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ROLE OF BENEFICIAL FAUNA, ASSOCIATED TO A SILVOPASTORAL SYSTEM OF *TITHONIA DIVERSIFOLIA* CV. ICA CUBA OC-10, ON THE INCIDENCE OF PEST INSECTS

FUNCIÓN DE LA FAUNA BENEFICIOSA, ASOCIADA A UN SISTEMA SILVOPASTORIL DE *TITHONIA DIVERSIFOLIA* VC. ICA CUBA OC-10, EN LA INCIDENCIA DE INSECTOS PLAGA

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To evaluate the beneficial fauna associated with a silvopastoral system of *Tithonia diversifolia* cv. ICA CUBA Oc-10, together with natural and improved grasses, and to determine their role in the incidence of insect pests, periodic random samplings were carried out (January, May and September). A sample of 20 raids was taken for each plant component. There was a lower proportion of phytophagous insects associated with the silvopastoral system with tithonia (9.97) compared to the base grass (19.13) and the control area (20.14) and, in turn, a higher proportion of bioregulators, with higher values in tithonia (9.63) in contrast to the base grass (5.94) and control (3.84). Over time, phytophagous insects decreased significantly in the silvopastoral system with tithonia (3.70), with differences in base grass (9.18) and control area (12.52). Bioregulators remained stable in the beneficial fauna associated with tithonia (9.81), although without statistical differences among the rest of plant communities. It is concluded that there is a marked influx of bioregulatory organisms associated with the silvopastoral system with tithonia and base grass compared to the control area, with grasses only. An increase or stability was achieved with the years of exploitation of the system. This is a favorable indicator, which increases zoological and functional biodiversity, contributes to the integral management of insect pests and guarantees the sustainability of the agroecosystem. It is recommended to promote increasingly diversified areas, such as silvopastoral systems, and avoid the extension of monoculture areas to favor the balance between phytophagous and bioregulatory species, under non-harmful levels.

Keywords: *bioregulators, grazing, Mexican sunflower, phytophagous*

Para evaluar la fauna beneficiosa, asociada a un sistema silvopastoril de *Tithonia diversifolia* vc. ICA CUBA Oc-10, junto a gramíneas naturales y mejoradas, y conocer su función en la incidencia de insectos plaga, se efectuaron muestreos aleatorios periódicos (enero, mayo y septiembre). Se tomó una muestra de 20 redadas por cada componente vegetal. Hubo menor proporción de fitófagos asociados al sistema silvopastoril con tithonia (9.97) con respecto al pasto base (19.13) y al área testigo (20.14) y, a su vez, mayor proporción de biorreguladores, con valores más altos en tithonia (9.63) en contraste con el pasto base (5.94) y testigo (3.84). Con el tiempo, los fitófagos disminuyeron significativamente en el sistema silvopastoril con tithonia (3.70), con diferencias en pasto base (9.18) y área testigo (12.52). Los biorreguladores se mantuvieron con una estabilidad en la fauna benéfica asociada en la tithonia (9.81), aunque sin diferencias estadísticas entre el resto de las comunidades vegetales. Se concluye que existe afluencia marcada de organismos biorreguladores asociados al sistema silvopastoril con tithonia y pasto base en comparación con el área testigo, con gramíneas solamente. Se logró incremento o estabilidad con los años de explotación del sistema. Esto es un indicador favorable, que incrementa la biodiversidad zoológica y funcional, contribuye al manejo integral de insectos plaga y garantiza la sostenibilidad del agroecosistema. Se recomienda el fomento de áreas cada vez más diversificadas, como los sistemas silvopastoriles, y evitar la extensión de áreas de monocultivos para favorecer el equilibrio entre especies fitófagas y biorreguladoras, bajo niveles no dañinos.

Palabras clave: *biorreguladores, botón de oro, fitófagos, pastoreo*

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Introduction

Tithonia diversifolia (Hemsl.) A. Gray (Asteraceae) is a shrub species that stands out for its agronomic parameters and nutritional quality (Botero-Londoño *et al.* 2019 and Vargas *et al*. 2022). It constitutes an invaluable forage potential in milk (Gallego *et al*. 2014) and meat (Iraola *et al.* 2022) production. These intensive silvopastoral systems also have an important role in reducing physical and biological soil degradation (Giraldo and Chará 2022), making them even more attractive and resilient.

