Australian Journal of Crop Science

AJCS

AJCS 18(08):460-465 (2024) ISSN:1835-2707
https://doi.org/10.21475/ajcs.24.18.08.p4083

Weed phytosociology survey in a Brazilian native pineapple, variety Turiaçu

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Submitted: 18/10/2023

Revised: 15/05/2024

Accepted: 24/05/2024

Abstract: The native pineapple variety Turiaçu holds significant market value and substantial export potential in comparison to other traditional pineapple varieties. Despite its economic importance, there is limited research on weed management for pineapple Turiaçu. Weed interference poses a threat to various crops at different phenological stages. This study had two primary objectives: (1) to assess the dynamics of weeds in a Turiaçu pineapple orchard across different climatic seasons and (2) to determine the critical control phase for weed management. We conducted weed phytosociological surveys during the dry, transition, and rainy seasons. Conventional methods were employed in 20 samples per season, evaluating relative density, relative frequency, relative abundance, importance value index, and Soresen's similarity index. Our findings revealed the presence of 32 weed species, spanning 24 genera and 12 botanical families, predominantly eudicotyledonous (78%), with an annual life cycle (50%) and sexual reproduction (78%). Seasonal variations significantly influenced the weed community, with a 500% increase in the number of species during the rainy season compared to the dry season. Based on our observations, we recommend implementing soil cover methods for controlling the weed seed bank. This approach is crucial in all seasons, with particular emphasis on the transition season, characterized by a relatively short and latent weed community that is more easily manageable.

Keywords: *Ananas comosus,* weed interference, weed management, weed seed bank, weather.

Introduction

The pineapple tree [*Ananas comosus* (L.) Merril] is a monocotyledonous herbaceous species belonging to the Bromeliaceae family, native to South America (Ding and Syazwani, 2016). Esteemed as one of the most crucial tropical fruits globally, it holds particular significance in Brazil, the world's fourth-largest pineapple producer, contributing substantially to food security, employment, and income (Reinhardt et al., 2018).

The 'Pérola' variety takes precedence in Brazilian pineapple cultivation, notably in states such as Pará, Paraíba, and Minas Gerais, the leading pineapple-producing regions. Despite Maranhão ranking fourteenth in Brazil's production hierarchy, it boasts a native cultivar known as 'Turiaçu' pineapple, distinguished by its unique sensory attributes—marked by high soluble solids content, low titratable acidity, appealing flesh color, and a distinctive aroma. Consequently, 'Turiaçu' holds substantial market value, commanding high prices and exhibiting considerable potential for exportation (Reis et al., 2024).

Pineapple plants are susceptible to weed interference due to their gradual vegetative development, modest size, limited soil coverage, and superficial root system (Corrêa et al., 2015). This interference can inflict damage across various phenological stages, making effective control imperative. Weed interference is categorized into three phases: before interference, critical interference prevention, and full interference prevention. The critical prevention phase, particularly crucial for safeguarding crops against weed interference, presents challenges in pineapple cultivation due to morphological limitations in weed control (Knezevic and Datta, 2015).

Conducting weed surveys proves essential for understanding weed flora diversity, identifying problematic species, and recommending sustainable control techniques across diverse production systems (Silva et al., 2021; Dorey et al., 2016). Rainfall significantly influences weed dynamics, thereby affecting the timing of control methods in pineapple cultivation (Santos et al., 2022; Sarkar et al., 2017). Embracing sustainable control practices not only facilitates efficient interventions at different phenological stages but also yields economic benefits while mitigating environmental impacts linked to excessive pesticide use (Fernandes et al., 2021).

Hence, the primary goals of this study were (1) to scrutinize weed dynamics in a 'Turiaçu' pineapple orchard throughout distinct climatic seasons and (2) to ascertain the critical control phase for effective weed management.

