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Full Length Article

Abundance and Diversity of Thrips Associated with Host Plants in Burkina Faso

Carine Patoingnimba Ouédraogo[1,2*], Fousséni Traoré[2], Aboubacar Boly[1], Elsa Nassira Zongo[1,2], Edouard Drabo[2], Antoine Waongo[2], Barry R Pittendrigh[4] and Manuele Tamò[3]
[1]*Université Joseph Ki-Zerbo, Ouagadougou, Burkina Faso*
[2]*Institut de l'Environnement et de Recherches Agricoles, Ouagadougou Burkina Faso*
[3]*Biorisk Management Facility (BIMAF), International Institute of Tropical Agriculture (IITA), Cotonou Benin*
[4]*The Urban Center, Department of Entomology, Purdue University, West Lafayette, IN, USA*
[*]For correspondence: pcarineouedraogo@gmail.com
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Abstract

Flower thrips are among the most damaging insect pests limiting cowpea yields. Despite their economic importance, the species composition and abundance of thrips associated with cowpea and alternative host plants are little knowing. This study aimed to identify the thrips species associated with various host plants during the main cropping season and to assess their abundance. Thrips samples were collected over two consecutive years across three climatic zones by carefully cutting off flowering structures of the different plants and placing them in vials containing 70% ethanol. Five thrips species were identified on cowpea: *Megalurothrips sjostedti, Frankliniella schultzei, Hydatothrips adolfifriderici, Florithrips traegardhi* and *Arorathrips mexicanus. Arorathrips mexicanus* was identified on only cowpea. Among them three species: *Megalurothrips sjostedti, Frankliniella schultzei* and *Hydatothrips adolfifriderici* were consistently recorded on cowpea across all three climatic zones. *Megalurothrips sjostedti* and *Frankliniella schultzei* were found only on wild host plants and common to all zones. Megalurothrips sjostedti (89.87%) and Frankliniella schultzei (6.91%) were the main thrips species in terms of abundance, occurring on both wild host plants and cultivated cowpea. *Florithrips traegardhi* (0.39%) was relatively rare, while *Arorathrips mexicanus* (0.006%) appeared to be an accidental species. Several plants species were identified as alternative thrips hosts. Among them, *Piliostigma thonningii* and *Piliostigma reticulatum* were recorded as the main alternative host plants in Burkina Faso.

Keywords: Cowpea; Thrips; *Megalurothrips; Frankliniella; Piliostigma thonningii*

Introduction

Cowpea *Vigna unguiculata* (L.) Walpers, Fabaceae is one of the most important edible legume crops in the moist and dry savannah of Sub-Saharan Africa, where it is grown as an intercrop with other cereal crops like sorghum, millet and maize (Sawadogo *et al.* 2022). Fresh leaves and pods as well as dry grains are widely consumed by humans, while plant residues after harvest are valuables fodder for livestock during the dry season (Omoigui *et al.* 2018). Cowpea grains are particularly valued for their protein and carbohydrate content (Owolabi *et al.* 2012).

Unfortunately, cowpea production is constrained by a range of insect pests during all stages of its growth from seedling to storage (Sobda *et al.* 2017), including flower thrips which have been reported to cause yield loss of up to 100% under of severe infestation (Singh and Allen 1980; Jackai and Daoust 1986; Ngakou *et al.* 2008; Omoigui *et al.* 2018).

In Burkina Faso, the cowpea flower thrips *Megalurothrips sjostedti* Trybom (Thysanoptera: Thripidae) is considered the most damaging insect pest in the Sahelian and Soudano-sahelian zones (Sidibe *et al.* 2019) and posing a major threat to cowpea cultivation as documented by several studies (Ba *et al.* 2008; Hamadou *et al.* 2018; Traore *et al.* 2019). However, the diversity of flower thrips on cowpea has not been extensively studied despite their economic importance.

Understanding the importance of thrips species across different zones and their population densities on cultivated plants (*e.g.*, cowpea) and weeds are critical for effective pest management (Mirab-balou *et al.* 2017). Weeds as

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alternative host plants may serve as reservoirs for thrips that could migrate to cultivated plants. However, only limited information was available as to which thrips species occurred in Burkina climatic zones. Therefore, this study was conducted to determine the species composition of thrips on cowpea across three climatic zones, as well as which thrips species are the most dominant on cowpea. A comprehensive list of species, their abundance and richness on cultivated cowpea can serve as a basis for pest management decision making.

Materials and Methods

Study Area

Thrips samples were collected during the period from mid-September to the beginning of October, 2021 and 2022 in three sites of cowpea production in Burkina Faso. These three sites (Dori, Ouagadougou and Bobo-Dioulasso) belong to different climatic zones where rainfall, temperature and vegetation vary (Fig. 1).

Dori (latitude: 14°02'07" N, longitude: 0°02'04" W) is located in northeast Burkina Faso. The climate is Sahelian, with average rainfall of 567mm/year. The vegetation is steppe-like, with shrubs, thorny bushes and trees. Soils are sandy and often covered with silt. This location receives less water, but is ideal for growing cowpeas (Tignegre *et al.* 2020).

