Seasonal abundance of *Thyanta perditor* (F.) (Heteroptera: Pentatomidae) and its preference among cultivated and non-cultivated plants

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Abstract – Results of field studies with the red-shouldered stink bug *Thyanta perditor* (F.) demonstrated that nymphs and adults are highly abundant in late summer (March) on maturing soybean [*Glycine max* (L.) Merrill] plants, and on maturing plants of the weed black jack (*Bidens pilosa* L.) in the northern area of the state of Rio Grande do Sul, Brazil. Since soybean is harvested in March, populations decreased sharply in April and resurged somewhat in May. After this month, stink bugs were not observed until late spring in November when adults on maturing wheat plants were captured. Laboratory tests comparing the bug preference for seedlings of cultivated plants indicated that soybean and maize (*Zea mays* L.) were preferred hosts compared to wheat (*Triticum aestivum* L.) and barley (*Hordeum vulgare* L.). For non-cultivated plants (weeds), seedlings of milkweed (*Euphorbia heterophylla* L.) and of flax-leaf fleabane (*Conyza bonariensis* L.) were preferred over those of signal grass [*Brachiaria plantaginea* (Link)] and black jack. Seedlings of non-cultivated plants were preferred over cultivated ones, in particular milkweed and black jack.

Index-terms: stink bug; population; associated plants; crops.

Abundância sazonal de *Thyanta perditor* (F.) (Heteroptera: Pentatomidae) e sua preferência entre plantas cultivadas e não cultivadas

Resumo – Resultados de estudos em campo com o percevejo *Thyanta perditor* (F.) demonstraram que ninfas e adultos foram mais abundantes no final do verão (março) em soja [*Glycine max* (L.) Merrill] em fase de maturação e em picão-preto (*Bidens pilosa* L.) em Passo Fundo, no norte do Rio Grande do Sul, Brasil. Após a colheita da soja em março, as populações diminuíram em abril e reapareceram em maio. Após maio, não foram constatados percevejos até o final da primavera em novembro, quando foram capturados adultos no trigo em maturação. Testes em laboratório indicaram que plântulas de soja e milho (*Zea mays* L.) foram hospedeiros preferidos em comparação ao trigo (*Triticum aestivum* L.) e cevada (*Hordeum vulgare* L.). Plântulas de ervas daninhas, como o leiteiro (*Euphorbia heterophylla* L.) e a buva (*Conyza bonariensis* L.) foram preferidas em relação às plântulas de capim-papuã [*Brachiaria plantaginea* (Link)] e picão-preto. Em geral, plântulas de espécies não cultivadas foram preferidas comparado com plântulas de espécies cultivadas, em especial o leiteiro e o picão-preto.

Termos para indexação: percevejo; população; plantas associadas; culturas.

Introduction

The red-shouldered stink bug *Thyanta perditor* (F.) (Heteroptera: Pentatomidae) is widely found in the Neotropics (CALLAN, 1948). In Brazil, it has been reported to occur in several states, from the southernmost state of Rio Grande do Sul (latitude range of 27-33 S) (GASSEN, 1984) to the far northeast state of Maranhão (latitude range 1-10 S) (PANIZZI, 2002). However, based on literature records, it is apparently more abundant in the states of the Mid-West (FERREIRA & SILVEIRA, 1991; MORAES et al., 2005), Southeast (AMARAL FILHO et al., 1992) and South regions of Brazil (PANIZZI & HERZOG, 1984).

T. perditor is associated with several species of cultivated plants, although rarely reaching pest status. Soybean [*Glycine max* (L.) Merrill], sorghum (*Sorghum vulgare* Pers.), sunflower (*Helianthus annuus* L.), and wheat (*Triticum aestivum* L.) are among its reported hosts (PEREZ et al., 1980; BUSOLI et al., 1984; PANIZZI & HERZOG, 1984; FERREIRA & SILVEIRA, 1991; AMARAL FILHO et al., 1992; MALAGUIDO & PANIZZI, 1998).

Little is known about the damage caused by *T. perditor* on cultivated plants. Gallo et al. (1988) refer to its damage to soft developing wheat seeds,

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causing reduction in seed germination. Ferreira & Silveira (1991), who studied the feeding damage by adults on wheat seed heads, reported that bugs caused reduction in seed yield. They indicated that control measures should be taken when populations reach one bug per five seed heads.