Research carried out at the Institute of Animal Science of the Republic of Cuba by a multidisciplinary team, led by Ruiz *et al.* (2016), makes available a group of outstanding materials, which biomass can be used for grazing (Ruiz *et al.* 2023a) as well as for cutting (Ruiz *et al.* 2024). The ICA CUBA Oc-10 variety stands out for its agronomic attributes, in both aspects, although with greater emphasis on grazing. Knowing its phytosanitary performance is important in order to extend this plant because of its benefits. Studies by Rodríguez *et al.* (2022) assert that *T. diversifolia* is a plant that serves as a reservoir for predators and parasitoids. Based on this idea, this study was carried out to evaluate the beneficial fauna associated with a silvopastoral system (SSP) of tithonia cv. ICA CUBA Oc-10 together with improved and natural grasses intended for bull fattening, and to know its role in the incidence of pest insects.

Materials and Methods

Location: The research was conducted over three years in experimental areas of the Institute of Animal Science (ICA), located at 22º 53' North, 82º 02' West and 92 m a.s.l., in San José de las Lajas, Mayabeque province, in the Republic of Cuba.

Experimental area: It consisted of 10 ha of improved grasses (*Cynodon nlemfuensis*) and natural grasses (*Paspalum notatum*, *Sporobolus indicus*, *Dichantium* sp.), divided into two five-hectare systems: one with grasses and another with a silvopastoral system (SSP) of grasses and tithonia, associated in 100% of the area, productively intended to fattening Cuban Siboney bovine males.

Methodology for establishing tithonia SSPs: Tithonia was sown on carbonated brown soil (Hernández *et al.* 2019), according to the concepts and methodologies developed by Ruiz and Febles (1999) and Ruiz *et al.* (2006) by preparing soil strips in grassland areas. The registered variety of *T. diversifolia* cv. ICA CUBA Oc10 was used for this purpose, which was proposed by Ruiz *et al.* (2010) for its use in grazing.

Experimental procedure: For the studies of the associated entomofauna, a stratified sampling in five blocks was implemented after the promotion of the silvopastoral system with *Tithonia diversifolia*. In the center of each block, the representative sampling area was defined, according to the methodology proposed by CIBA-GEIGY (1981).

At three contrasting climatic moments of the year (January, May and September), a sample of 20 raids was taken in each block using the entomological net per each plant component (tithonia and base grass) for a total of 10 samples (five in the tithonia and five in the base grass). Five samples were taken in the control area, established only with grasses. All were individualized in plastic bags with their respective identifications and transferred to the Pest Management Laboratory of the Pastures Department of ICA for processing and taxonomic identification. A stereoscopic microscope, entomological collections and related dichotomous keys were used for this. Phytophagous insects, visiting organisms and associated beneficial fauna (bioregulators) were identified in each study area according to the assignment of functional groups according to Metcalf and Flint (1965), Triplehorn and Johnson (2005), Mancina and Cruz (2017) and World Spider Catalog (2020). In addition, the damage level caused by pest insects in each plant component was evaluated according to Calderón (1982). The climatic performance of the area is shown in figure 1.

Statistical analysis: During the three years of study, for the variables of the associated arthropod fauna (visitors, phytophagous and bioregulators) the theoretical assumptions of the analysis of variance, normality of errors by the Shapiro Wilk (1965) test, Pearson correlation analysis and Mauchly (1940) sphericity were tested. Since these assumptions were not fulfilled, the methodology proposed by Gómez (2019) was used. Data were processed with the help of Proc GLIMMIX from SAS. Plant community, year, interaction and plant community per year were considered as fixed effects. The intercept was considered as random effects and the plant nested in the month was used as the subject. The variance-covariance structures compound symmetry (CS), autoregressive of order 1 Ar (1), unstructured (UN), variance components (CV) and topeplitz (Toep) were tested. The latter obtained the smallest selection criteria values. Data were adjusted to the Gamma distribution with link function (log). For the comparison of means, the Tuckey-Kramer fixed range test (Kramer 1956) was used for $p<0.05$. For data processing, the statistical package SAS (2013), version 9.3, was used.

