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Antibiosis in *Ascia monuste orseis* Godart (Lepidoptera: Pieridae) caused by kale genotypes

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***Ascia monuste orseis* (Lepidoptera: Pieridae) is one of the main insect pests of kale. The study was done to identify kale varieties resistant to *A. monuste orseis* by the antibiosis resistance mechanism. Kale genotypes (26) were evaluated in experiments performed at the Laboratory of Agricultural Entomology of Goiano Federal Institute - Campus Urutaí. A completely randomized experimental design with 50 replicates was used. The biological parameters evaluated were (a) larval stage: development time, instars, viability and larval weight 15 days after hatching; (b) pupal stage: development time, weight of 24-h-old pupae, viability; (c) larvae-adult stage: development time and viability. The genotypes Gigante I-915 and Pires 1 de Campinas have antibiosis resistance. Gigante I-915 caused high larval mortality and Pires 1 de Campinas resulted in low larval and pupal viability of *A. monuste orseis*.**

Key words*:* *Brassica oleracea* L. var. *acephala*, Brassicaceae, Great Southern White, host plant resistance, integrated pest management (IPM).

INTRODUCTION

Kale (*Brassica oleracea L. var acephala D.C*) is an important vegetable for human consumption because it is rich in minerals and essential vitamins (Ferreres et al., 2007). This plant is originally from the Mediterranean and Southwestern Europe, occurring from the north to south of England (Vaughan and Geissler, 1997).

Among the insect pests that occur in kale, the caterpillar *Ascia monuste orseis* (Lepidoptera: Pieridae) is particularly relevant due to its frequent occurrence and the severe defoliation it causes (Schlick-Souza et al., 2011; Baldin et al., 2014). The insect *A. monuste orseis* is mainly observed in plants of the family: Brassicaceae, including narrow leaved pepperwort (*Lepidium ruderale*), broccoli (*Brassica oleracea* var. *italica*), wild mustard (*Sinapis arvensis*), wild radish (*Raphanus raphanistrum*), cabbage (*Brassica oleracea* var. *capitata*), cauliflower (*Brassica oleracea* var. *botrytis*) and Chinese cabbage (*Brassica rapa* var. *pekinensis*) as well in forest crops

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(Chamberlin and Kok, 1986; Lasota and Kok, 1989; Kok and Acosta-Martinez, 2001; Pratissoli et al., 2007).

Infestation by *A. monuste orseis*is is primarily controlled by periodical application of chemical insecticides (Kuhar et al., 2003). These products may cause serious problems such as residues in food, elimination of natural enemies, toxicity to handlers and selection of insecticide-resistant populations (Roel et al., 2000).

The use of alternative methods is a promising strategy for controlling pests in vegetable plants because it reduces the amount of insecticides applied and the levels of residues in food. Therefore, the use of kale varieties resistant to insects becomes important to control pests of this crop (Fancelli and Vendramim, 1992; Boiça Juniior et al., 2011; Schlick-Souza et al., 2011; Baldin et al., 2014).

Host-plant resistance is a control method within the precepts of integrated pest management (IPM), especially to reduce the pest population density to a level below the economic threshold with no impact on the agro-ecosystem and no additional costs for the farmer. Host-plant resistance also has persistent effects during the phenological cycle of crops and is compatible with other methods (Eigenbrode and Trumble, 1994; Seifi et al., 2013; Sousa et al., 2014). Resistance in Brassicaceae can manifest by antibiosis, which disrupts the insect's biology and reduces its abundance and the damage caused by the pest, and/or by antixenosis that affects the insects' behavior and is usually expressed as feeding or oviposition non-preference in resistant plants (Painter, 1951; Panda, 1979; Lara, 1991; Smith, 2005).

There are few studies of resistance of kale to *A. monuste orseis*, and their analyses are based on biological data of the pest development in hosts and not on the host plant characteristics (Schlick-Souza et al., 2011). The genotypes Manteiga de Jundiaí, Comum, Arthur Nogueira 1, Manteiga de Ribeirão Pires I-2446, Manteiga de Ribeirão Pires I-2620 and Tronchuda Portuguesa exhibited oviposition non-preference (antixenosis) resistance. The genotypes Japonesa, Pires 1 de Campinas, Roxa I-919 and Manteiga de São Roque I-812 exhibited feeding non-preference in *A. monuste orseis* (Schlick-Souza et al., 2011).

