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Influence of herbivorous insects on the production of *Lagenaria siceraria* (Molina) Standley (Cucurbitaceae)

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The production of indigenous cucurbits remains very low in tropical zones, mainly due to herbivorous insect damage. This study was conducted in Manfla located in the centre of Côte d'Ivoire at 400 km from Abidjan to evaluate the impact of herbivorous insects on foliar damage and agronomic parameters of *Lagenaria siceraria* (Molina) Standley (Cucurbitaceae). Our study revealed that nine insect species belonging to four families and three orders were responsible for foliar damage. The leaves were perforated, shredded and eaten away. The extent of foliar damage was estimated for each accession during three consecutive cropping seasons. For the oleaginous gourd accessions NI227, NI219 and NI180, over 75% of the leaf surface was regularly destroyed. For the bottle gourd accessions NI431 and NI432 and the oleaginous gourd accession NI354, leaf surface damage was less than 25%. Thirteen accessions were intermediate between the two groups of accessions cited above. There was no significant difference between fruits weight and seed weight for accessions NI431, NI432, NI354 and NI434, whether or not plants were treated with a broad spectrum cypermethrin based-insecticide (Cypercal 50 EC). However, these parameters differed significantly for accessions NI227, NI219 and NI180.

Key words: Herbivorous insect damage, agronomic parameters, damage on foliar surface, extent of foliar damage.

INTRODUCTION

In several areas of Africa, the production of numerous crops has declined sharply as the result of major pests and disease outbreaks (Gogi et al., 2009; Stoddard et al., 2010). Literature on sustainability often touches on pest

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and disease issues, but concern has been limited to major crops. Little attention has been paid to neglected and underutilized crops such as indigenous oleaginous gourd *Lagenaria siceraria* (Molina) Standley (Cucurbitaceae) cultivated for seed consump-tion. *L. siceraria* has been reported to have considerable agronomic and economic potential for small farm holders (Taffouo et al., 2008), and its leaves and flowers play an important role in traditional medicine (Edeoga et al., 2010; Achu et al., 2013). This species is composed of two varieties. The first called “egussi” is cultivated for their oleaginous seeds. The dried and slightly roasted kernels are transformed into a paste for consumption as soup thickener. The second called “bottle gourd” is grown for non-food used and the mature fruit can be used as bowls, utensils, and musical instruments. However *L. siceraria* production remains low (Zoro Bi et al., 2003; Achigan-Dako et al., 2008; Taffouo et al., 2008). The low production of *L. siceraria* may be due to several factors, among them are insect pests (Dhillon, 2005; Ayalew, 2006; Koch et al., 2004). Herbivorous insects are known to affect the fitness and dynamics of plant populations and strongly influence morphology, physiology, phenology, and seed production of individual host plants (Maron and Vila, 2001; Maron and Crone, 2006). According to Muro (1998), defoliation causes significant yield reduction on onion crops. In fact, leaves play an important role in the production of food substances through the process of photosynthesis; hence defoliation might be detrimental to plant growth, survival and crop production. Hoffmann (2000) showed that removal of 20% of the leaf area of *Cucurbita pepo* L. significantly reduced the weight of marketable fruit. Agunloye (1986) reported that foliar damage by the flea beetle *Podogrica* on *Abelmoschus esculentus* L. Moench in Nigeria led to as much as a 50% reduction in yield. Unfortunately quantitative data on yield loss in *L. siceraria* attributed to herbivorous insect damage is limited. Knowledge of the yield-loss relationships between a crop and its associated pest is an important aspect of any integrated pest management program (Pitan and Okoja, 2011). So ethology of insect pests could be necessary in order to understand their effect on plants (Fomekong et al., 2010). The aim of this study is to estimate the extent of foliar loss to herbivorous insects on *L. siceraria* and its conse-quences for reduction in yield. Such data would provide a basis to develop effective pest control methods and to improve the productivity.

MATERIALS AND METHODS

Study site

On farm experiments were conducted in 2008 and 2009 in the village of Manfla (6°49'34.38''N, 5°43'47.68''W). This village located 400 km North of Abidjan (Côte d'Ivoire) is characterized by high production of cucurbits. There are two rainy seasons separated by a short period dry (July-August) and a long dry season (December-February) at the target site. Annual rainfall varies from 800 to 1400 mm with a long-term mean of 1200 mm and the annual mean temperature is 27°C.