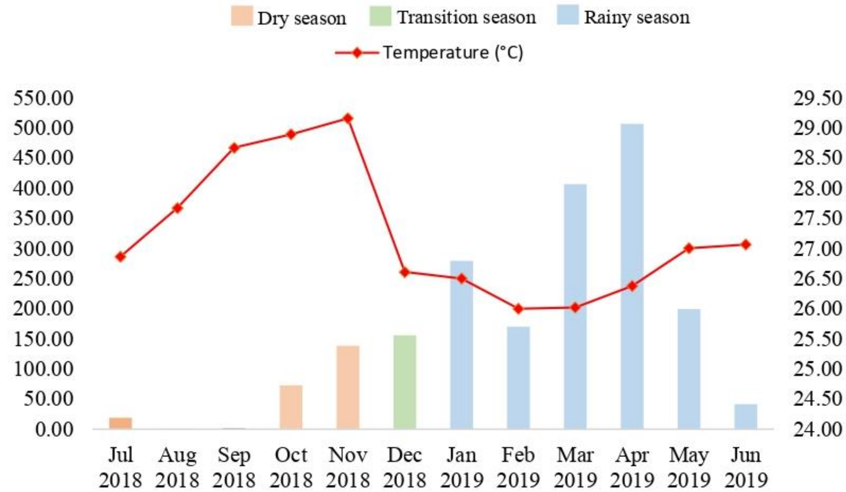

Figure 1. Weather in the experimental field cultivated with pineapple 'Turiaçu'. The database was collected between the dry season, transition season and rainy season.

Results and Discussion

Weed classification

We have identified 32 weed species, distributed among 24 genera and 12 botanical families, with a notable prevalence of eudicotyledonous weeds (78%) exhibiting an annual life cycle (50%) and engaging in sexual reproduction (78%). The Poaceae family exhibited the highest species count (6), succeeded by Rubiaceae (5), Fabaceae (4), Euphorbiaceae (3), Malvaceae (3), Asteraceae (2), Convolvulaceae (2), Lamiaceae (2), and Plantaginaceae family (2) (Table 1). According to Adegas et al. (2022) Poaceae is recognized as one of the weed families with the highest herbicide resistance, documenting 86 resistant weeds worldwide. Poaceae species typically have a perennial life cycle and a substantial number of seeds during the reproductive stage, enhancing their capacity to spread and colonize diverse environments, even in conditions of limited availability of abiotic resources such as water and light (Fernandes et al., 2021).

Weather effects on the weed community

In the dry season, just five weed species were identified, including *Aeschynomene histrix*, *Chamaesyce prostrata*, *Emilia coccinea*, *Panicum repens* and *Platonia insignis*. *Emilia coccinea* stood out as the most significant species, registering an index of 127.22. Certain weed species exhibit drought acclimatization mechanisms, encompassing rapid deepening of roots, reduction in leaf area, shortening of the phenological cycle, earlier reproduction, alterations in stomatal conductance, and enhanced water use efficiency (Naidoo and Naidoo, 2018).

During the transition season, alterations in floristic composition were observed in comparison to the dry season, revealing the identification of nine distinct species: *Chamaesyce hirta*, *Chamaesyce prostrata*, *Emilia coccínea*, *Eragrostis maypurensis*, *Hyptis atrorubens*, *Neptunia plena*, *Poa annua*, *Turnera subulata* and *Waltheria indica*. The *Chamaesyce prostrata* and *Emilia coccinea* occurred simultaneously in the dry and transition seasons. The *Poa annua* had the highest importance value index (149.3), followed by *Emilia coccinea* (51.5) and *Eragrostis maypurensis* (33.5) (Figure 3).

Poa annua L. has the capability to produce 1,000 to 2,500 seeds per plant within a short timeframe and initiates germination just two days after dissemination, as observed by (Svyantek et al., 2016). Additionally, this species can maintain seed viability in the soil for several years, as reported by (Benson et al., 2023). Notably, *Poa annua* L. demonstrates tolerance to extreme temperatures and exhibits resistance to multiple herbicides, particularly those targeting photosystem II inhibitors and acetolactate synthase inhibitors, as highlighted by (Brosnan et al., 2015). In our current investigation, it displayed a high density, aligning with findings by Rutland et al. (2022) and Chwedorzewska et al. (2015).

During the rainy season, there was a notable surge, showing a 500% increase compared to the number of species identified in the dry season and a 278% increase compared to the transition season. This substantial increase can be attributed to elevated rainfall and improved water availability for seed germination, as depicted in Figure 4. Typically, the seed bank remains dormant until favorable conditions of soil moisture and temperature are achieved (Harrison et al., 2016). In accordance with it, *Chamaecrista rotundifolia, Chamaesyce hyssopifolia, Cenchrus echinatus, Cyperus rotundus, Diodella teres, Eragrostis airoides, hyptis suoveolens, Ipomoea ramosissima, Mimosa pudica, Pennisetum purpureum, Richardia brasiliensis, Richardia scabra, Sida cordifolia, Sida linifolia, Spermacoce capitata, Spermacoce latifolia, Stemodia verticillata* and *Vernonia nudiflora* occurred exclusively during the rainy season.

