed Management (2008) Coolatai grass (*Hyparrhenia hirta*) in Management guide. . https://archive.dpi.nsw.gov.au/__data/assets/pdf_file/0007/347155/coolatai-grass-weed-management-guide.pdf.

Clayton, W.D. (1975) Some Discriminant Functions for Hyparrhenia: Studies in the Gramineae. In XLI Kew Bulletin, 30(3). https://doi.org/10.2307/4103079

General Wildlife Law, Official Journal of the Federation (D.O.F) 1 (2000).

List of exotic species for Mexico. Official Journal of the Federation D.O.F.(2016).

http://www.dof.gob.mx/nota_detalle.php?codigo=5464456&fecha=07/12

Edossa A,Bekele A, Debella H, (2021) Diet preferences of common warthogs (Phacochoerus africanus) inGassi and Haro Aba Diko controlled hunting areas, Western Ethiopia. GECCO 29:1-16.

Flores-Mendez J (1980) Bromatología animal, Limusa (ed) 2ª ed.

López S, Mainor G, CHanona A, Texocotitla A, Castro L (2019) Technical Guide for the control of Jaragua grass (*Hyparrhenia rufa*) (1st ed). United Nations Development Program http://www.mx.undp.org/

Mancilla-Margalli N, Ramírez-Huerta G, Ramírez-Huerta L, Chavira-Díaz A, Lunea M, López-Muraira I (2016) Effects of Cyperus rotundus L. extracts on seed germination of two weed species. Paper presented at the XXXVII Mexican Congress of Weet Science XLII National Symposium of Agricultural Parasitology (IAP) Second Technical Conference (ASA):26-28.

Rivera-Andújar V, Rivera-Vargas L, Rodríguez-Carias A (2016) Fungal pathogens of Hyparrhenia rufa (Nees) Stapf. an invasive weed in Puerto Rico and their potential as biological control agents. *J. Agrie. Univ. P.R.*, *100*(2), 237–247.

Vibrans H, García-Moya E, Clayton D, Sánchez-Ken J (2014) Hyparrhenia variabilis and Hyparrhenia cimbaria (Poacea): New for the Americas, Successful in México. *Invasive Plant Science and Management 7(2):222-2228*