Over the experimental periods the mean monthly temperature was 32°C in 2008 for the first cropping season (March–June) and mean monthly rainfall was 138.88 mm. Mean relative humidity was 786.52%. In second cropping season (July–December), the mean monthly temperature was 31°C. Mean monthly rainfall and mean relative humidity were 76.91 mm and 83.04% respectively. In 2009, the mean monthly temperature, mean monthly rainfall and mean relative humidity were 32°C, 100.13 mm, and 81.52%, respectively for the only third cropping season.

The vegetation is a woodland savanna. Soil testing at 20 cm depth revealed the following characteristics: pH=6.45 with 57% sand, 36% Silt, 7% clay, 6% organic matter, 3.5 g/kg total N, 24.4 g/ kg of available P and 0.45 g / kg of K (Kouassi and Zoro Bi, 2009).

Plant material and experimental design

Plant material is composed of two varieties of *L. siceraria*: an oilseed type and a bottle gourd type. Nineteen open-pollinated accessions of *L. siceraria* were selected from the collection of the University Nangui Abrogua (Abidjan, Côte d'Ivoire), 13 accessions of oleaginous (oilseed) type and 6 of bottle gourd. Plants were collected from different areas of Côte d'Ivoire (Table 1). Genotypes used in this work resulted from three generations of in-breeding. A plot of 50 m x 30 m was established to evaluate herbivorous insect damage on leaves of *L. siceraria*. Plants were sown according to a completely randomized design with one replication per accession. Each accession is being represented by 5 plants. Three seeds were sown per hole at depth of 3 cm and thinned to one plant per hole at the two-leaf stage. The holes were arranged in rows at spacing of 3 m between and within rows. And the distance between the plot and edge was 1.5 m. A total of 95 plants were screening. The plot was weeded manually throughout the period of plant development.

Sampling of herbivorous insects

Sampling of herbivorous insects was carried out in vine creeping stage. Activities of herbivores were monitored daily on each plant during this vegetative stage. The type of damage caused by each insect species on leaves and their modes of attack was noted. Insects were sampled with sweet netting and those which only fed leaf were considered in this study. An inventory of insects was performed twice weekly. Insects captured were stored in a pillbox 2/3 filled with ethanol (70%) until they were identified. Defoliating insects were identified to the species level in the laboratory of Zoology and Entomology of National Polytechnic Institute Houphouët Boigny of Yamoussoukro (INP-HB). Identification keys adapted for insects from the tropical zones were used (Appert and Deuse, 1988; Michel, 1990; Poutouli et al*.,* 2011).

Intensity of foliar damage on accessions

The extent of foliar damage to each plant was scored based on visual inspection of insect damage on leaves. An estimate of the Severity of Damage on a plant (SeDa) was assigned to each plant. Five plants were used for each accession. The SeDa score consisted of 5 classes (1 – 25% or less of the leaf surface damaged, 2 – 26 to 50% damage, 3 – 51 to 75% damage, 4 – 76 to100% damage, and 5 indicating plant death) (Bubici and Cirulli,

Table 1. Collection zone and physical characteristics of *Lagenaria siceraria* accessions.

Accessions	Variety	Fruit shape	Collection site	Collection zone
NI219	Oleaginous	Round	Alépé	South
NI227	Oleaginous	Round	Alépé	South
NI252	Oleaginous	Oval	Alépé	South
NI180	Oleaginous	Oval	Bongouanou	Southeast
NI174	Oleaginous	Round	Bongouanou	Southeast
NI185	Oleaginous	Oval	Bongouanou	Southeast
NI354	Oleaginous	Round	Bondoukou	East
NI359	Oleaginous	Oval	Bondoukou	East
NI347	Oleaginous	Oval	Bondoukou	East
NI304	Oleaginous	Oval	Bondoukou	East
NI106	Oleaginous	Elongated	Gohitafla	Centre
NI421	Oleaginous	Elongated	Mankono	North
NI420	Oleaginous	Elongated	Mankono	North
NI425	Bottle gourd	Oval	Ouangolo	North
NI429	Bottle gourd	With sleeves	Ouangolo	North
NI430	Bottle gourd	With sleeves	Niéllé	North
NI431	Bottle gourd	Round	Niéllé	North
NI432	Bottle gourd	With sleeves	Ouangolo	North
NI434	Bottle gourd	With sleeves	Ouangolo	North

2008; Sobrinho et al., 2010).