Ouagadougou (latitude: 12°20'60" N and longitude: 1°31'0.001" W) is the capital city in central Burkina Faso. The climate is Soudano-Sahelian, with average rainfall of 745 mm/year. The region has a wooded savannah in the south and a grassy savannah in the north. Soils are of the superficial tropical ferruginous type. It is a preferred zone (with good cultivation practices and organic matter input) for cereal crops (sorghum, millet, maize) and legumes, including cowpeas (Tignegre *et al.* 2020).

Bobo Dioulasso (latitude: 11°10'59.999" N, longitude: 4°16'59.999" W) is located in southwest Burkina Faso. The climate is Sudano-Guinean, with average rainfall of 1,000 mm/year. The region's denser vegetation is dominated by wooded savannahs, open forests and gallery forests. The soils are ferruginous and not very advanced due to low organic matter content. This zone is well suited to the production of a wide range of crops: cash crops, cereals, food crops, etc. However, it is not ideal for growing cowpeas because of the higher rainfall (Tignegre *et al.* 2020). However, cowpeas are grown as an agricultural precursor to cereals or in association with them (Coulibaly *et al.* 2017).

Collecting and sampling of wild host plants and thrips specimens

Thrips samples were collected from cowpea and wild plant species according to the methodology provided by Silva *et al.* (2021), with slight modifications. Sampling was conducted during mi-September to early October in both 2021 and 2022. Ten cowpea fields approximately 5 km apart from one site to another were visited. The fields surveyed were planted exclusively with cowpeas. In each field, ten flowers were collected in ten replicates and ten fields per zone.

A total of 100 flowers were randomly collected on the improved cowpea plants in the field following the diagonals. The flowers were placed in 30 cc vials (10 flowers per vial). Specimens were preserved in 70% ethanol throughout. A total of 1,000 cowpea flowers were collected per climatic zone.

Due to the uneven distribution of wild host plants and variation in flowering stages, a standardized sampling plan could not be applied. However, before collection, visual inspection was conducted to ensure thrips presence prior to collection. Samples of wild host plants were brought to the botanical laboratory of the University Joseph KI-ZERBO for identification.

Identification of thrips species

All cowpea and wild host plant flowers were dissected in Petri dishes using flexible forceps in the entomology laboratory at Kamboinsé. Under a binocular microscope, the thrips were first sorted according to size and color, then counted and distributed in tubes for morphological identification. This identification was carried out under the supervision of an expert of Biodiversity Center of the International Institute of Tropical Agriculture (IITA), Cotonou Station in the Republic of Benin.

Subsequently, ten adult thrips specimens per batch were processed in the IITA laboratory using the method described by Silveira and Haro (2016) for mounting between slides. Twenty-four (24) h after mounting, the specimens were identified under a CETI light microscope equipped with a digital camera using standard taxonomic keys, including: Palmer *et al.* (1990), Mound and Marullo (1998), Mound and Kibby (1999), Nakahara and Foottit (2012). The pictures taken by the digital camera have been used to illustrate Fig. 2-6.

Identification criteria used

Megalurothrips sjostedti is a large, glossy-black thrips with dark forewings that are pale at the base. Its antennae have eight segments, and segments 3 and 4 bear forked sensory cones (Fig. 2). The head has three pairs of setae located in the ocellary zone. The pronotum has two pairs of long posteroangular setae. The forewings have a row of setae on the first vein, interrupted apically. Abdominal tergites are generally ten in number, the eighth bearing microtrichia. In males, the ninth abdominal tergite has a pair of small, bristle-like tubercles on the posterior margin, with no glandular areas. Females have a curved ovipositor on tergite 8.

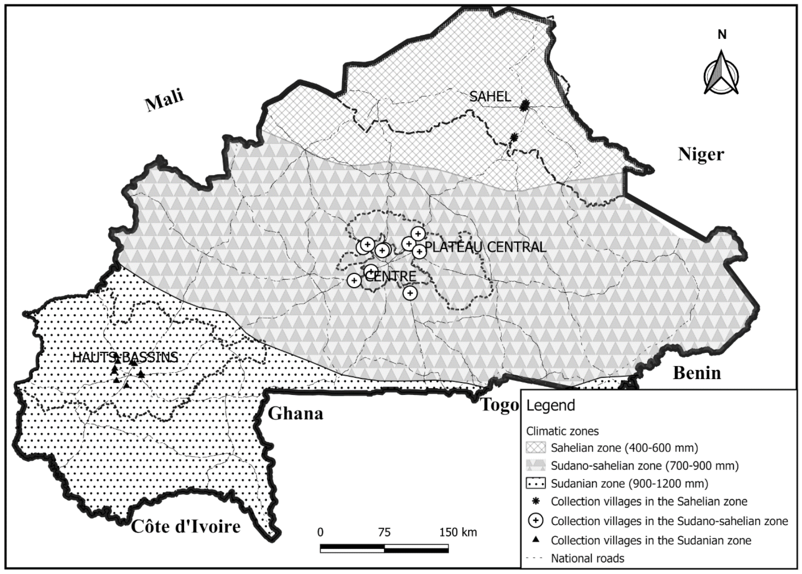

Fig. 1: Map of Burkina Faso, showing different climatic zones (collecting sites)

