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Orchidists' profile, management and perception of the main pests in orchid cultivation

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ABSTRACT

This study investigated the profile of orchidists, their cultivation practices, and their knowledge about pests in orchid cultivation in the state of Bahia. There were applied 74 questionnaires to producers (amateurs and commercials) in 23 municipalities. The data were submitted to univariate statistics using the chi-square test, the Mann–Whitney U-test and the Kruskal–Wallis H-test. The survey shows that orchid cultivation is mostly practiced by women (67.6%) and those with higher education (48.7%). Most respondents were amateurs (87.8%). Insects (39.9%) and diseases (32.5%) were the main organisms associated with phytosanitary problems. The presence of insects was reported to occur mainly in the leaves (47%), mainly mealybugs (46.3%). Correspondence was significant between commercial and amateur groups according to the pairwise Mann–Whitney $U\text{-test}_{(1)} = 370.04$ and $p < 0.01$. The Kruskal–Wallis $H\text{-test}_{(27)} = 924.78$ and $p < 0.01$ discriminated categories between the groups. Despite the growing interest in orchid cultivation in the state of Bahia, most orchidists are amateurs. The study warns about the risk of pest dispersion between crops since exchanging plants and purchasing specimens in open markets are common practices.

Keywords: mealybugs; insects; plant health.

INTRODUCTION

Species of the Orchidaceae family have high commercial value, as plants are distinguished by the beauty of their flowers, and can be sold as flower stems or in vases in the flower market (FARIA; COLOMBO, 2015). Considered worldwide as one of the largest botanical families among higher plants, Orchidaceae contains more than 27,000 species, distributed in 899 genera (THE PLANT LIST, 2019), with the highest occurrence in tropical and subtropical regions (CHASE et al., 2015).

Brazil has more than 2,500 species of Orchidaceae, distributed in 238 genera (BARROS et al., 2015), with 628 of these species found in the Northeast region, mainly in the state of Bahia, with 522 species. This species richness has boosted the production and commercialization of orchids in recent years (INSTITUTO DE PESQUISAS JARDIM BOTÂNICO DO RIO DE JANEIRO, 2022).

Although cultivation and commercialization of these plants are predominant in the state of São Paulo, other states have increased the commercialization of orchids, such as Minas Gerais and Bahia (FARIA; COLOMBO, 2015). Therefore,

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proper management of orchid crops is an important factor for good plant growth and quality for trade (SANGHAMITRA et al., 2019).

The expansion of the ornamental plant market and consequently cultivation areas lead to phytosanitary problems. This, in turn, has stimulated field research to identify the main plant pests, such as the study carried out on *Dendrobium* Sw. and *Cymbidium* Sw. in Canada, which reported the occurrence of beetles of the genus *Stethopachys* (Chrysomelidae) and *Orchidophilus* sp. and *Stethobaris* sp. (Curculionidae) in other Orchidaceae (LIGHT; MACCONAILL, 2011).

Similarly, the beetle *Stethobaroides nudiventris* Champion, 1908 (Curculionidae) was reported in Mexico to cause damage to *Catasetum integerrimum* (Orchidaceae) (MORALES-BÁEZ et al., 2016) and mites of the genus *Brevipalpus* were also identified in Costa Rica causing damage to *Grammatophyllum scriptum* (Orchidaceae) (PIEDRA; GUEVARA, 2020).

However, few studies have been conducted on orchid cultivation in Brazil. A study conducted by LEITE et al. (2017) identified the occurrence of the aphid *Aphis craccivora* Koch, 1854 (Aphididae) causing damage to orchids of the genus *Catasetum* in the flowering period. KUBO et al. (2009) investigated phytophagous mites in the state of São Paulo in which the genus *Brevipalpus* was associated with a virus transmission in *Dendrobium* sp. Therefore, further studies are required to investigate the phytosanitary conditions of orchids in Brazil.