Impact of foliar damage on agronomic parameters

Two plots (treated and untreated) were established to evaluate the impact of foliar damage on agronomic parameters of *L. siceraria*. Each plot was a 50 m × 30 m. One of the two plots was treated with a broad spectrum cypermethrin based-insecticide (Cypercal 50 EC) at a dose of 0.8 l/ha and the second was not treated. Three applications of insecticide were conducted on the treated plot to insure that most herbivorous insects were eliminated from the plot. The first application occurred when 50% of seedlings reached the stage of 2-3 leaves, the second application occurred when 50% of the plants began crawling, and the final application occurred when 50% of male flowers appeared (Goré Bi et al., 2011).

Four parameters were measured during each cropping seasons: the Plant Length (PL) was measured on main stem from the plant basis for the 5 estimates per accessions (95 plants of each plot were measured after 120 days), the Number of Fruits (FN), was the total number of fruits per plant at maturity in each plot. Fruit Weight (FW): 5 fruits where weighted with a scale after harvest for the 5 estimates per accessions (475 fruits in each plot). Seeds Weight (SW): total seeds from each fruit were weighted with an electronic scale after drying for the 5 estimates per accessions (475 fruits in each plot).

Comparison of agronomic traits between accessions from the treated and untreated plots allowed us to estimate the impact of pests on crop productivity. The estimation of seed weight loss (SWL) for each accession was done through the ratio of the difference of seed weight collected from the treated and untreated plots and was calculated as SWL (%) = $[(SW_{treated} - SW_{untreated})/SW_{treated}] \times 100$ according to Ahn (2005).

Statistical analysis

Statistical analyses were carried out using SPSS 16.0 (SPSS, 2007). To test for differences among accessions data on the severity of damage on leaf surfaces from each accession were subjected to Analysis of Variance (ANOVA). Following the ANOVA, when there were significant differences between accessions, means were separated using the Student Newman Keul Test (SNK). Student's – *t* test was carried out also to evaluate impact of foliar damage on agronomic parameters of *L. siceraria*. All tests were performed with an $\alpha = 0.05$.

RESULTS

Inventory of herbivorous insects and description of damage

Insects collected belong to three orders (Coleoptera, Lepidoptera and Orthoptera), four families (Chrysomelidae, Coccinellidae, Plutellidae and Pyrgomorphidae) and nine species (Table 2). A total of 1,388 herbivorous insects were collected during the three cropping cycles (512, 451 and 425 insects respectively for the first, the second, and the third cycle). The average number of herbivorous insects per plant was 5.39, 4.74 and 4.47 during the first, the second and the third cropping cycle respectively. Among these insects sampled on *L. siceraria*, *Lamprocopa occidentalis* (Coleoptera: Chrysomelidae), *Lilioceris livida* (Dalman) (Coleoptera: Chrysomelidae) and *Henosepilachna elaterii* (Rossi) (Coleoptera: Chrysomelidae) were present during the three cropping

Table 2. Number and percentages of herbivorous insects collected on *Lagenaria siceraria* per cropping cycle.

Herbivore collected			Individual record (%)		
Orders	**Families**	**Species**	**1st cropping cycle**	**2nd cropping cycle**	**3rd cropping cycle**
Coleoptera	Chrysomelidae	*Lamprocopa occidentalis*	207 (40.43)	291 (64.52)	114 (26.82)
Coleoptera	Chrysomelidae	*Ootheca mutabilis*	9 (1.76)	-	-
Coleoptera	Chrysomelidae	*Lilioceris livida*	104 (20. 31)	140 (31.04)	120 (28.23)
Coleoptera	Chrysomelidae	*Asbecesta cyanipennis*	60 (11.72)	-	37 (8.70)
Coleoptera	Chrysomelidae	*Aulacophora foveicolis*	27 (5.27)	-	59 (13.88)
Coleoptera	Coccinellidae	*Henosepilachna elaterii*	30 (5.86)	20 (4.43)	25 (5.88)
Coleoptera	Coccinellidae	*Henosepilachna reticulata*	33 (6.44)	-	21 (4.94)
Lepidoptera	Plutellidae	*Plutella xylostella*	13 (2.54)	-	-
Orthoptera	Pyrgomorphidae	*Zonocerus variegatus*	29 (5.67)	-	49 (11.53)

-: absent.

Lamprocopa occidentalis *Asbescesta cyannipennis* *Hennosepilachna elaterii*

a b c

Figure 1. Damage of host-specific herbivore.

Table 3. Mean values of the SeDa score of herbivorous insect damage for accessions per cropping cycle.