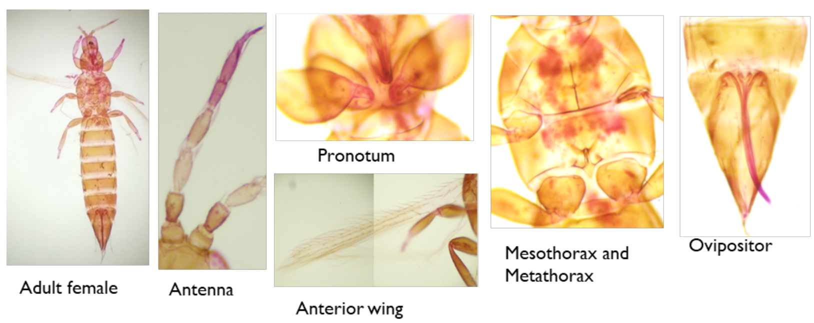

Fig. 2: Some morphological criteria of *Megalurothrips sjostedti*
The magnifications: adult female = 10 x 4; antenna, anterior wing = 10 x 10; pronotum, mesothorax- metathorax, ovipositor = 10 x 40

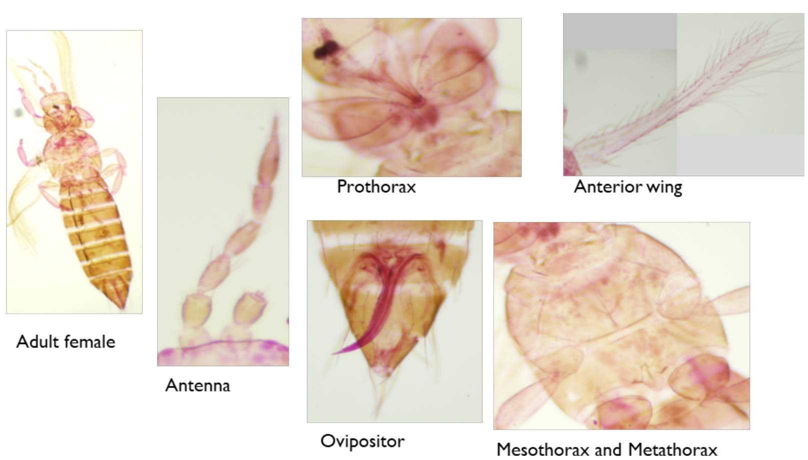

Fig. 3: Some morphological criteria of *Frankliniella schultzei*
The magnifications: adult female = 10 x 4; antenna, anterior wing = 10 x 10; pronotum, mesothorax- metathorax, ovipositor = 10 x 40

Frankliniella schultzei is a medium-sized thrips existing in two distinct color forms that may be genetically different and are sometimes considered separate species. It is generally dark brown with brown antennae and pale forewings, but in tropical regions with a yellow body (Fig. 3). Antennae have 8 segments and forked sensory cones on segment III and IV. The head has a pair of setae in front of the first ocelli and a pair in the ocellar triangle, appearing

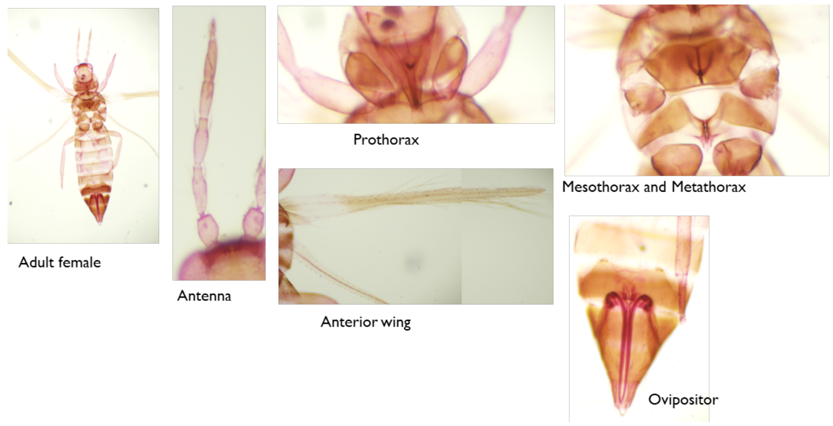

Fig. 4: Some morphological criteria of *Hydatothrips adolfifriderici*
The magnifications: adult female = 10 x 4; antenna, anterior wing = 10 x 10; pronotum, mesothorax- metathorax, ovipositor = 10 x 40

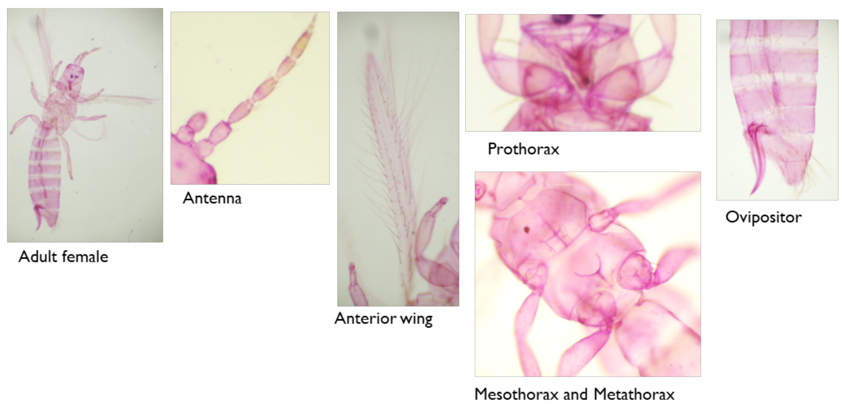

Fig. 5: Some morphological criteria of *Florithrips traegardhi*
The magnifications: adult female = 10 x 4; antenna, anterior wing = 10 x 10; pronotum, mesothorax- metathorax, ovipositor = 10 x 40