In addition to cultivated plants, *T. perditor* was found to feed from and reproduce on the weed black jack (*Bidens pilosa* L.) (PANIZZI & HERZOG, 1984). Because this weed grows commonly in crop fields, in between cultivated plants or on the edges of cultivated fields, sometimes it allows *T. perditor* populations to grow up and reach high levels. Growers often mistake it as a pest of cultivated plants, not knowing that these populations are breeding mostly on the fruiting structures of the black jack. However, these bugs also feed on certain cultivated plants, as previously referred.

The monthly fluctuation of *T. perditor* on associated cultivated and non-cultivated plants in southern Brazil was studied. Moreover, dual preference choice tests were carried out in laboratory to identify the preferred plants (seedlings) of common cultivated and non-cultivated plants in the southern region.

Material and methods

Field and laboratory studies were conducted at the Embrapa National Wheat Research Center and in the Laboratory of Entomology, respectively, in Passo Fundo, RS, Brazil (latitude 28°15'46"S, longitude 52°24'24"W and altitude 687m).

Nymph and adult seasonal fluctuation in the field

To evaluate the seasonal fluctuation of *T. perditor* nymphs and adults, samples were taken weekly for a year (January to December 2016). Bugs were sampled on cultivated plants such as sunflower, maize (*Zea mays* L.), soybean, sorghum, wheat and barley (*Hordeum vulgare* L.); and on non-cultivated plants (weeds) including black jack, flax-leaf fleabane (*Conyza bonariensis* L.), milkweed (*Euphorbia heterophylla* L.) and signal grass [*Brachiaria plantaginea* (Link)]. Samples from the soil surface were also taken (examining plant residues), and on native vegetation (mixture of plants of different species) from nearby cultivated fields.

On cultivated and non-cultivated plants (weeds), samples were taken by visually examining the plants present in $1m^2$ in the field. Each sample consisted of five points selected at random. In areas with crop residues only, we used an iron frame ($1m^2$) placed on the ground. Plants (trees) from the native vegetation were examined by using a white cloth (2 x 2m) placed underneath the branches, which were beaten ten times.

The data obtained on the total number of *T. perditor* captured on the different plants and on crop residues, during the one-year-period of the research, was relatively small. Therefore, the data were presented by adding the numbers obtained of all sites wherein the bugs (nymphs and adults) were sampled.

Plant preference tests in the laboratory

Insect colony. An insect colony of *T. perditor* was established in the laboratory from adults collected in the field on cultivated (soybean) and non-cultivated (black jack) plants. They were taken to the laboratory and placed inside plastic boxes (25cm high x 20cm length x 20cm width), lined with filter paper. The bugs were fed with branches of black jack with reproductive structures (flowers and fruits) placed inside glass jars with water, sealed with a cotton swab. Food was replaced twice a week. The boxes were kept inside an acclimatized room (25±1°C, 65±5% RH, and 14L: 10D photoperiod). The eggs and nymphs produced were removed daily and placed in additional boxes in order for adults to be obtained, which were used in the dual preference tests. To avoid any induced food preference on the part of emerging adults, they were exposed to a mixture of foods we usually use to rear stink bugs in our laboratory [fresh green bean pods (*Phaseolus vulgaris* L.), raw shelled peanuts (*Arachis hypogaea* L.), and mature seeds of soybean] for a couple of weeks before being used in the tests.

Cultivated and non-cultivated plants. Soybean (cv. BRS 6203 RR), maize (cv. Pioneer 1630 Herculex), wheat (cv. BRS Parrudo) and barley (cv. BRS Cauê) were used as cultivated plants. Non-cultivated plants included black jack, flax-leaf fleabane, signal grass, and milkweed. From February to September 2016, every two-weeks, seeds of each plant species were sown in plastic pots (250mL) and kept in the greenhouse. When plants reached 20cm height, they were taken to the laboratory to have the dual preference tests conducted.

Treatments and bioassays. Three sets of comparisons were tested: cultivated vs. cultivated plants; non-cultivated vs. non-cultivated plants; and cultivated vs. non-cultivated plants, in mutual combinations. The comparisons between signal grass vs. flax-leaf fleabane, barley, wheat, and soybean were not performed, since plant seedlings were not available at the time of the test.

Bugdorm I cages (30cm high x 30cm length x 30cm width) with bottoms lined with filter paper were used in these tests. Four pots containing two different plant species were placed alternatively in the corners of each cage. One adult *T. perditor* obtained from the laboratory colony established was released in the center of each cage used. For each comparison, a different adult was used to avoid any induced preference. Having passed 24 hours, daily observations were taken twice (9:00 AM and 4:00 PM) for five days, and the position of the bugs on the different plants being compared were recorded. Each comparison was replicated six times (six cages). The total number of observations per comparison was 60 (6 cages x 2 observations x 5 days).