In addition to the direct collection of pest organisms in the field, other methods are used for the investigations, such as surveys to learn about production practices, experiences of producers with the pest insects, the use of phytosanitary products and biological control agents (ARISTIZÁBAL et al., 2013). In this study, a questionnaire was used because it allowed to obtain noninduced responses, based on the perception of each participant as feeling more confident when responding (CERVO et al., 2007).

This study investigated the profile of orchidists, their cultivation practices, and their knowledge about pest occurrences in orchid cultivation in the state of Bahia, Brazil.

MATERIAL AND METHODS

The study used a semi-structured questionnaire with 23 questions, subdivided into three topics, named the following: orchidist profile, cultivation practices, and the main pests.

The study was carried out with owners of commercial and amateur nurseries, randomly chosen using the snowball sampling technique (BAILEY, 1994), with the inclusion of new participants through an indication of other orchidists. This technique was used because no records of associations and/or groups of orchidists were found in the region studied.

Univariate statistics were used through a cross-contingency table, differentiating the classes of the categories using the chi-square test, Mann–Whitney U-test, and Kruskal–Wallis H-test for comparisons between two or more groups, respectively, at a level of significance of 5% ($p < 0.05$).

Assessments of different assertions of the respondents were submitted to the multiple correspondence analysis, which allows the analysis of more than two variables at the same time, as well as the establishment of profiles of each unit observed. This analysis is considered a technique of interdependence and associates the categories of statements with the dimensionality levels discriminated in the model under study, generating a perception map. This graphic distribution facilitates the visualization of relationships between the variables, simultaneously, leading to a general conclusion of the results observed (HAIR et al., 2009).

The main procedures for analyzing the research data were processed by IBM SPSS Statistics, version 20. This study is registered with the Research Ethics Committee, from the Universidade Federal do Recôncavo da Bahia (UFRB) under protocol number 03480918.4.0000.0056.

RESULTS AND DISCUSSION

There were applied 74 questionnaires to orchid producers in 23 municipalities in Bahia (Fig. 1), 9 (12.2%) commercial and 65 (87.8%) amateur producers. Commercial producers cultivate and commercialize orchid seedlings and flowers for a profit, while amateur producers grow plants for decoration the domestic environment as a form of leisure/therapy.

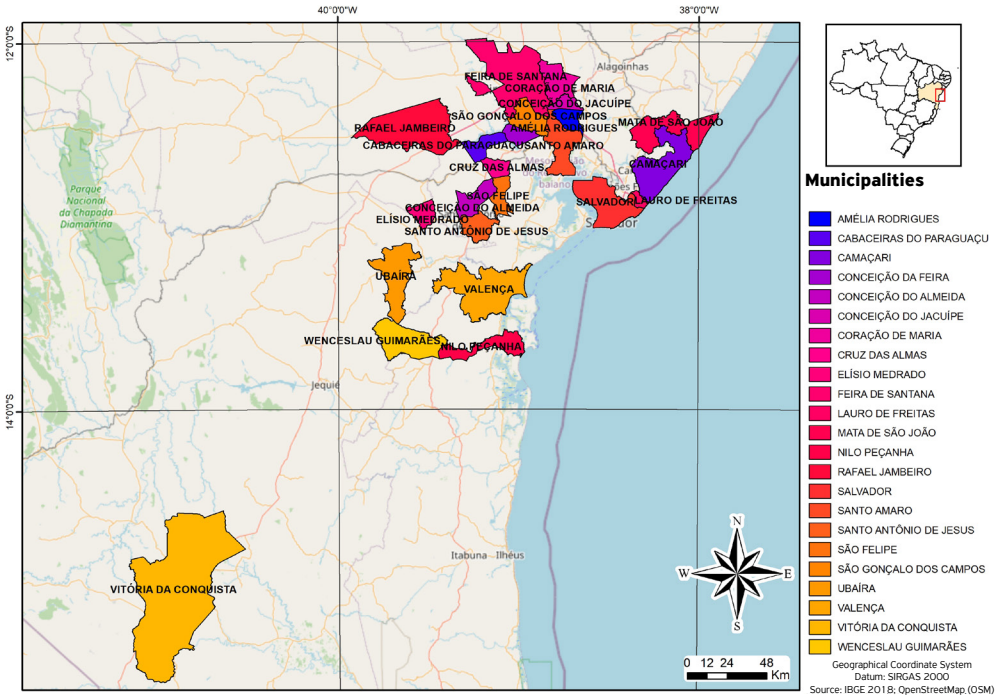


Figure 1. Municipalities of orchidists interviewed in the state of Bahia in 2019.