Emilia coccinea was consistently present in all seasons under investigation, suggesting a high physiological plasticity that enables it to persist in the field, even under conditions of lower soil moisture. Lessa et al. (2013) noted that the germination of this species is enhanced by an average temperature of 30°C, a condition likely favored by the weather observed in this study. *Emilia coccinea* has a dispersal center in Asia, Africa, and America, being particularly abundant in America, where it interferes with both annual and perennial crops, causing production losses (Witter et al., 2019).

The Soresen similarity index indicated a higher similarity between the transition and rainy seasons (35%). The transition season and dry season exhibited 29% similarity, while the dry season and rainy season showed 20% similarity (Table 2). Weed distribution can be influenced by changing weather conditions, including rainfall volume and distribution, wind speed, soil temperature, and soil moisture (Asgarpour et al., 2015). Therefore, it is plausible that the increase in rainfall also

Table 1. Classification of weed found in the pineapple 'Turiaçu' cultivation. The weed was classified by scientific name, family, scientific name, number of cotyledons (CN), life cycle (LC) and reproduction type (RT). Chapadinha, Maranhão, Brazil.

Family	Scientific name	CN	LC	RT
Asteraceae	*Emilia coccinea*	E	A	S
	Vernonia nudiflora	E	P	S
Clusiaceae	*Platonia insignis*	E	P	S
Convovulaceae	*I. fimbriosepala*	E	P	S
	I. ramosissima	E	A	S
Euphorbiaceae	*Euphorbia hirta*	E	A	S
	E. hyssopifolia	E	A	S
	Euphorbia prostrata	E	A	S
Fabaceae	*A. histrix*	E	A	S
	C. rotundifolia	E	P	S
	Mimosa pudica	E	P	S
	Neptunia plena	E	P	S/As
Lamiaceae	*Hyptis atrorubens*	E	A	S
	Hyptis suaveolens	E	A	S
Malvaceae	*Sida cordifolia*	E	P	S
	Sida linifolia	E	P	S
	Waltheria indica	E	P	S
Plantaginaceae	*Bacopa salzmannii*	E	A	S/As
	S. verticillata	E	A	. S
Rubiaceae	*Diodella teres*	E	A	S
	R. brasiliensis	E	A	S
	Richardia escabra	E	A/P	S
	S. capitata	E	A	S
	S. latifolia	E	A	S
Turneraceae	*Turnera subulata*	E	P	S
Cyperaceae	*Cyperus rotundus*	M	P	S/As
Poaceae	*C. echinatus*	M	A	S
	Eragrostis airoides	M	P	S
	E. maypurensis	M	A	S/As
	Panicum repens	M	P	S/As
	P. purpureum	M	P	S/As
	Poa annua	M	A	S/As

Table 2. Weed Similarity index with Soresen analytics methods in different seasons hold pineapple 'Turiaçu' cultivation.

Weed similarity	Dry season (%)	Transition (%)	Rainy season (%)
Dry season	--	29	20
Transition	29	--	35
Rainy season	20	35	--

contributed to the higher weed similarity between the transition and rainy seasons.

These similarity results were lower than those reported by Lima et al. (2015) in a guava orchard, where a 60% similarity between species at different phases was observed. This difference may be attributed to management practices, as the guava tree is a perennial fruit tree, whereas pineapple is cultivated as a semi-perennial crop. Sarmento emphasized the need for adopting distinct and effective control methods for each crop period, even in surveys with higher estimates of similarity.

Eudicotyledonous weeds exhibited higher density than monocotyledons. During the rainy season, eudicotyledons reached a density of 70.25 plants m^{-2}, with a significant decrease during the dry season, illustrating the regulatory effect of rainfall on the weed population (Figure 5). Therefore, it is crucial to intensify weed management during the transition period, which can be achieved through the implementation of soil cover techniques, weeding, and chemical control.