Data analysis. The total number of observations of bugs on the different plants tested by means of dual choice comparisons were compared using the Chi-square test (χ^2). The bugs that were found to be away from the plants at the time the observations were conducted were not considered in the analysis. The Chi-square test comparisons were ▸

performed using the R program (R DEVELOPMENT CORE TEAM, 2016).

Results and discussion

Nymph and adult seasonal fluctuation in the field

T. perditor showed a variable seasonal abundance in the central-north area of the state of Rio Grande do Sul (Figure 1). Because the total number of bugs captured on the different plants and on crop residues during the one-year-period of research was relatively small (166 nymphs and 125 adults), the data from all sites where bugs were sampled is presented in a single figure. The populations of both nymphs and adults showed similar fluctuation trends. Nymphs and adults started being captured in January, mostly on soybean and its associated weed, black jack. Few bugs were captured on sunflower, and none on maize. Two distinct population peaks were observed. The first one occurred in late summer-beginning of autumn (March), with the total number of nymphs reaching ca. 40 individuals (Figure 1A), and adults ca. 20 individuals (Figure 1B). At the end of March, a drastic reduction in populations was observed when soybean, the prevailing plant in the area, matured and was harvested. At this time, black jack plants from cultivated fields were also eliminated. During April, no bugs were captured. In May, a second peak of nymphs and adults was observed, although less intense, with about 15 nymphs and 22 adults captured. Most of these bugs were caught on the remaining black jack plants in the area. As the season progressed toward winter, populations mitigated, and only a few adults (less than 5) were captured in June. During winter months (July and August) and late winter and spring (September and October), no bugs were collected. In mid spring (November), the first adults (less than 5) were captured on wheat plants during the reproductive period (carrying maturing seed heads). As the wheat plants were harvested, no adults and no nymphs were captured in December.