This study shows that amateur orchid producers do not concern about the physical structure of the nursery nor about the most suitable plant variety and/or species for their production. This result corroborates with FARIA; COLOMBO (2015), who stated that orchids could be grown in small spaces without the need for intense management as required for other crops. On the other hand, professional orchid growers have a structured production system, adequate plants, substrates, and appropriate management to protect plants against pest attacks and disease.

Most research participants were female (67.6%), while male producers accounted for 32.4%. Among the participants, 48.7% had higher education, including Master's and Doctoral levels, 48.6% had elementary or secondary education, and only 2.7% declared to be illiterate. The different academic backgrounds and genders of the participants show that these variables do not limit the orchid cultivation since orchidists have varied education background, different genders, and distinct production systems.

Regarding the time producers have cultivated orchids, 17.6% reported cultivating orchids for more than 10 years, 24.3% for more than 5 years, 31.1% for more than 1 year, and 9.5% for less than 1 year. The survey shows that 84% of the participants acquire knowledge through the Internet, among these participants, 41% have primary or secondary education, and only 13.5% have taken some type of specific training to work with orchids. The study revealed the inexistence of a standard profile for the cultivation and commercialization of orchids.

The ornamental plant market, which includes orchids, covered 8% of the world floriculture trade, considered an international business (GNASEKARAN et al., 2016). This growth may be associated with the inexistence of specific criteria, regardless of academic level or gender specificity to cultivate these plants.

The nurseries comprise one or more plant species, according to the purpose of the cultivation. The research participants reported a wide range of plants used in their cultivation, ranging from less than 50 plants in 69% to more than 1,000 in 7% of the nurseries. *Cattleya*, *Dendrobium*, *Oncidium*, *Phalaenopsis* and *Vanda* were the most cited genera of orchids cultivated. Generally, seedlings of these plants are acquired through exchanges, purchases, or own production. In most cases, orchidists have their own seedling (79%), exchange with other producers (54%), or buy at florists, street markets, websites, and even from other countries in 50% of cases.

Regarding the use of products and/or preventive measures by orchidists to control recurrent pests shows that 67% of commercial nurseries use chemical products, while 9% of amateur producers use these products (Table 1).

Commercial orchidists reported the use of insecticides with the following active principles: abamectin, malathion, acephate and thiamethoxam, and lambda-cyhalothrin, as well as the fungicides azoxystrobin and captan. Amateur producers reported the use of the insecticides icaridin, cypermethrin, organophosphates, and the fungicides thiophanate-methyl and chlorothalonil and calcium polysulfide, as well as acaricides.

Table 1. Percentage of nurseries that use products or preventive measures in the state of Bahia, Brazil, in 2019.

Products/preventive measures	Percentage of nurseries (%)	
	Amateurs	Commercials
Chemical product	9	67
Organic product	54	22
Chemical and organic	12	11
No use of products	25	-
Total	100%	100%

As for organic products, commercial orchidists mentioned the use of cattle milk, rope tobacco, and neem oil. Amateur producers reported the use of tobacco syrup, neutral detergent and water, magnesia milk, neem syrup, horsetail tea, andiroba oil, colloidal silver, (tobacco extract + neem syrup + eucalyptus), cattle urine, cinnamon powder, vinegar solution, alcohol, detergent, mineral oil, coffee powder, cloves, propolis, coconut soap, plant extracts, onion fermented in water for 10 days or just the mechanical method for removing the leaves affected.