Accessions	*Defoliating damage on *Lagenaria siceraria*		
	First cropping cycle (March-July 2008)	**Second cropping cycle (August-December 2008)**	**Third cropping cycle (March-July 2009)**
NI227	5.000±0.000[a]	4.666±0.577[a]	4.750±0.500[b]
NI219	5.000±0.000[a]	5.000±0.000[a]	4.750±0.500[ab]
NI180	5.000±0.000[a]	5.000±0.000[a]	5.000±0.000[a]
NI185	3.000±0.000[c]	3.000±0.000[c]	3.000±0.000[c]
NI174	3.666±0.577[b]	3.000±0.000[c]	4.000±0.000[bc]
NI252	3.666±0.577[b]	3.000±0.000[c]	3.333±0.577[c]
NI106	2.333±0.577[d]	3.000±0.000[c]	-
NI304	2.000±0.000[d]	2.000±0.000[e]	3.000±1.000[c]
NI347	2.000±0.000[d]	2.000±0.000[e]	3.250±0.500[c]
NI354	1.333±0.577[e]	1.250±0.500[fg]	4.000±1.000[bc]
NI359	2.333±0.577[d]	2.000±0.000[e]	2.666±0.577[c]
NI420	2.666±0.577[d]	2.333±0.577[de]	1.666±0.577[d]
NI421	2.333±0.577[d]	3.000±0.000[c]	3.000±0.000[c]
NI425	2.000±0.000[d]	3.000±0.000[c]	2.666±0.577[c]
NI429	2.000±0.000[d]	3.000±0.000[c]	3.000±1.000[c]
NI430	2.000±0.000[d]	3.000±0.000[b]	3.000±0.000[c]
NI431	1.000±0.000[e]	1.000±0.000[g]	1.500±0.577[d]
NI432	1.333±0.577[e]	1.333±0.577[fg]	3.000±0.000[c]
NI434	2.000±0.000[d]	1.666±0.577[ef]	3.000±0.000[c]
F	32.990	51.180	9.070
P	<0.001	<0.001	0.001

*Mean values followed by the same superscript were not significantly different (p≥ 0.05).
-: absent

cycles. *L. occidentalis* was the most abundant with 40.43, 64.52 and 26.80% respect-tively in the first, the second, and the third cropping cycle. Injuring symptoms caused by herbivorous insects are characterized by round feeding holes on *L. siceraria* leaves (Figure 1a). Leaves were also shredded by herbi-vorous insects (Figure 1b) and eaten away (Figure 1c).

Intensity of foliar damage on accession

The insect feeding damage on the tested *L. siceraria* accessions varied from 1 to 5. The foliar damage of the three accessions NI354 (oleaginous gourd), NI431 and NI432 (bottle gourd) was less than 25% according to the classification scale adopted. On the other side, the accessions NI227, NI219 and NI180 presented more than 75% of foliar damage. Percentage of leaves destroyed was between 25 and 75% for thirteen accessions composed of 4 accessions of bottle gourd (NI425, NI429, NI430 and NI434) and 9 accessions of oleaginous gourd (NI185, NI174, NI252, NI106, NI304, NI347, NI359, NI420 and NI421) (Table 3).

Impact of damage plant production

Four parameters were measured to evaluate plant production. Among the nineteen accessions, seed weight (SW) did not differ significantly for only four accessions between treated and untreated plots: NI354, NI431, NI432 and NI434 respectively (Table 4). The loss of seed weight varies between 0.74% (NI431) to 18.97% (NI432) and high of 60% for NI227, NI219 and NI180 accessions. It varied from 26.03 to 44.92% for the other accessions. NI219 and NI434 were the only two accessions out of nineteen for which plant length (PL) and numbers of fruit (NF) were significantly influenced by the treatment. Fruit weight (FW) variation showed that 6 accessions (NI429, NI425, NI420, NI180, NI227 and NI219) of the 19 accessions were significantly influenced by insect feeding damage. Fruit weight of these accessions was lower in untreated plots compared to treated plots.

DISCUSSION

The present study revealed nine species of insects

Table 4. Agronomic parameters of *Lagenaria siceraria* from treated and untreated plots.