Control of the weed seed bank holds great importance as it can lead to cost savings in production and help mitigate the selection of herbicide-resistant weeds (Furtado et al., 2022). According to Tursun, maintaining crop residues and using plastic mulch on the soil can enhance weed control by inhibiting light, a germination-regulating factor in several weed species. The use of straw is a promising strategy for weed management in pineapple cultivation (López-Marín et al., 2021). Mulching techniques reduce fluctuations in soil temperature and moisture, providing favorable conditions for both pineapple development and weed control (Fan et al., 2017). Cultural control, as suggested by Osipitan et al. (2019) and Morota et al. (2019), proves to be an efficient method for altering or complementing chemical and mechanical control strategies, particularly in small and medium-sized properties in Brazil with Turiaçu pineapple orchards.

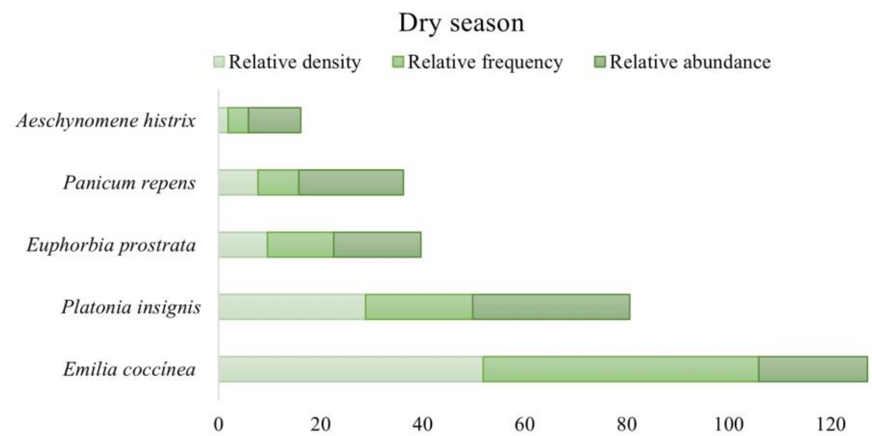

Figure 2. Relative density, relative frequency, relative abundance and importance value index of weeds in the dry season in an experimental field cultivated with pineapple 'Turiaçu'.

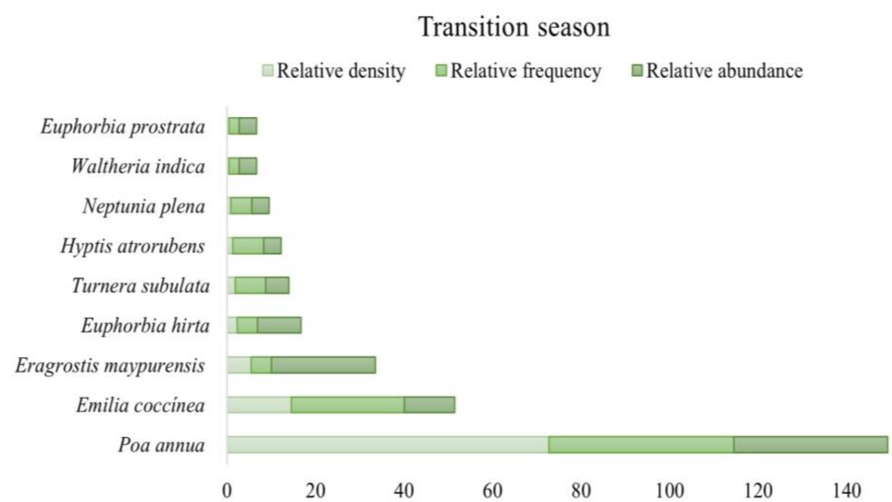

Figure 3. Relative density, relative frequency, relative abundance and importance value index of weeds in the transition season in an experimental field cultivated with pineapple 'Turiaçu'.

Materials and Methods

Location of the study

The study was carried out between and 2019 in an experimental orchard at the Universidade Federal do Maranhão, Centro de Ciências de Chapadinha, Chapadinha, Maranhão, Brazil, coordinates 03°44'30" S, 43°21'37" W, altitude 107 m. The climate classification is Aw, with a tropical rainy climate. The weathers in this study are showed in Figure 1.