Only three chemical products are used to control pests in ornamental plants. The active ingredients were abamectin (insecticide), indicated for chrysanthemum cultivation; azoxystrobin (fungicide), listed by commercial orchidists; and thiophanate-methyl with chlorothalonil (fungicide) indicated for chrysanthemum and roses and used by amateur producers. These products are indicated for plants grown in a greenhouse, which reinforces the need for ideal dosages for amateur producers.

The frequency of product application varied among producers and only 38.3% of respondents use these products on a regular basis (weekly, fortnightly or monthly), 39.7% only use them when pests occur, and 22% never applied any product to control pests.

Orchidists use fertilizers based on nitrogen, phosphorus, and potassium (NPK), calcium (Ca), limestone (Ca), copper (Cu), iron (Fe), magnesium (Mg), among other elements. Orchid fertilization also receives alternative products, such as rice water, eggshells, chayote, beans, and coffee grounds, in addition to urine and cattle manure, coconut fiber, earthworm humus, pine and coconut bark.

The Brazilian Ministry of Agriculture, Livestock and Supply (MAPA) establishes guidelines for the use of chemical pesticides in ornamental plants. It highlights the need for recommendations on leaflets and/or labels about the cultivation environment (open or protected environments), as well as the identification of the biological agent, the recommended dose and the application mode, according to the plant size. This information may contribute to the proper use of products by orchidists without the necessary restrictions. The MAPA indicates one insecticide for insect pest control in orchid cultivation with pymetrozine as the active principle, recommended for the whitefly *Bemisia tabaci* (Gennadius, 1889). For diseases, MAPA recommends thiophanate-methyl, cyprodinil, chlorothalonil, mandipropamid, and metalaxyl-M with chlorothalonil (BRAZIL, 2019).

Orchidists do not follow the product recommendations for pest control in orchid crops, mainly due to the lack of adequate technical assistance or the scarcity of products, leading owners of nurseries to use products indicated for other crops and/or other pests. FARIA et al. (2010) highlight the importance of correctly identifying the agent that is damaging the crop to combat the attack properly.

Coconut (37%) is the mostly used substrate by orchidists. The association of the pest occurrence (mites, insects and diseases) with the substrate type used shows that insects mostly occur (Fig. 2).

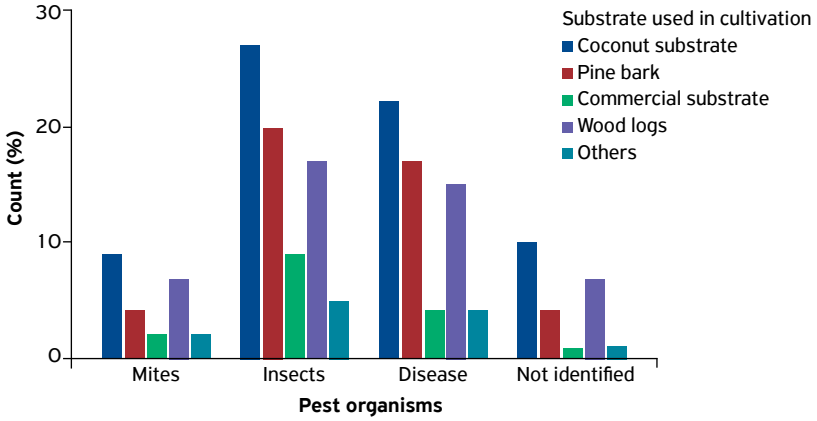


Figure 2. Association of pests to substrates used by orchid producers in the state of Bahia in 2019.

Suitable substrates for these plants must meet their physiological needs. Thus, substrate combinations are commonly tested and the set consisting of coconut husk, coal, and gravel is indicated as efficient for orchid cultivation (SANGHAMITRA et al., 2019). In this study, coconut substrate was the most used, mentioned as the only substrate or accompanied by others, such as gravel and coal. Furthermore, the physical structure of nurseries and inadequate acclimatization can also influence pest occurrence, such as environments that do not allow light to enter, contributing to excessive humidity (CASTEX et al., 2018). Controlled climatic conditions and well-designed structures can prevent the occurrence and help control these harmful organisms to orchids.