Results and Discussion

Figure 2 shows the performance of the relative abundance of the arthropod fauna associated with each plant component at the different sampling times. In May, there was equity in the associated organisms with a similar percentage (33 %) in each evaluated plant component. In September, the abundance was slightly higher in the control area (41.90 %)

with no differences with those collected in the SSP area of tithonia (31.43 %). It was lower in base grass (26.67 %). In January, it had an inferior performance in the SSP with tithonia (29.33 %), and it was slightly higher in the base grass (34.60 %) and in the control area with grasses only (36.07 %), but with no statistical differences among them.

September was the most representative of the associated entomofauna. This performance must have been subjected to the incidence of climatic factors during the studied period (figure 1). At the beginning of May, when the sampling was carried out, the dry season became more severe (<50 mm of monthly precipitation). Therefore, it is assumed that the insect fauna was reduced, as there were no turgid pastures and quality biomass that would keep them active in the area. In September, climatic conditions favored the appearance of insects with diverse habits. Rains became stable and temperatures were warmer, conditions that favor the increase of these organisms. In January, rains are scarce and temperatures are cooler, sometimes falling below 20 ºC. During this time, many insects have lower levels of their population and fewer generations are obtained. It is important to highlight the decrease in the accumulated rainfall that occurred in 2023 in the study area, which, never reached 200 mm on the rainy days of the month, compared to previous years (2021 and 2022), when records of 300 and even 400 mm were reached. The rainiest year was 2022, in which 480 mm were reached in June, with 14 days of rain. This climatic perfomance is undoubtedly reflected in the performance of the associated insects (Doria-Bolaños *et al.* 2021).

In the study carried out over three consecutive years (2021, 2022 and 2023) with the same sampling methodology, there was significant interaction between the plant community and the year, for all variables (table 1). In this case, the lower proportion of phytophagous species associated with the SSP with tithonia (9.97) stands out compared to the base grass (19.13) and control area with grasses (20.14). In turn, there was higher proportion of bioregulatory species associated with these plant communities, with higher values in tithonia (9.63) compared to the base grass (5.94) and the control (3.84).

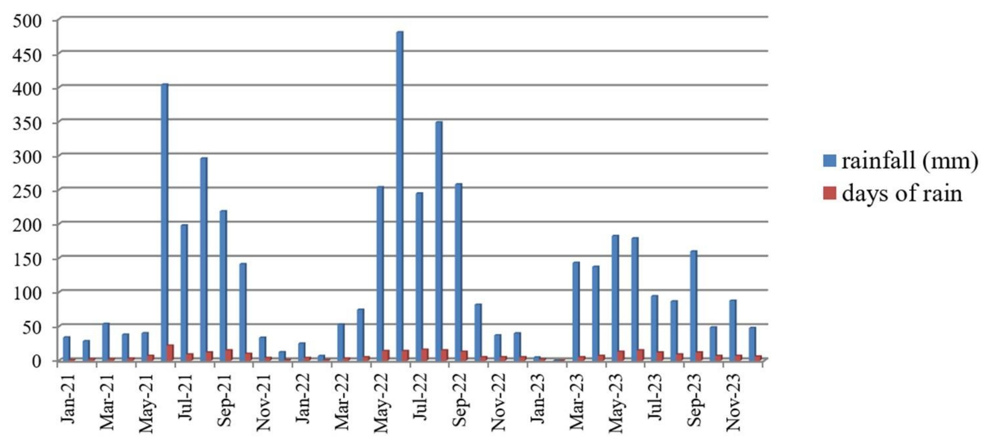
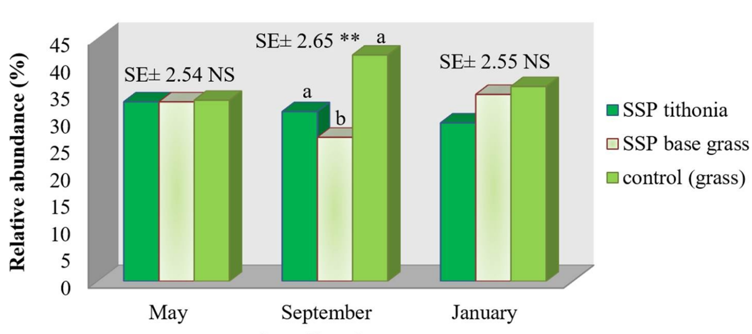


Figure 1. Climate performance in the area under study



a,b,c - Uncommon letters at each sampling time are significantly different at p≤0.05 (Duncan 1955)