Accessions	Length of the plant				Number of fruits per plant				Fruit weight				Seed weight				Loss of seed weight Pg (%)
	Untreated	Treated	*t*	*P*	Untreated	Treated	*t*	*P*	Untreated	Treated	*t*	*P*	Untreated	Treated	*t*	*P*	
NI227	4.12±1.11	4.19±1.12	0.12	0.90	1.10±0.87	1.88±1.05	1.78	0.09	372.72±153.07	936.76±191.44	8.20	<0.01	6.98±4.46	20.24±9.25	4.41	<0.01	65.51
NI219	2.99±0.55	3.45±0.75	2.99	0.13	0.70±0.82	1.88±1.05	2.75	0.01	375.00±72.16	633.82±149.72	4.32	<0.01	6.38±4.20	16.62±5.68	4.28	<0.01	61.61
NI180	3.40±1.14	3.23±1.43	2.27	0.78	0.70±0.67	1.44±1.01	1.90	0.07	375.00±50.00	690.38±169.10	4.76	<0.01	6.91±5.10	20.24±7.78	4.05	<0.01	65.85
NI185	4.27±1.18	4.20±1.42	0.11	0.90	1.77±0.83	1.50±0.70	0.78	0.44	525.00±179.35	578.33±152.38	1.38	0.38	8.88±4.40	16.12±8.71	3.91	<0.01	44.92
NI174	4.38±2.17	4.28±2.27	0.09	0.92	2.00±0.86	2.00±1.18	0.00	1.00	623.68±219.29	715.27±214.22	1.28	0.20	13.75±6.77	22.78±9.92	3.26	<0.01	33.64
NI252	3.18±1.22	2.63±1.25	0.95	0.35	1.55±0.72	2.00±1.24	0.93	0.36	525.00±135.87	645.00±218.16	1.82	0.07	12.16±4.14	20.58±6.88	4.07	<0.01	40.91
NI106	6.16±0.90	5.99±0.95	0.31	0.75	1.83±0.75	1.66±1.21	0.28	0.78	963.63±252.5	1152.50±507.77	1.09	0.28	13.17±3.72	23.75±12.67	2.65	0.01	44.54
NI304	6.92±0.91	7.78±1.30	1.62	0.12	2.00±1.00	1.66±1.11	0.66	0.51	1431.94±349.45	1445.00±416.53	0.09	0.92	20.85±7.93	35.70±17.44	0.80	<0.01	41.59
NI347	7.54±0.68	7.89±1.53	0.65	0.51	2.10±0.73	2.22±0.97	0.31	0.75	1379.76±320.11	1461.25±497.32	0.62	0.53	17.63±10.68	31.56±13.08	3.74	<0.01	44.13
NI354	6.35±1.18	6.54±0.84	0.42	0.67	1.50±0.52	1.27±0.46	1.04	0.30	1731.61±729.96	1663.63±524.18	0.43	0.66	31.60±6.91	34.97±14.06	3.23	0.42	10.66
NI359	8.11±1.38	8.64±1.75	0.76	0.45	2.80±1.39	2.27±1.34	0.87	0.39	1336.60±343.96	1345.00±341.86	0.08	0.92	21.17±15.54	32.06±17.21	2.42	0.01	33.96
NI420	6.46±2.16	6.21±1.04	0.30	0.76	2.00±1.00	1.77±1.39	0.38	0.70	1208.33±492.96	1514.06±324.51	2.10	0.04	24.31±9.32	35.38±19.41	2.15	0.03	34.52
NI421	5.31±0.87	5.56±0.68	0.68	0.50	1.66±0.70	1.88±1.05	0.52	0.60	898.21±331.00	1063.23±165.15	1.80	0.08	19.66±10.02	26.58±6.76	2.28	0.02	26.03
NI425	4.78±1.53	4.63±1.49	0.20	0.84	2.77±1.48	2.33±0.86	0.77	0.44	275.00±102.06	366.66±88.85	3.21	<0.01	9.89±3.81	14.99±6.47	3.22	<0.01	34.02
NI429	6.57±1.19	5.88±1.41	1.14	0.26	1.44±0.52	1.30±0.48	0.62	0.54	873.07±146.65	1101.92±250.51	2.84	<0.01	12.62±5.89	19.25±7.18	2.57	0.01	34.44
NI430	5.87±0.74	5.37±1.48	0.91	0.37	1.44±0.52	1.30±0.67	0.51	0.69	840.38±295.19	913.46±194.08	0.74	0.46	15.37±7.38	25.19±5.76	3.77	<0.01	38.98
NI431	6.63±0.95	7.33±1.54	1.20	0.24	0.88±0.33	0.90±0.56	0.05	0.95	2480.55±951.05	2325.00±192.43	0.48	0.63	69.81±27.69	70.33±17.21	0.04	0.96	0.74
NI432	5.10±0.69	4.77±0.85	0.89	0.38	1.12±0.35	1.11±0.33	0.08	0.93	1347.22±447.81	1445.00±448.88	0.47	0.64	35.40±10.04	43.69±19.95	1.12	0.27	18.97
NI434	5.34±0.71	4.55±0.69	2.50	0.02	1.22±0.44	1.27±0.64	0.19	0.84	1395.45±374.13	1503.84±497.37	0.59	0.55	36.83±19.56	41.89±23.55	1.44	0.56	12.07