The fertilization schedule is practiced by 33.8% of the owners, while irrigation is carried out by 48.6%. Irrigation uses a sprinkler, drip, or manual system, with different frequencies that depend on the region climate.

Technical assistance is nonexistent for producers, even for commercial producers, as 93.2% of the nurseries do not receive instructions on how to grow the plant. These crops are 50% protected and 50% open. Producers that opt for protection use 50% and/or 70% shading screens or use trees and structures from their own homes to protect the plants. The nurseries evaluated have sizes ranging from 10 to 2,000 m^2. However, the absence of these criteria contributes to the circulation of infested plants, given that many of these producers do not follow or are not aware of the importance of phytosanitary care to prevent damage and the spread of pests. This situation reveals the need for technical assistance to producers.

The main pests were insects with 39.9%, followed by diseases with 32.5%, and mites with 18.4%, and 9.2% of the respondents could not identify the insects. Mealybugs (Hemiptera) were the most common insects, comprising 46.3% of the orchid pests mentioned by the producers (Fig. 3).

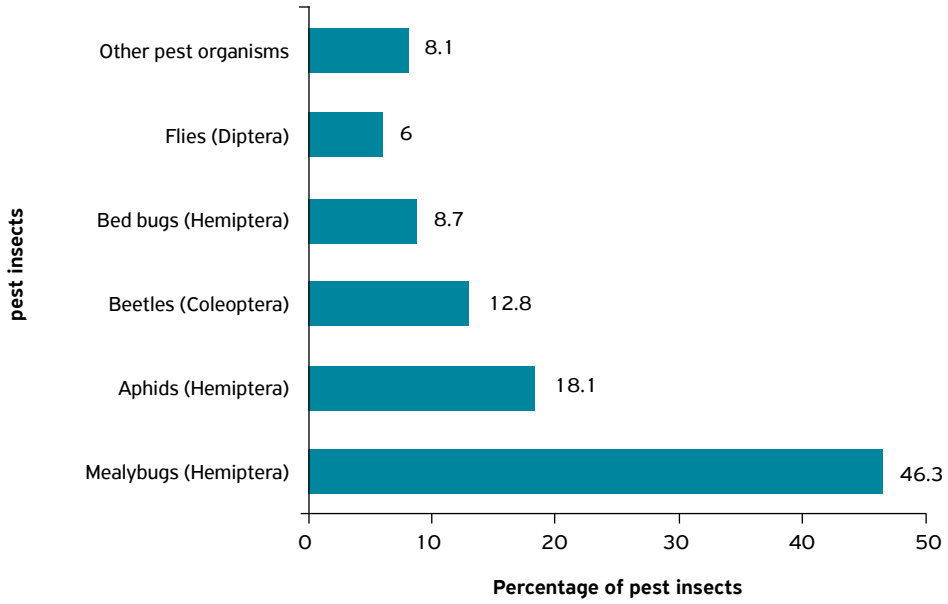


Figure 3. Percentage of insect pests that affect orchid plants mentioned by orchidists in the state of Bahia in 2019.