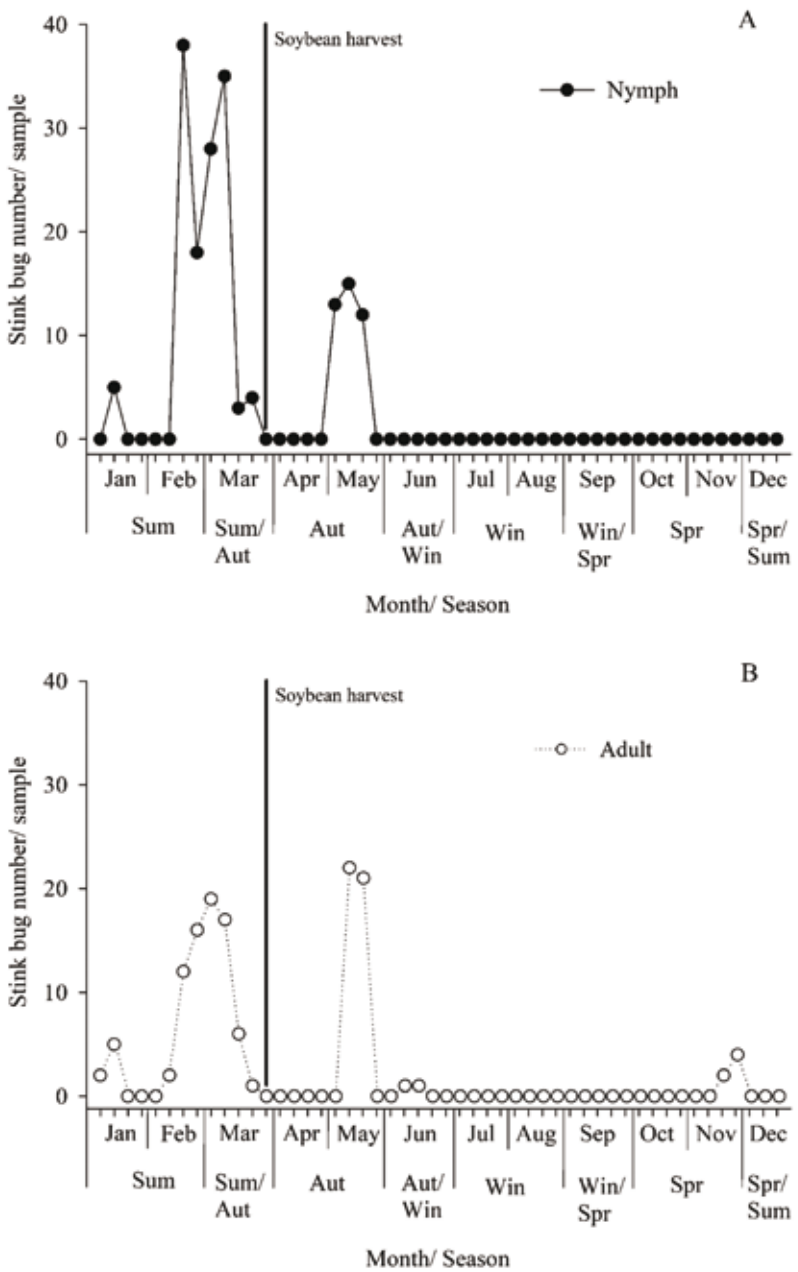

Figure 1. Population fluctuation of nymphs (A) and adults (B) of *Thyanta perditor* during January to December 2016 at the Embrapa National Wheat Research Center experimental station at Passo Fundo, RS

The appearance of the first nymphs and adults in January/February was related to the presence of early generations of black jack, and maturing plants of sunflower. Black jack is known to be a preferred host plant of *T. perditor*, allowing nymphs to develop and adults to reproduce (PANIZZI & HERZOG, 1984). Sunflower has been reported to host *T. perditor* in northern Paraná State (MALAGUIDO & PANIZZI, 1998).

The first and greater peak correlates with soybean in reproduction as *T. perditor* is known to feed and reproduce on such plant (WALDBAUER, 1977; PANIZZI & HERZOG, 1984). In a similar way, this peak can also be attributed to the presence of black jack plants in reproductive stages present in soybean fields and nearby areas. In several occasions, nymphs and adults were observed to feed on mature seeds of black jack; younger nymphs were

commonly observed to congregate in between the mature seeds that, beyond serving as a food source, were able to offer protection. Egg masses deposited on soybean and on black jack leaves were also observed, as previously reported (PANIZZI & HERZOG, 1984).

The drastic reduction in *T. perditor* populations observed at the end of March may be attributed to the soybean harvest, and the elimination of black jack plants, either during the crop harvest or by herbicides applied to burn down weed plants to facilitate machinery operation. In May, bugs were captured mostly on black jack present between sorghum plants. Although bugs were not captured on sorghum, this plant species is known to be attacked and suffer damage by the feeding activity of *T. perditor* in the state of São Paulo (BUSOLI et al., 1984).

As winter started and temperatures decreased in June, nymphs and adults of *T. perditor* were no longer caught. Samplings conducted on crop residues on the soil surface from June to October resulted in no bugs captured. Apparently, different than other species of pentatomid-pests, such as the Netropical brown stink bug, *Euschistus heros* (F.) (PANIZZI & NIVA, 1994), and the green-belly stink bugs, *Dichelops furcatus* (F.) and *D. melacanthus* (Dallas) (PANIZZI et al., 2015), *T. perditor* does not overwinter under debris. Most likely, it moves out from cultivated areas to nearby natural vegetation in order to overcome unfavorable conditions during winter/early spring. In spite of this hypothesis, *T. perditor* was not collected from the natural vegetation at the Embrapa Wheat experimental station area.

Two different adult morphs were observed (Figure 2). The summer morph showed body with the typical green color, the red band on the pronotum and red marks on the head. The winter morph showed body with brownish coloration and no distinct red band nor red marks on the head. Panizzi & Herzog (1984) referred to the brownish coloration of *T. perditor* while feeding on maturing wheat plants during late winter. This variation in body color with the seasons is a common occurrence

Figure 2. Adult *Thyanta perditor* of different morphs found on black jack (*Bidens pilosa* L.) at the Embrapa National Wheat Research Center experimental station at Passo Fundo, RS, in 2016. Summer morph (A) and winter morph (B)

on several species of pentatomids in the Neotropics, such as the southern green stink bug, *Nezara viridula* (L.) (RIZZO, 1968), the small green stink bug, *Piezodorus guildinii* (West. (ZERBINO et al., 2015), and the green-belly stink bugs, *Dichelops* spp. (PANIZZI et al., 2015).