close together between the anterior margins of the posterior ocelli. The pronotum has 2 pairs of long setae on the anterior margin, 2 pairs of long posteroangular setae and one pair posteromedial. Metanotum with median setae appearing at (or very close to) the anterior margin. Forewings consist of two longitudinal veins bearing a full row of setae. Tergites V-VIII each with a ctenidium laterally, on VIII anterolateral to the spiracle; posterior margin of tergite VIII without microtrichial comb. Sternites lack discal setae. Male sternites III-VII have a transverse glandular zone.

Hydatothrips adolfifriderici is a small bicolored thrips. The head is brown in front and pale yellow behind the occipital crest (Fig. 4). The pronotum or prothorax is pale anteriorly and laterally, with a median brown band. The wings are brown with a pale band near the base. Abdominal tergites IV and V are pale yellow and tergites VII-IX are dark brown.

Florithrips traegardhi Trybom is a small, pale-yellow thrips (Fig. 5). Its antennae have 8 segments. It has a full comb bearing long, fine microtrichia on the posterior edge of abdominal tergite VIII. The lateral tergites have microtrichia along the sculptural lines. Elliptical glands are located on sternites III-VII.

Arorathrips mexicanus is a small brown thrips with shaded forewings (Fig. 6). Its head is much smaller than the trapezoidal pronotum. The antennae are divided into 8 segments. The first segment is enlarged, while the second is highly asymmetrical. Simple or linear detection cones are located on segments III and IV. The anterior tibiae extend around the outer edge of the anterior tarsus. The mesonotum has two rows of small tubercles. The forewings are slender and acute. The mesothoracic furca has no large, wing-like lateral lobes. The tergites have a transverse row of small tubercles along the antecostal ridge. The ovipositor is small. The male is yellow and apterous; sternites III-VII have a large circular glandular area.

Data analysis

Species richness, relative species abundance and diversity indices Shannon-Wiener's Index and Pielou's evenness index (Pedel and Fabri 2012; Khouloud and Nadjette 2021) were calculated using software R (version 4.2.3) ANOVA was performed to compare diversity indices across the three climatic zones. The t-test was used to compare indices between years 1 (corresponding to 2021) and 2 (corresponding to 2022).

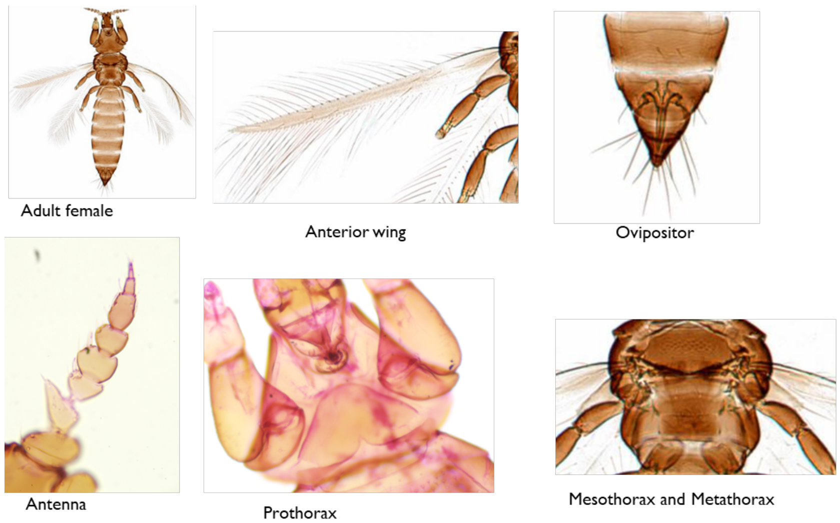

Fig. 6: Some morphological criteria of *Arorathrips mexicanus*
The magnifications: adult female = 10 x 4; antenna, anterior wing = 10 x 10; pronotum, mesothorax- metathorax, ovipositor = 10 x 40

Relative abundance (centesimal frequency FC%)

Relative abundance is the ratio between the number of individuals of a species and the total number of individuals of the species collected in a given environment (Benoufella-Kitous and Medjdoub-Bensaad 2016; Guermah *et al.* 2019).

$$\text{Relative abundance } (\%) = \frac{n_i}{\text{N}} \text{ x } 100$$

In which, n_i = Number of individuals of a given thrips species and N= Total number of thrips individuals in the area.

Shannon-wiener species diversity index (H')

According to Omayio *et al.* (2019), the Shannon-Wiener diversity index evaluates a stand in a biotope and the uniformity of the distribution of different species. It is estimated by the following formula:

$$\text{Species Diversity index } (\text{H}') = -\sum_{i=1}^{k} \text{x lnpi}$$

In which, pi = Proportion of ith species in the total sample.

pi = ni/N; ni = Number of specimens of the ith species; N = Total number of the specimen in the sample, k = Total number of trips species and ln = Natural logarithm (loge).