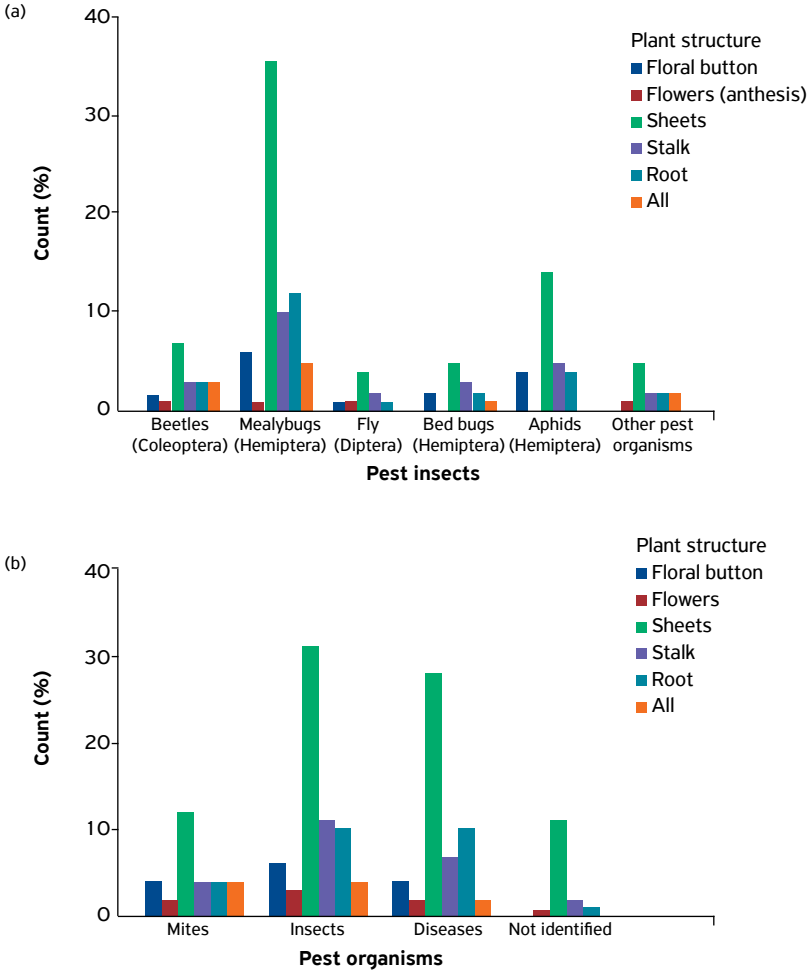
Some insects and mites are vectors of viruses (indirect damage); also, when using plant structures for reproduction and feeding (direct damage), they cause lesions to the structures, facilitating the entry of pathogens (LIGHT; MACCONAILL, 2011). Thus, diseases are associated with microorganisms, such as viruses and bacteria, which can modify the defense mechanisms of plants, impairing their development (WIELKOPOLAN; OBRĘPALSKA-STĘPLOWSKA, 2016). Thus, these individuals can cause irreversible damage to the plant, as reported by the producers interviewed, who mentioned that insects, mites and fungi are common in their crops.

Although specimens were not collected for taxonomic identification, the results obtained through questionnaires are similar to those found in some works. MIRANDA et al. (2007) reported the occurrence of mites of the genus *Brevipalpus* causing injuries to orchids (*Dendrobium* and *Oncidium*). These arthropods damage the plant, resulting in spots on the leaf structure (KITAJIMA et al., 2010).

Mealybugs, as well as other insects, are more common on plant leaves (Fig. 4a). ARISTIZÁBAL et al. (2013) investigated insects associated with tropical foliage and recorded the occurrence of the Coccidae family (*Ceroplastes* sp., *Saissetia* sp.). Mealybugs are prominent in the cultivation of ornamental plants, including orchids, and *Chrysomphalus ficus* Ashmead,

1880, is one of the main species (GONZÁLEZ-DÍAZ et al., 2010). Although these individuals are deleterious pests in several crops and cause serious damage to the production, few studies have investigated these insects in orchids in Brazil, as they affect the plant by sucking the sap, weakening the plant and thus affecting its commercial value (SANTOS; PERONTI, 2017). Moreover, in line with the results presented here regarding mealybugs as the most cited pest insects, RIVERA-COTO; CORRALES-MOREIRA (2007) mentioned several species of mealybugs causing injuries to the plants studied, mainly species belonging to the Diaspididae family, causing damage to *Cattleya*, *Catasetum*, *Cymbidium*, *Encyclia*, *Epidendrum*, *Laelia*, *Oncidium* and *Phalaenopsis*, orchid genera also cultivated by orchidists that participated in this study.

The presence of pests (mites, insects and diseases) is more frequent on the leaves; however, they also damage other plant structures (Fig. 4b). Producers mentioned the occurrence of other pests, namely slugs (Stylommatophora), ants (Hymenoptera), and thrips (Thysanoptera).