The crop was planted in May 2017 with pineapple seedlings variety Turiaçu from commercial cultivations in the Turiaçu, Maranhão, Brazil. The planting was done manually at a spacing of 1.0 m x 0.30 m, with a density of 33,333 plants ha^{-1}. We maked a macro and micronutrient fertilization for get 40 to 50 t ha^{-1} of fruits. The soil analysis in the 0 to 20 cm depth involved the following features: pH (CaCl2): 4.5; phosphorus (P): 1.6 mg dm^{-3}; organic matter (OM): 1.1%; sum of bases (Ca + Mg + K + Na): 1.18 mg dm^{-3}; base saturation (V%): 40.4%. The soil was classified in Latossolo Amarelo Distrófico (LAd), sandy loam texture with 54 g kg^{-1} of sand, 14 g kg^{-1} of clay and 42 g kg^{-1} of silt.

Weed survey

The weed survey was done in conventional method with an inventory square, measuring 1 m^2, arranged in 20 samples, in a regular transect measuring 10 m x 10 m. The sampling was carried in dry, transition and rainy season, between 2018 and 2019. The first assessment was carried out in September 2018 (dry period), the second in December 2018 (transition period) and the third in April 2019 (rainy period) (Figure 1).

The weeds were identified using a specialized literature and quantified for to estimate to relative density (RD), relative frequency (RF), relative abundance (RA), importance value index (IVI) and Soresen similarity index (SSI), by following equations:

$$Eq.1: Relative\ density\ (RD) = \frac{Species\ density \times 100}{Total\ species\ density}$$

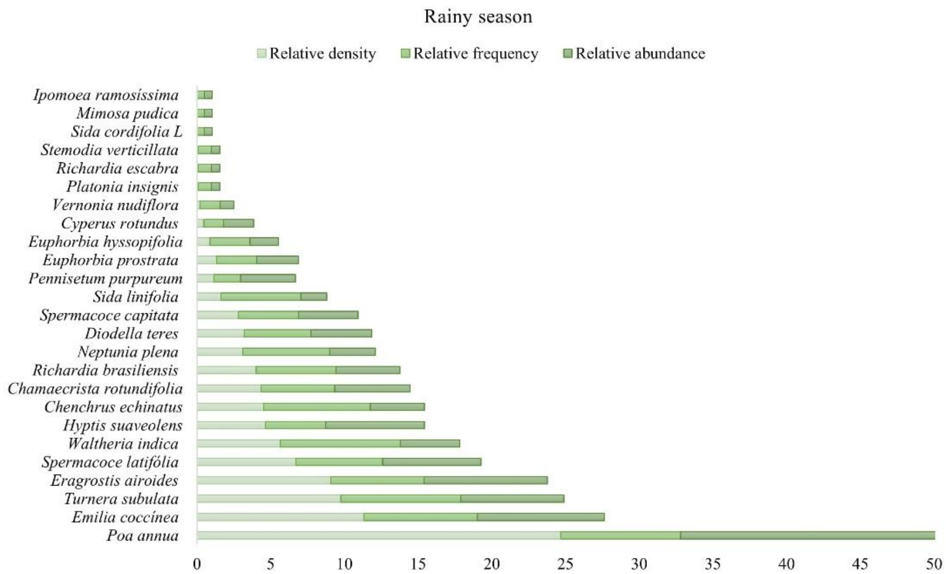

Figure 4. Relative density, relative frequency, relative abundance and importance value index of weeds in the rainy season in an experimental field cultivated with pineapple 'Turiaçu'.

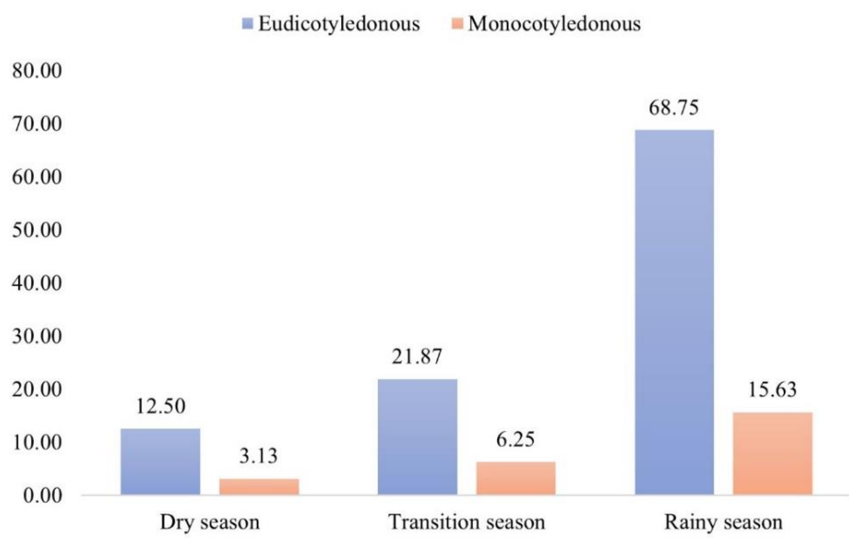

Figure 5. Weed density by botanical class in the different seasons in an experimental field cultivated with pineapple 'Turiaçu'.