Pielou's evenness index (J)

The Pielou's index expresses the uniformity of the distribution of the numbers of each species. Its values range from 0 to 1. It is maximal when the different species have identical abundances in the community, and minimal when one species dominates the community. It is evaluated using the following formula:

$$\text{Pielou's evenness index (J)} = \frac{\text{H}}{\text{H}_{\text{max}}}$$

In which, H = number derived from the Shannon diversity index and H_{max} = maximum possible value of H.

Results

Wild host plants of thrips

A total of fourteen (14) and twenty-three (23) plants species were recorded as wild host plants of thrips in 2021 and 2022 respectively, across three climatic zones. During the first year, the highest number of plants (7) were found in the Sudano-Sahelian zone (SSZ), followed by four in the Sudanese (SuZ), and three in the Sahelian (SZ) zone (Fig. 7). In all zones, high thrips populations were found in the flowers of shrubs belonging to *Piliostigma* genus, whereas the annual plants were found carrying lower thrips populations (Fig. 7).

During the second year, out of a total of twenty-three host plants inventoried, six were found in SZ, ten in SSZ and seven in SuZ (Fig. 8). The annual herbaceous legume *Crotalaria retusa* harbored the highest thrips population in SSZ, while comparatively lower populations were observed in SZ and SuZ.

Thrips species collected per wild host plant sampled

Megalurothrips sjostedti was the species found on all spontaneous vegetation plants sampled. Among these plants, *Crotalaria retusa*, *Piliostigma thonningii*, *Piliostigma reticulatum* and *Sesbania pachycarpa* were the main hosts of *Megalurothrips sjostedti* (Table 1). *F. schultzei* was found on 10 species with *Piliostigma reticulatum*, *Ceratotheca sesamoïdes* and *Sesamum indicum* as main hosts. *Hydatothrips adolfifriderici* was observed on 4 species with *Sesbania pachycarpa* as the main host plant.

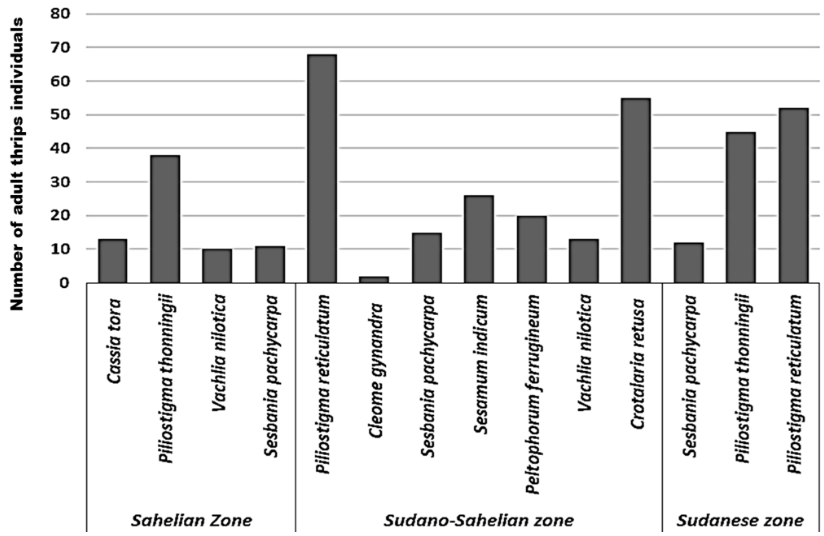

Fig. 7: Total number of thrips adults collected on wild host plants during the year 2021

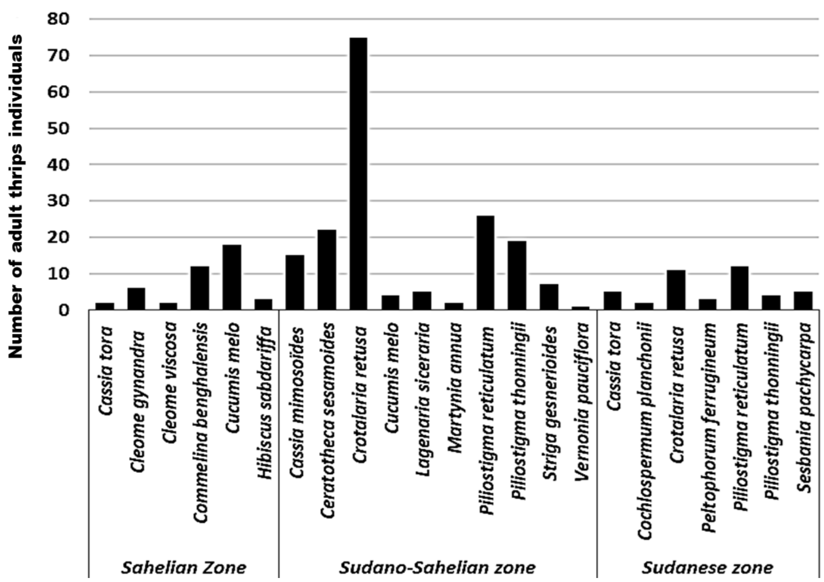

Fig. 8: Total number of thrips adults collected on wild host plants during the year 2022

Florithrips traegardhi was found on 8 species with *Piliostigma reticulatum* and *Vachellia nilotica* as main hosts. *Piliostigma thonningii* thus appears to be the thrips' preferred host plant in spontaneous vegetation.