Figures 4. Plant structures most frequently observed by orchidists being affected by pest organisms. (a) Association between the main insect pests and plant structures; (b) association between insects and other pests (mites, insects, and diseases) and structure of the plant affected and mentioned by orchidists in the state of Bahia in 2019.

Besides insects, mites and diseases also affect mainly the leaves in more than 40% of the cases (Fig. 5).

The participants also reported beetles (Coleoptera), since many species of these groups are harmful to orchid crops, causing economic losses (WIELKOPOLAN; OBRĘPALSKA-STĘPLOWSKA, 2016). Beetle pests of orchids encompass *S. nudiventris*, belong to the family Curculionidae (MORALES-BÁEZ et al., 2016).

Aphids (Hemiptera) were identified as pests by the orchidists interviewed. In this group of insects, *A. craccivora* was listed as pests of orchids belonging to the genus *Catasetum* (LEITE et al., 2017), the same orchid genus frequently cultivated in the orchids studied.

Similarly, respondents mentioned the occurrence of thrips (Thysanoptera) and flies (Diptera). Among dipterans, the fly *Contarinia maculipennis* Felt, 1933 (Cecidomyiidae) is considered a pest of the Orchidaceae family, as it lays its eggs on the flower buds and they feed on the floral structures after larval emergence, causing total loss of flowers (TOKUDA et al., 2002).

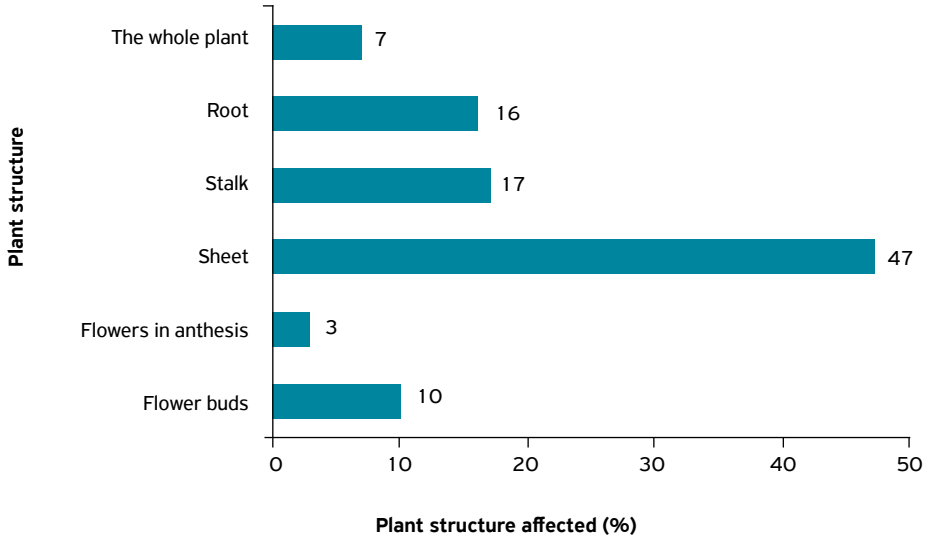


Figure 5. Percentage of plant structures mentioned by orchidists affected by pests (mites, insects, and diseases) in the state of Bahia in 2019.

Thrips are reported as important pests of orchids, often associated with a virus transmission (MORAES et al., 2017). Considered pests of several cultures, such as the genus *Frankliniella*, which has been reported as an insect vector of the chrysanthemum stem necrosis virus (FREIRE; MOSCA, 2009). Representatives of these insects, such as *Frankliniella insularis* (Franklin, 1908), *Pseudothrips inequalis* (Beach, 1896) and *Elixothrips brevisetis* (Bagnall, 1919) have been recorded in *Epidendrum patens* and *Vanilla fragrans* orchids (ETIENNE et al., 2015). Information on the occurrence of these insects, obtained through the research participants, draws attention to the need for entomological surveys in environments where crops have been expanding.