$$Eq.\,2: Relative\ frequency\ (RF) = \frac{Species\ frequency \times 100}{Total\ frequency\ of\ species}$$

$$Eq.\,3: Relative\ abundance\ (RA) = \frac{Species\ abundance \times 100}{Total\ species\ abundance}$$

$$Eq.\,4: Importance\ Value\ Index\ (IVI) = RD + RF + RA$$

$$Eq.\,5: Sorensen\ Similarity\ Index\ (SSI) = \left(\frac{2 \times a}{b + c}\right) \times 100$$

Whose: a = number of exclusive species for two periods; b + c = sum of shared species in two periods. The data was analyzed using descriptive statistics methods in each season.

Conclusion

We identified 32 weed species, distributed across 24 genera and 12 botanical families, with a predominant presence of eudicotyledonous (78%) characterized by an annual life cycle (50%) and sexual reproduction (78%). The weather conditions in each season significantly influenced the weed community, with a noteworthy 500% increase in the number of species during the rainy season compared to the dry season. We recommend implementing soil cover methods for controlling the weed seed bank. This practice is advisable in all seasons, with a particular emphasis on the transition season, characterized by a brief and dormant weed community that is easily manageable.

Declaration of conflict of interest

The authors declare no conflict of interest in the publication of this article.

References

Asgarpour R, Ghorbani R, Khajeh-Hosseini M, Mohammadvand E, Chauhan BS (2015) Germination of spotted spurge (*Chamaesyce maculata*) seeds in response to different environmental factors. Weed Science. 63: 502-510.

Benson CW, Sheltra MR, Maughan PJ, Jellen EN, Robbins MD, Bushman BS, Patterson EL, Hall ND, Huff DR (2023) Homoeologous evolution of the allotetraploid genome of *Poa annua* L. BMC Genomics. 24: 350.

Brosnan JT, Breeden GK, Vargas JJ, Grier L (2015) A biotype of annual bluegrass *(Poa annua*) in Tennessee is resistant to inhibitors of ALS and photosystem II. Weed Science. 63: 321-328.

Chwedorzewska KJ, Giełwanowska I, Olech M, Molina-Montenegro MA, Wódkiewicz M, Galera H (2015) *Poa annua* L. in the maritime Antarctic: an overview. Polar Record. 251: 637-643.

Corrêa MJP, Alves GL, Rocha LGF, Silva MRM (2015) Weed interference periods in cowpea cultivation. Revista de Ciências Agroambientais. 13: 50-56.

Ding P, Syazwani S. Physicochemical quality, antioxidant compounds and activity of MD-2 pineapple fruit at five ripening stages (2016) International Food Research Journal. 23: 549-555.

Dorey E, Fournier P, Léchaudel M, Tixier P (2016) Modeling sugar content of pineapple under agroclimatic conditions on Reunion Island. European Journal of Agronomy. 73: 64-72.

Fan Y, Ding R, Kang S, Hao X, Du T, Tong L, Li S (2017) Plastic mulch decreases available energy and evapotranspiration and improves yield and water use efficiency in an irrigated maize cropland. Agricultural Water Management. 179: 122-131.

Fernandes T, Inouea HM, Silva LMA, Guimarães DCA, Maciel GDC, Mendes FK, Neto SCJ, Martins HG (2021) Phytosociological survey of weeds in pineapple crops at different times. Revista Brasileira de Agropecuária Sustentável. 11: 322-335.

Furtado JAL, Almeida EIB, Oliveira LBT, Santos AC, Costa TV, Silva MS, Souza JBC, Sousa WS, Ponte IS, Freitas JRB (2022) Spatial relation of weed competition and soil fertility in soybean farming. Australian Journal of Crop Science. 16: 899-906.

Harrison MT, Cullen, BR, Rawnsley RP (2016) Modelling the sensitivity of agricultural systems to climate change and extreme climatic events. Agricultural System. 148: 135-148.