Thrips species collected on wild host plants

On wild host plants, a total of 627 adult thrips individuals belonging to five thrips species were observed. In SZ, all five species were inventoried during the first year of sampling, while four of them were encountered during the second year with *Florithrips traegardhi* (Trybom) (Thysanoptera: Thripidae) being absent (Table 2). In SSZ, two species were found during the first year, while five were found during the second year (Table 2). In SuZ, only two thrips species were found during both years.

Megalurothrips sjostedti (Trybom) (Thysanoptera: Thripidae) was the most abundant thrips followed by *Frankliniella schultzei* (Trybom) (Thysanoptera: Thripidae) in all zones (Table 2). The population of the remaining species *Hydatothrips adolfifriderici* Karny (Thysanoptera: Thripidae), *F. traegardhi* and *Gynaikothrips* sp. (Thysanoptera: Phlaeothripidae) were overall lower in SZ, during the second year in SSZ, and totally absents in SuZ (Table 2).

The Shannon diversity index different across years for SZ and SSZ, but remained similar in SuZ. In SZ it was higher (0.72 ± 0.24) for year 2 compared to year 1 (0.30 ± 0.25) (Table 2). The same trend was observed in SSZ with 0.87 ± 0.17 in year 2 and 0.37 ± 0.17 in year 1. In SuZ the indexes remained similar during both years.

Table 1: Thrips species collected on wild host plants

Families	Species	*Megalurothrips sjostedti*	*Frankliniella schultzei*	*Hydatothrips adolfifriderici*	*Florithrips traegardhi*
Fabaceae	*Cassia tora*	16	2	-	-
	Cassia mimosoides	11	-	-	4
	Crotalaria retusa	121	11	-	7
	Peltophorum ferrugineum	17	1	-	5
	Piliostigma thonningii	83	11	2	9
	Piliostigma reticulatum	122	21	-	12
	Sesbania pachycarpa	37	-	4	-
	Vachellia nilotica	7	5	-	11
Cleomaceae	*Cleome gynandra*	6	-	2	-
	Cleome viscosa	4	-	-	-
Cucurbitaceae	*Cucumis melo*	14	5	-	1
	Lagenaria siceraria	5	-	-	-
Pedaliaceae	*Ceratotheca sesamoides*	3	17	-	-
	Sesamum indicum	8	15	-	-
Malvaceae	*Hibiscus sabdariffa*	3	-	-	-
Martyniaceae	*Martynia annua*	2	-	1	-
Orobanchaceae	*Striga gesnerioides*	5	-	-	2
Asteraceae	*Vernonia pauciflora*	1	-	-	-
Cochlospermaceae	*Cochlospermum planchonii*	2	-	-	-
Commelinaceae	*Commelina benghalensis*	9	3	-	-

Table 2: Total number of adult thrips species collected on wild host plants in three different climatic zones, their dominance coefficient (centesimal frequency FC%), Shannon diversity index (H'), Pielou's evenness index (J)

Thrips species/wild hosts	SZ		SSZ		SuZ	
	2021	2022	2021	2022	2021	2022
Megalurothrips sjostedti	63 (87.51)	31 (72.09)	154 (77.39)	82 (48.81)	107 (98.17)	34 (94.44)
Frankliniella schultzei	4 (5.56)	6 (13.95)	45 (22.61)	70 (41.67)	2 (1.83)	2 (5.56)
Hydatothrips adolfifriderici	1 (1.39)	5 (11.64)	0	1 (0.59)	0	0
Florithrips traegardhi	2 (2.77)	0	0	14 (8.34)	0	0
Gynaikothrips sp.	2 (2.77)	1 (2.32)	0	1 (0.59)	0	0
Total number	72	43	199	168	109	36
Total number of observed species	5	4	2	5	2	2
Shannon diversity index	0.30 ± 0.25b	0.72 ± 0.24a	0.37 ± 0.17b	0.87 ± 0.17a	0.22 ± 0.14a	0.27 ± 0.16a
Pielou's evenness index	0.23 ± 0.18b	0.70 ± 0.18a	0.45 ± 0.20a	0.69 ± 0.05a	0.32 ± 0.20a	0.39 ± 0.24a

Shannon and Pielou indexes within a line, followed by the same lower- and upper-case letter respectively, comparing the indexes of the same area in two years, do not differ significantly at the level of 5%

Table 3: Total number of adult thrips species collected on cowpea in three different climatic zones, their dominance coefficient (centesimal frequency FC%), Shannon diversity index (H'), Pielou's evenness index (J)

Thrips species/cowpea	SZ		SSZ		SuZ	
	2021	2022	2021	2022	2021	2022
Megalurothrips sjostedti	2413 (90.64)	2683 (93.71)	5470 (97.05)	4529 (96.65)	934 (93.86)	847 (72.45)
Frankliniella schultzei	151 (5.68)	59 (2.06)	68 (1.20)	87 (1.85)	49 (4.93)	304 (26.01)
Hydatothrips adolfifriderici	88 (3.30)	77 (2.69)	95 (1.69)	45 (0.96)	12 (1.21)	18 (1.54)
Florithrips traegardhi	9 (0.33)	43 (1.50)	3 (0.06)	25 (0.54)	0	0
Gynaikothrips sp	0	1 (0.03)	0	0	0	0
Arorathrips mexicanus	1 (0.04)	0	0	0	0	0
Total number	2662	2863	5636	4686	995	1169
Total number of observed species	5	5	4	4	3	3
Shannon diversity index	0.63 ± 0.09a	0.84 ± 0.04a	0.51 ± 0.04a	0.55 ± 0.09a	0.44 ± 0.12a	0.49 ± 0.08a
Pielou's evenness index	0.44 ± 0.04a	0.47 ± 0.02a	0.35 ± 0.02a	0.31 ± 0.05a	0.30 ± 0.08a	0.45 ± 0.07a