The association of pests (mites, insects and diseases) and agents (beetles, mealybugs, flies, bed bugs and aphids) with the substrate used or with the structure of the affected plant shows no significant difference between the variables ($p > 0.05$), according to Pearson's chi-square test, indicating that they are independent.

Of the mites mentioned by the research participants as pests in their crops, the Tenuipalpidae family is considered the most economically important in Brazil, as they congregate virus vectors that cause the disease known as orchid spot, which has as vector the species *Brevipalpus californicus* (Banks, 1904) (KONDO et al., 2003). In addition to diseases, when feeding on plants, these mites can cause other damage, such as leaf necrosis and gall formation (OCHOA; SALAS, 1989).

The multiple correspondence analyses identified through the perception map 13 categories for commercial nurseries and 15 for amateur nurseries. The analysis of the relationship of interdependence between the cultivation resulted in the discrimination of two profiles of orchidists.

The commercial producers reported greater abundance of plants, predominance of mealybugs as the main pest, and longer cultivation time. Amateur nurseries registered that they did not receive technical assistance, cultivated less than 50 plants, controlled pests and diseases with natural products, used organic fertilization for plant nutrition and multiplied their culture with their own seedlings.

In this context, the correspondence relationships of the groups defined between the purposes (commercial and amateur) were significant according to the Mann–Whitney test $U_{(1)} = 370.04$, $p < 0.01$. In addition, the Kruskal–Wallis test, $H_{(27)} = 924.78$, and $p < 0.01$ discriminated the categories between the groups, demonstrating that the producers have different characteristics and purposes in their orchid cultivation.

CONCLUSION

Most orchid producers are amateurs, without technical criteria, especially regarding phytosanitary control, since technical assistance in this branch of agribusiness is nonexistent in the state of Bahia, Brazil.

The study highlights problems of pest dispersion in orchid crops, since the absence of sanitary surveillance in certain environments can cause phytosanitary problems in Brazil and consequently to the state of Bahia. The acquisition of infested plants from abroad, at local markets, or through exchanges, favors the occurrence of these pests.

AUTHORS' CONTRIBUTIONS

Conceptualization: Silva, A.C.S.; Carvalho, C.A.L.; Machado, C.S.; Alves, R.M.O.; Sodré, G. S.; **Formal analysis:** Silva, A.C.S.; Carvalho, C.A.L.; Machado, C.S.; Costa, J.A.; Alves, R.M.O.; Sodré, G.S.; **Investigation:** Silva, A.C.S.; Carvalho, C.A.L.; Machado, C.S.; Almeida, R.S.J.; Santos, J.A.; Alves, R.M.O.; Sodré, G.S.; **Methodology:** Silva, A.C.S.; Carvalho, C.A.L.; Machado, C.S.; Costa, J.A.; Almeida, R.S.J.; Santos, J.A.; Alves, R.M.O.; Sodré, G.S.; **Project administration:** Silva, A.C.S.; Carvalho, C.A.L.; Machado, C.S.; Alves, R.M.O.; Sodré, G.S.; **Visualization:** Silva, A.C.S.; Carvalho, C.A.L.; Machado, C.S.; Costa, J.A.; Almeida, R.S.J.; Santos, J.A.; Alves, R.M.O.; Sodré, G.S.; **Writing – original draft:** Silva, A.C.S.; Carvalho, C.A.L.; Machado, C.S.; Costa, J.A.; Almeida, R.S.J.; Santos, J.A.; Alves, R.M.O.; Sodré, G.S.; **Writing – review & editing:** Silva, A.C.S; Carvalho, C.A.L.; Machado, C.S.; Costa, J.A.; Almeida, R.S.J.; Santos, J.A.; Alves, R.M.O.; Sodré, G.S.

AVAILABILITY OF DATA AND MATERIAL

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

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CONFLICTS OF INTEREST

All authors declare that they have no conflicts of interest.

ETHICAL APPROVAL

This study was approved by Research Ethics Committee of the Federal University of Recôncavo da Bahia (UFRB) under protocol number 03480918.4.0000.0056 on February 07, 2019.

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