Plant preference tests in the laboratory

Cultivated vs. cultivated plants. The dual choice test indicated that maize seedlings were significantly preferred compared to wheat (41% vs. 5%) and barley (42% vs. 6%), but not when compared to soybean seedlings, which were greatly preferred than maize seedlings (39% vs. 11%). Soybean seedlings were also significantly preferred when compared to wheat (41% vs. 4%) or barley (31% vs. 4%). When the two winter crops were compared, wheat seedlings were greatly preferred than barley seedlings (33% vs. 8%) (Figure 3).

Non-cultivated vs. non-cultivated plants. Seedlings of milkweed were significantly preferred compared to seedlings of signal grass (36% vs. 12%) or seedlings of black jack (40% vs. 18%). However, seedlings of milkweed were significantly less preferred when compared to flax-leaf fleabane (21% vs. 36%). Comparisons between seedlings of black jack and flax-leaf fleabane (25% vs. 14%) and black jack and signal grass (18% vs. 28%) demonstrated that they were equally preferred (Figure 4). In general, except considering the dual comparisons involving milkweed seedlings, the preferences of *T. perditor* adults for a particular weed plant seedling was less pronounced than what was observed for the dual comparisons among the seedlings of cultivated plants, as shown in Figure 3.

Cultivated vs. non-cultivated plants. Adults of *T. perditor* showed greater significant preferences for non-cultivated over cultivated seedlings in most comparisons, i.e., 8 out of 13 comparisons (Figure 5). For instance, seedlings of milkweed were significantly more preferred than seedlings of wheat (55% vs. 0%), barley (44% vs. 8%), soybean (48% vs. 9%), or maize (45% vs. 2%). Other comparisons, in which non-cultivated were greatly preferred than cultivated plants included flax-leaf fleabane over wheat (100% vs. 0%) and black jack over maize (34% vs. 14%), barley (50% vs. 2%), and wheat (37% vs. 9%) seedlings; however, black jack was as equally preferred as soybean (22% vs. 27%). Similarly, non-preference results were observed for two additional comparisons, between flax-leaf fleabane and barley (50% vs. 50%), and signal grass and maize (24%▸

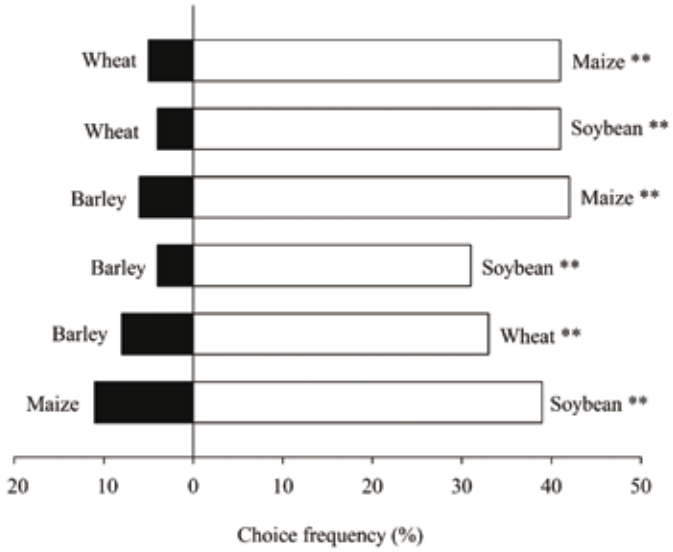

Figure 3. Frequency of choice of adult *Thyanta perditor* among different species of cultivated plants in dual choice tests. ** Significantly different according to the Chi-square test (χ^2) (P < 0.01).

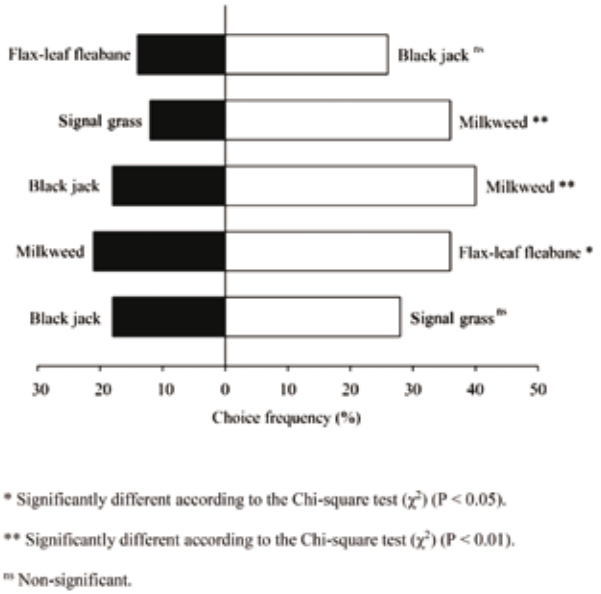

Figure 4. Frequency of choice of adult *Thyanta perditor* among different species of non-cultivated plants in dual choice tests. * Significantly different according to the Chi-square test (χ^2) (P < 0.05). ** Significantly different according to the Chi-square test (χ^2) (P < 0.01). ns Non-significant.

vs. 25%). Finally, flax-leaf fleabane seedlings were less preferred compared to maize (2% vs. 45%) or soybean (3% vs. 46%) seedlings (Figure 5).