Knezevic SZ & Datta A (2015) The critical period for weed control: revisiting data analysis. Weed Science, 63: 188-202.

Lessa BFT, Ferreira VM, Araújo Neto JC, Souza RC (2013) Germination of *Emilia coccinea* (Sims) G. Don as a function of light, temperature, storage and sowing depth. Semina: Ciências Agrárias. 34: 3193-3204.

Lima LKS, Araújo RC, Santos JPS, Lopes MFQ (2015) Phytosociology of weeds in a guava orchard at different sampling times. Revista Biociências. 21: 45-55.

López-Marín J, Romero M, Gálvez A, Del Amor FM, Piñero MC, Brotons-Martínez JM (2021) The use of hydromulching as an alternative to plastic films in an artichoke (*Cynara cardunculus* cv. Symphony) Crop: A study of the economic viability. Sustainability,.13: 5313.

Marques LJP, Bianco S, Cecílio Filho AB, Bianco MS, Lopes GDS (2017) Weed interference in eggplant crops. Revista Caatinga. 30: 866-875.

Morota FK, Mendes RR, Mattiuzzi MD, Biffe DF, Raimondi RT, Padovese LM, Martoneto JVS (2020) Weed management in tropical fruit trees: pineapple, banana, coconut, papaya and passion fruit. Revista Brasileira de Herbicidas. 19: 1-11.

Naidoo G, Naidoo KK (2018) Drought stress effects on gas exchange and water relations of the invasive weed *Chromolaena odorata*. Flora. 248: 1-9.

Osipitan OA, Anita DJ, Assefa Y, Radicetti E, Ayeni A, Knezevic S (2019) Impact of cover crop management on level of weed suppression: a meta-analysis. Crop Science. 59: 833-842.

Reinhardt DHRC, Bartholomew DP, Souza FVD, Carvalho ACPP, Páuda TRP, Junghans DT, Matos, AP (2018) Advances in pineapple plant propagation. Revista Brasileira de Fruticultura. 40: 1-22.

Reis FO, Ramos LM, Araujo, JRG, Figueiredo F, Ferraz TM, Assunção AKS, Neves Junior ACV (2024) Ecophysiological responses of 'Turiaçu' pineapple plants at vegetative and reproductive stages to soil fertilization and crop location. Ciência Rural, Santa Maria. 54: e20220592.

Rutland CA, Russell, EC, Hall ND, Patel J, McElroy JS (2022) Resolving issues related to target-site resistance detection in *Poa annua* alpha-tubulin. International Turfgrass Society Research Journal. 14: 808-811.

Santos JRP, Maia VM, Silva BS, Demicheli PM, Aspiazú I, Concenço G (2022) Dynamics of the weed community during pineapple growth in the Brazilian semi-arid region. Agronomía Colombiana. 40:109-119.

Sarkar AK, Mazunder M, Dey M (2017) Weed species composition of pineapple based cropping system at northern part of West Bengal, India. Advances in Bioresearch. 8: 258-269.

Sarmento HGS, Rodrigues TM, Aspiazu I, Corsato CE (2017) Phytosociological survey in pineapple cultivated in northern Minas Gerais. Nativa, 5: 231-236.

Silva MS, Costa TV, Furtado JAL, Souza JBC, Silva EA, Ferreira LS, Silva CAAC, Almeida EIB, Sousa WS, Oliveira LBT, Freitas JRB, Oliveira JT (2021) Performance of pre-emergence herbicides in weed competition and soybean agronomic components. Australian Journal of Crop Science. 15: 610-617.

Svyantek AW, Aldahir P, Chen S, Flessner ML, McCullough PE, Sidhu SS, McElroy JS (2016) Target and non-target resistance mechanisms induce annual bluegrass (*Poa annua*) resistance to atrazine, amicarbazone, and diuron. Weed Technology. 30:773-782.

Tursun N, Datta A, Budak S, Kantarci Z, Knezevic SZ (2016) Row spacing impacts the critical period for weed control in cotton (*Gossypium hirsutum*). Phyto. 44: 139-149.

Witter APW, Nohatto MA, Borges BL, Kaseker JF, Rosa EFF, Madeira LG, Fermiano AP (2019) Phytosociology and weed suppression under the effect of solarization and elephant grass cover. Brazilian Journal of Sustainable Agriculture. 9: 56-63.