Chemical, morphological and physical characteristics of the Brassicaceae are involved in those resistance mechanisms to insects (Farnham and Elsey, 1995; Renwick and Kimberly, 1999; Ulmer et al., 2002; Thuler et al., 2007; Vendramin and Guzzo, 2009; Baldin and Beneduzzi 2010; Schlink-Souza et al., 2011).

The present study evaluates the antibiosis resistance mechanism in kale genotypes by determining the biological parameters of *A. monuste orseis* caterpillars under laboratory conditions.

MATERIALS AND METHODS

Seedlings of the kale genotypes were obtained from the Laboratory of Plant Resistance to Insects (LPRI), School of Agricultural and Veterinary Sciences, University of São Paulo States, Municipality of Jaboticabal-São Paulo, and were transplanted to the field at the Goiano Federal Institute-Campus Urutaí–Goias States.

The cultivation practices were performed following the recommendations for kale crops and irrigation was applied as needed using a conventional sprinkler irrigation system (Filgueira, 2008). The following genotypes were studied: Manteiga de Mococa, Manteiga de Jundiaí, Manteiga de Tupi, Pires 2 de Campinas, Vale das Garças, Crespa de Capão Bonito, Couve Arthur Nogueira 1, Couve Arthur Nogueira 2, Hortolândia, Orelha de Elefante, Crespa I-918, Manteiga I-1811, Manteiga de Ribeirão Pires I-1811, Manteiga de Ribeirão Pires I-2620, Verde Escura, Pires 1 de Campinas, Verde Claro, Manteiga de São José, Manteiga de Monte Alegre, Roxa I-919, Couve Comum, Manteiga de São Roque I-1812, Manteiga de Jaboticabal, Geórgia 1, Geórgia 2 and Gigante I-915.

Insect rearing and maintenance

Egg masses were collected from kale plants, transported to the Laboratory of Agricultural Entomology (T 25 ± 2°C, 70 ± 10% RH and 12 h photophase), and placed in Petri dishes (14 cm diameter) containing moistened filter paper until the larvae hatched.

The newly hatched larvae were transferred to rearing cages (50 cm height x 30 cm diameter), sealed with tulle fabric secured with the aid of an elastic band. The bottom of the rearing cages was lined with paper towels to absorb the moisture from the excrement. Initially, 50 first-instar larvae were placed in each cage. Kale leaves were placed in pots (250 mL) containing water to maintain turgor pressure and were renewed daily or according to the larval development.

The pupae were placed in hatching cages (300 mL plastic cups), the bottom of which was covered with paper towel and the top was sealed with tulle fabric secured with the aid of an elastic band. The hatching cages were moistened daily to avoid possibly drying of pupae. After emergence, the adults were released in the field to ensure copulation, oviposition and egg collection.

Antibiosis test

To assess biological parameters, newly hatched *A. monuste orseis* larvae were placed in Petri dishes (14 cm diameter) containing a leaf disc (10 cm diameter) of each kale genotype and were kept in these containers from the larval to pupal stage. The pupae were placed in the same hatching cages used for *A. monuste orseis* rearing. Sexual identification and longevity of adults were assessed after their emergence.

The following biological parameters were evaluated: (a) larval stage: development time, instars, viability and larval weight 15 days after hatching; (b) pupal stage: development time, weight of 24-h-old pupae, viability and sex ratio; (d) larval-adult stage: development time and viability. A completely randomized experimental design with 26 treatments and 50 replicates was used. The treatments consisted of the different kale genotypes.

Statistical analysis

The biological parameters of *A. monuste orseis* were assessed by analysis of variance (ANOVA). For analysis, the original data were $(x+0.5)^{1/2}$ transformed. Means were compared using the Scott-Knott test at a 5% probability level (Winer et al., 1991). The statistical analysis was performed using the software SISVAR (Ferreira, 2011). Cluster analysis and Euclidean distance analysis were performed as a dissimilarity measure using the software Statistica

Table 1. Development time (mean±standard error) of the larval stages of *Ascia monuste orseis* (Lepidoptera: Pieridae) in kale genotypes (25°C, 70% RH and 12 h photophase).