Shannon and Pielou indexes within a line, followed by the same lower- and upper-case letter respectively, comparing the indexes of the same area in two years, do not differ significantly at the level of 5%

Regarding the Pielou's evenness indexes, during both years they remained similar within SSZ and SuZ (Table 2). In contrast, they were different in SZ, with 0.70 ± 0.18 for year 2 and 0.23 ± 0.18 for year 1.

Thrips species collected on cowpea

On cowpea, a total of 18 011 adult thrips individuals belonging to five species were collected in three climatic zones (Table 3). In SSZ, only four species: *M. sjostedti*, *F. schultzei*, *H. adolfifriderici*, *F. traegardhi* were found on the cowpea during the two consecutive year of sampling (Table 3). In SuZ three species *M. sjostedti*, *F. schultzei*, *H. adolfifriderici* were found during both years (Table 3). All these three species were common to all study zones, while *F. traegardhi* was inventoried only in SZ and SSZ.

The species *Arorathrips mexicanus* (Crawford) (Thysanoptera: Thripidae) and *Gynaikothrips* sp. were only encountered in SZ during year 1 and 2, respectively (Table 3).

The relative abundance of *M. sjostedti* was highest at all sites in the different climatic zones during the two years of collection, followed by *F. schultzei, H. adolfifriderici* and *F. traegardhi*, respectively, while *A. mexicanus* and *Gynaikothrips* sp. were the least abundant species (Table 3).

The species diversity, evenness and richness of adult thrips in the three climatic zones are presented in Table 3. The results showed that there were no significant differences among the three zones in terms of both diversity and Pielou's evenness index.

Discussion

The number of wild host plants recorded varied from year 1 to year 2. Indeed, fourteen (14) and twenty-three (23) wild host plants species were identified as thrips host plants in the year 1 and 2, respectively. The crop rotation practices in the fields may also explain the variation in the number of wild host plants on one hand and on the other hand by the cleaning practices adopted. Regardless of the year, SSZ had the highest number of important plants species belonging to both herbaceous annuals and perennial plants such as trees and shrubs. The higher number of perennial plants in the center compared with other areas could be explained by the fact that, due to the shortage of grass and the occupation of grazing areas, growers prefer saving these species around their fields, which they then use to feed their small ruminants. In SuZ, because of the availability of space for grazing and wild grasses to feed the animals, the producers don't hesitate to clean manually or by using herbicide everything shrubby in their fields.

All these wild species as well as cowpea host several of the same thrips species. In fact, on all wild host plants and cultivated cowpea five species of thrips: *Megalurothrips sjostedti*, *Frankliniella schultzei*, *Hydatothrips adolfifriderici, Florithrips traegardhi* and *Arorathrips mexicanus* have been inventoried. Among them, *Megalurothrips sjostedti* is the most important in terms of adult individual number.

The Fabaceae botanical family was the most represented among thrips alternate host plants, particularly *Megalurothrips sjostedti*. This species was identified on all plant species sampled. Tamò *et al*. (2002) identified several species of alternative thrips host plants, most of which belongs to the *Fabaceae* family. *Megalurothrips sjostedti* in addition to the other species identified belong to the suborder Terebrantia and the *Thripidae* family. This suborder is the most represented on cowpea and host plants in Burkina Faso. It encompasses almost all thrips collected. *Megalurothrips sjostedti*, *Frankliniella schultzei*, *Hydatothrips adolfifriderici*, *Florithrips traegardhi* and *Arorathrips mexicanus* were formally identified under the light microscope using identification keys Muvea *et al.* (2014) identified *Hydatothrips adolfifriderici* and *Frankliniella schultzei* in addition to *Megalurothrips sjostedti*, which has been described as the main thrips pest of cowpea by Singh and Allen (1979). The abundance of *Megalurothrips sjostedti* on cowpea is explained by the fact that cowpea is the preferred plant. Also, the thrips number may increase with flowers emergence (Maria 2011).

Indeed, when the insect lives on cowpea, it has the ideal substrate for its biological functions of nutrition and reproduction (Razi 2017). It then deploys all its abilities to feed and reproduce. With a short life cycle: 18 to 21 days, several generations can survive on cowpea crops, making their management a major challenge. Palmer *et al.* (1990) asserted that most species of the *Megalurothrips* genus live in the flowers of legumes such as *Phaseolus*, *Caesalpinia*, *Crotalaria, Vigna* and *Centrosoma*. In the same context, Agbahoungba *et al.* (2021) reported that cowpea is the crop most attacked by *Megalurothrips sjostedti*. On host plants, *Megalurothrips sjostedti* is also the most important thrips, with a relative abundance rate of 83%. *Megalurothrips sjostedti* is a phytophagous insect with a varied host range, and populations are able to survive in weed flowers to infest the cowpea crop at pre-flowering (Palmer *et al*. 1990).