Results on the higher preference of *T. perditor* adults for soybean seedlings were expected, since it is known that it reproduces on such plant (PANIZZI & HERZOG, 1984). Its preference for maize seedlings when compared to other cultivated plants (except soybean) was unexpected, since *T. perditor* is not known to occur on such plant. Its low preference for wheat seedlings was also unexpected, because it is known to reproduce on wheat seed heads (PANIZZI & HERZOG, 1984), however, it does not seem to choose wheat plants at their early stage of development, as happens with soybean.

Of the several preference comparisons between non-cultivated plants, milkweed seedlings were greatly preferred, except when compared to flex-leaf fleabane. Milkweed plants are known to be eventually utilized as food source by other species of stink bugs, such as the neotropical brown stink bug, *Euschistus heros* (F.) (PINTO & PANIZZI, 1994); hence, in the case of *T. perditor*, it may play a similar role. The preference of *T. perditor* adults for flex-leaf fleabane seedlings may be attributed to the plant's architecture, providing better shelter compared to other weed seedlings. However, further studies are needed to prove this hypothesis.

Results indicated that, in the majority of the comparisons, non-cultivated seedlings were preferred over cultivated ones, suggesting that these weed plants may play an important role in the life history of *T. perditor*. In this new scenario of agriculture in the Neotropics there is high abundance of weed plants. These weeds might serve as source of nutrients and water, additionally providing shelter. In a literature research conducted by Smaniotto & Panizzi (2015), *T. perditor* was found on 15 different species of plants, of which around 50% were uncultivated. In most plants (12 species), these bugs were found not to be reproducing, but temporarily exploiting these plants for other purposes (e.g., source of nutrients, water and/or shelter).

Conclusion

This field study allowed for concluding that the seasonal fluctuation of *T. perditor* in southern Brazil is mostly conditioned by soybean and by black jack in late summer and early autumn, and by maturing wheat in late spring. Laboratory studies indicated that seedlings of some weeds are preferred over those of cultivated plants. This information must be taken into account for monitoring and possible control of this pest.

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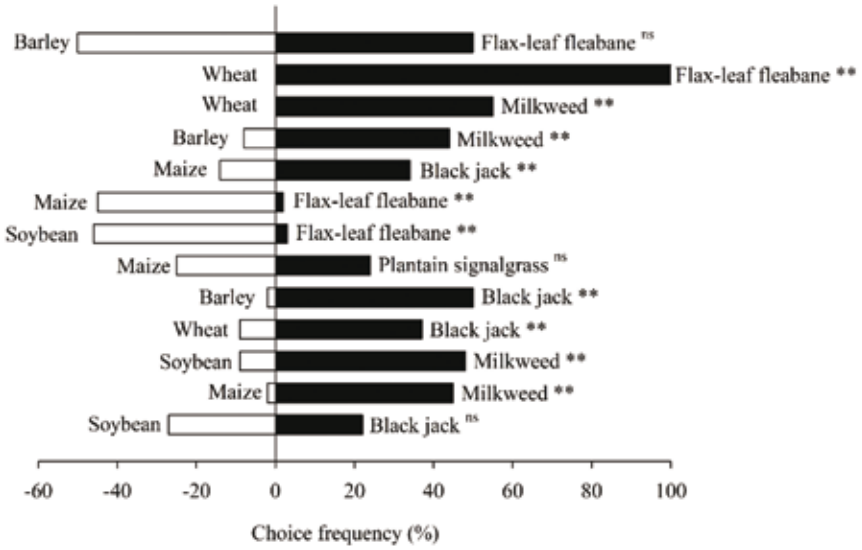

** Significantly different according to the Chi-square test (χ^2) ($P < 0,01$).

ns Non-significant.

Figure 5. Frequency of choice of adult *Thyanta perditor* among different species of cultivated and non-cultivated plants in dual choice tests. ** Significantly different according to the Chi-square test (χ^2) ($P < 0,01$). ns Non-significant

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