Figure 2. Relative abundance of arthropod fauna associated with each plant component evaluated in the second year at the different sampling times, %

Table 1. Analysis of the performance of the arthropod fauna (visitors, phytophagous and bioregulators) in plant communities per year

Variables	Community years	Tithonia in SSP	Base grass in SSP	Control (grasses)	EE (±) Sign.
Visitors	2021	1.99[b] (7.32)	2.36[a] (10.56)	2.38[a] (10.77)	0.14 p=0.0005
	2022	2.33[a] (10.24)	2.01[b] (7.44)	2.11[ab] (8.28)	
	2023	1.96[b] (7.11)	1.90[b] (6.66)	1.56[c] (4.76)	
Phytophagous	2021	2.30[c] (9.97)	2.95[a] (19.13)	3.00[a] (20.14)	0.16 p<0.0001
	2022	2.46[bc] (11.75)	2.43[bc] (11.33)	2.62[b] (13.72)	
	2023	1.31[d] (3.70)	2.22[c] (9.18)	2.53[bc] (12.52)	
Biorregulators	2021	2.26[a] (9.63)	1.78[ab] (5.94)	1.36[b] (3.88)	0.23 p=0.0083
	2022	1.68[ab] (5.38)	1.72[ab] (5.56)	1.87[ab] (6.46)	
	2023	2.28[a] (9.81)	1.57[ab] (4.82)	1.66[ab] (5.26)	

[abc] Different letters in each variable indicate significant differences p<0.05 (Kramer 1956).

(…) Values in parenthesis indicate data transformed by log link function

As previously stated, visitors influence the entire system indiscriminately, with greater emphasis on the flowering stage of tithonia. In 2023, which is the fourth year of promoting the SSP, there was a significant decrease in phytophagous species associated with the SSP with tithonia (3.70), which significantly differs from the base grass (9.18) and the control area (12.52). An increase or stability of the associated beneficial fauna (9.81, 4.82 and 5.26) was also recorded for tithonia, base grass and control area, respectively, although without statistical differences among these plant communities.

These results coincide with studies by Ochoa *et al.* (2017), who found 54 % less *Collaria oleosa* (Hemiptera: Miridae) and 59 % less *Draeculacephala* sp. (Hemiptera: Cicadellidae) in the associated plants in the silvopastoral systems compared to the single-crop area with the kikuyu grass (*Cenchrus clandestinus*), which experienced the greatest damage. Therefore, the silvopastoral systems kept the populations of sucking insects under control. The authors confirmed that the larger the single-crop area, the greater the incidence and damage by phytophagous insects.

A marked influx of bioregulatory organisms associated with the SSP with tithonia was observed, compared to the control area, with grasses only. The SSP with the association of plants of different sizes and architectures creates various refuge and nectar sites for the habitat of multiple organisms, such as the associated beneficial fauna. This, without a doubt, constitutes a favorable indicator, which is confirmed in this study, as it contributes to the comprehensive management of pest insects in the agroecosystem. Studies in Cuba by Rodríguez *et al.* (2022) recommend *T. diversifolia* associated with pastures and forages, which promotes ecosystem services and increases the resilience of livestock agroecosystems.

Results in tithonia confirm that silvopastoral systems achieve the stability of phytophagous and bioregulatory organisms over time, which prevents economic and physiological damage to the main crop. This was also reported in similar studies by Valenciaga *et al.* (2019, 2020) and Ruiz *et al.* (2023b) in diversified silvopastoral systems with leucaena-Guinea. In this case, the SSP with the association of plants of different sizes and architectures, creates various refuge and nectar sites for the habitat of multiple organisms such as the associated beneficial fauna, which makes it possible to reduce phytophagous insects and damage associated with the base grass under the SSP with tithonia.

Conclusions

There is a marked influx of bioregulatory organisms associated with the SSP with tithonia and base grass compared to control area, with grasses only. An increase or stability was achieved with the years of exploitation of the system. This is a favorable indicator, which increases zoological and functional biodiversity, contributes to the integral management of insect pests and guarantees sustainability of the agroecosystem.

It is recommended to promote increasingly diversified areas, such as silvopastoral systems, and avoid the extension of single-crops to favor the balance between phytophagous and bioregulatory species at levels that are not harmful.

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