Once identified as the only *Frankliniella* species known from Africa (Palmer *et al*. 1990), *Frankliniella schultzei* is a species of low abundance in cowpea cultivation in Burkina Faso. It is a polyphagous species, and cowpea is one of its host plants, though not its preferred host. It is generally found on sorghum, cotton, chilli, onion, tomato, *Cajanus cajan*, Phaseolus and composite crops (Palmer *et al.* 1990). According to Reynaud (2010), this polyphagy enables them to feed on a wide range of plants, even weeds. This may explain their abundance on host plants more than on cowpeas during our observations. However, Razi (2017) and Oudjiane *et al.* (2018) identified *Frankliniella occidentalis* on broad beans and vegetable crops respectively in Algeria.

Hydatothrips adolfifriderici and *Florithrips traegardhi* are not very abundant on cowpeas and host plants. They are polyphagous but cause little damage to cowpea crops. Cowpeas are therefore not an ideal host plant for *Hydatothrips adolfifriderici* and *Florithrips traegardhi*. These thrips would therefore be insects of secondary importance for cowpeas. *Florithrips traegardhi* is generally found on sorghum, sugarcane, rice, maize, grasses and acacias (Palmer *et al.* 1990). *Hydatothrips adolfifriderici* is found on Phaseolus and groundnuts (Muvea *et al.* 2014).

Arorathrips mexicanus is a rare species that we encountered only in the first year of collection on cowpeas. It is generally found on Poaceae (Minaei and Mound 2010).

The species richness of thrips varies from one zone to another in Burkina Faso, and climate is a significant factor in this distribution. Indeed, as we move towards the Southern Sudanian zone, the abundance and specific richness of thrips decreased. The Sahelian zone has a Sahelian-type climate (hot and dry, with 567 mm/year of rainfall) that is favorable to the development of thrips. These insects prefer hot, dry conditions, but also tolerate high humidity. In addition, water stress in crops makes plants more vulnerable to thrips infestation (Nahashon *et al.* 2016). The North Sudanian zone is an area of high cowpea production where relative humidity is higher than in the Sahelian zone: this explains the abundance of thrips in this zone, and more particularly *Megalurothrips sjostedti*. Of the three climatic zones, the Southern Sudan zone has the lowest thrips population. This zone is the best-watered in the country, with an average annual rainfall of 1,000 mm. Heavy rainfall considerably reduces the thrips population, as it kills larvae and washes away nymphs and adults (Nahashon *et al.* 2016). According to Aviron *et al.* (2016), these rains encourage the development of entomopathogenic fungi on pre-nymphs and soil nymphs.

The Shannon index calculated over the two years on cowpeas and host plants shows that the thrips population is more diverse on cowpeas than on host plants. This is due to the fact that cowpea is a crop on which several insects can survive, and to the polyphagy of thrips. The Sahelian zone is thus designated for being home to a diverse thrips population. Pielou's equitability index values reflect an uneven distribution of the number of individuals per species. No index value is zero to show the dominance of one of the species. This indicates abundance rather than dominance in the thrips population by climatic zone. This can be explained by the fact that Burkina Faso's dry tropical climate is hostile to the development of these cosmopolitan insects. Indeed, according to (Murai 2000), the optimum temperature for thrips growth is around 25°C, and an increase in this temperature to 30°C results in a low rate of egg hatching. However, average annual temperatures range from 28°C to 42°C in Burkina Faso (Bambara *et al*. 2018). A few specimens belonging to the Tubulifera suborder were also encountered in the course of our collections. However, given their very limited numbers and the difficulty of morphological identification, these will be subjected directly to molecular analysis, in addition to the Terebrantia already identified by light microscopy.

Conclusion

Understanding the thrips diversity in an agrosystem is critical for developing effective pest management strategies. In Burkina Faso five thrips species were identified on wild host and cultivated cowpea, with low overall biodiversity likely due to climatic conditions. Thrips biodiversity decreases from the Sahelian zone to the South-Sudanese zone, passing through the North-Sudanese zone where pest pressure is high. This study confirms that *Megalurothrips sjostedti* is the most important thrips species on cultivated cowpeas and host plants. *Frankliniella schultzei*, *Hydatothrips adolfifriderici* and *Florithrips traegardhi* are relatively frequent species. *Florithrips traegardhi* has not yet been encountered in the South Sudan zone. *Arorathrips mexicanus* is a rare grass-inhabiting species, first recorded in Burkina Faso on cowpea. The results of this study can be used in a varietal selection program for thrips resistance.

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Author Contributions

Conceptualization: Carine P Ouédraogo and Fousséni Traoré. Methodology: Fousséni Traoré, Carine P Ouédraogo and Aboubacar Boly. Validation: Fousséni Traoré, Carine P Ouédraogo and Manuele Tamò. Formal analysis: Aboubacar Boly. Writing—original draft preparation: Carine P Ouédraogo, Fousséni Traoré, Aboubacar Boly, Elsa N Zongo, Edouard Drabo. Supervision and project administration: Fousséni Traoré.

All authors have read and agreed to the published version of the manuscript.

Conflict of Interest

All authors declare no conflict of interest.

Data Availability

Data presented in this study will be available on a fair request to the corresponding author.

Ethics Approval

Not applicable to this paper.

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