belonging to three orders and four families responsible for leaf damage. Chrysomelidae represents more than 50% of the herbivorous insects sampled. The same species of Chrysomelideae have been reported by Adja et al. (2014) on *L. siceraria*. Insects belonging to Coleoptera and specifically to Chrysomelideae family were also collected on *Cucurbita moschata* (Duchesne) (Koch et al., 2004), *Citrullus lanatus* (Thunberg) Nakai and Matsumara and *C. pepo* L. (Thapa and Neupane, 1992). Although Lepidoptera and Orthoptera have not been reported as pests of cucurbits to our knowledge, they were reported as defoliators of other plants (Vayssieres et al*.,* 2000; Idowu and Akinsete, 2001). The damage caused by these insects on the cited plants was identical to those observed in the present study on the leaves of *L. siceraria*. The pests caused three types of damages. The leaves were perforated, shredded and eaten away. Insects belonging to Lepidoptera and Orthoptera were already present before the planting in a large number and were found on the leaves of *L. siceraria* during the vegetative and flowering stages. These insects cannot be host-specific to *L. siceraria*. *L. occidentalis*, *Lilioceris livida* and *Henosepilachna elaterii* were present during the three cropping cycles. They might be considered as host-specific to *L. siceraria*. *L. occidentalis* appeared as the most abundant respectively in the first, second and third cropping cycle. The damage caused by this insect on the leaves was very impressive. It could be seen as the most harmful to *L. siceraria*.

The present study is the first step of a program research on screening collection of *L. siceraria* to defoliating insects. The determination of visual damages on leaves by herbivorous insects in this study has been also used by other researchers (Jacas et al., 1997; Kumar, 1997). This study showed that *L. siceraria* accessions react differently to insect attacks. Some of these accessions were less attacked than others. Our results show that herbivorous insects preferred leaves of oleaginous gourd than bottle gourd. These results could be explained by the fact that the leaves of oleaginous gourd are tenderer than the bottle gourd leaves. On the other hand, bottle gourd is the wild form of *L. siceraria* which is known to be well resistant to pests (Mladenović et al., 2012; Morimoto et al., 2006). It was reported that wild types have a high level of genetic diversity (Given, 1994). They are well adapted to extremely divergent agro-ecosystems and pests (Chweya and Eyzaguirre, 1999). One accession of oleaginous gourd presented the least foliar damage (NI354). This accession was identified as large-seed cultivar of *L. siceraria* (Koffi et al*.,* 2009) which was characterized by larger leaves. Some authors have reported that plants can react through a mechanical process by increasing for example, the size of their leaves or by elaborating wax or hairs on the surface of leaves to protect themselves (Eigenbrode and Espelie, 1995; Li et al., 2000; Lucas et al., 2000; Tsumuki et al., 1989).

The impact of leaf destruction was observed on plant production. Significant decrease of seed weight of NI227, NI219 and NI180 was observed. It might be due to intensity of the defoliation (above 80%). Leaf destruction reduces photosynthetic activities (Muro et al., 1998) and consequently, decreases plant production. This study showed that the seed weight of four accessions NI431, NI432, NI354 and NI434 were similar when plants were from plot treated or plot not treated. These accessions could be used in breeding program to develop high yielding accessions of *L. siceraria.*

Conclusion

Nine herbivorous insects belonging to four families and three orders were identified as responsible for foliar damage on *L. siceraria*. *L. occidentalis*, *L. livida* and *H. elaterii* might be considered as host-specific to *L. siceraria*. The leaves were perforated, shredded and eaten away. During the three cropping cycle, three accessions (NI431, NI354 and NI432) were less attacked. These accessions should be used as parental genotypes to investigate tolerance to defoliating insect for uses in breeding program.

Conflict of Interest

The authors have not declared any conflict of interest.

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