Genotype (G)	Development time (days)				
	1° instar	2° instar	3° instar	4° instar	5° instar
Manteiga de Mococa	2.03±0.04b	2.91±0.07a	2.95±0.04a	3.49±0.22b	5.65±0.19a
Manteiga de Jundiaí	1.65±0.10c	1.97±0.02d	1.82±0.25b	3.09±0.10b	3.61±0.19d
Manteiga de Tupi	2.02±0.02b	1.99±0.00d	1.55±0.23b	2.52±0.22c	3.70±0.19d
Pires 2 de Campinas	2.02±0.02b	3.00±0.00a	2.83±0.21a	3.25±0.19b	3.82±0.11d
Vale das Garças	1.49±0.22d	2.05±0.05d	3.42±0.19a	3.17±0.21b	4.56±0.23c
Crespa de Capão Bonito	1.20±0.20f	2.50±0.22c	2.20±0.20b	2.49±0.22c	5.14±0.16b
Couve Arthur Nogueira 1	2.04±0.04b	2.01±0.01d	2.24±0.19b	4.51±0.22a	5.68±0.10a
Couve Arthur Nogueira 2	1.06±0.06f	2.16±0.11d	2.25±0.19b	3.14±0.22b	4.84±0.10b
Hortolândia	1.00±0.00f	2.19±0.12d	2.25±0.32b	3.20±0.20b	4.08±0.10c
Orelha de Elefante	1.10±0.11f	2.80±0.09b	3.05±0.20a	3.22±0.19b	4.24±0.15c
Crespa I-918	1.08±0.09f	2.52±0.12c	2.28±0.19b	2.71±0.20c	4.05±0.06c
Manteiga I-1811	2.03±0.04b	2.25±0.11d	2.26±0.20b	2.55±0.23c	4.23±0.19c
Manteiga de Ribeirão Pires I-1811	2.01±0.01b	2.77±0.10b	2.30±0.12b	3.33±0.21b	5.00±0.00b
Manteiga de Ribeirão Pires I-2620	1.30±0.14e	2.07±0.08d	2.11±0.20b	2.77±0.14c	3.69±0.20d
Verde Escura	1.69±0.09c	3.06±0.04a	2.29±0.09b	3.02±0.02c	4.64±0.27d
Pires 1 de Campinas	1.30±0.05e	3.06±0.12a	2.13±0.06b	3.04±0.32c	4.11±0.16c
Verde Claro	2.75±0.14a	3.09±0.09a	2.57±0.20b	2.81±0.20c	4.13±0.13c
Manteiga de São José	1.99±0.00b	3.10±0.10a	2.63±0.20a	3.48±0.22b	5.56±0.11a
Manteiga de Monte Alegre	2.06±0.06b	2.07±0.07d	2.28±0.19b	3.26±0.19b	3.06±0.07e
Roxa I-919	2.01±0.01b	3.02±0.03a	2.25±0.21b	2.55±0.23c	4.13±0.13c
Couve Comum	2.05±0.05b	2.64±0.19b	3.18±0.12a	3.57±0.24b	5.35±0.16a
Manteiga de São Roque I-1812	1.78±0.05c	2.31±0.20c	2.16±0.12b	2.86±0.10c	4.36±0.13c
Manteiga de Jaboticabal	1.52±0.02d	2.49±0.22c	2.35±0.12b	2.62±0.23c	4.06±0.06c
Geórgia 1	1.13±0.08f	2.01±0.02d	2.00±0.00b	2.72±0.13c	5.05±0.06b
Geórgia 2	1.73±0.06c	2.97±0.16a	2.17±0.12b	3.00±0.15c	4.14±0.14c
Gigante I-915	1.56±0.03d	2.22±0.10d	2.20±0.20b	2.68±0.00c	-2
F (G)	25.15**	13.56**	5.18**	4.95**	21.55**
C.V. (%)	11.64	10.12	17.24	14.52	7.50

Means followed by the same letter in the columns do not differ statistically based on Skott Knott test. **Significant at 1% probability level. [2]Caterpillars fed with these genotypes do not complete their cycle (no variance).

version 7.0 to separate the kale genotypes according to their resistance level to *A. monuste orseis*.

RESULTS AND DISCUSSION

Significant differences were observed in the development time of each instar and in the total life cycle of *A. monuste orseis* fed on the different kale genotypes (Table 1 and Figure 1). The first instar of *A. monuste orseis* larvae fed with the genotype Verde Claro had the longest development time (2.75 days), whereas the first instar of insects reared on the genotypes Hortolândia, Couve Arthur Nogueira 2, Crespa I-918, Orelha de Elefante, Geórgia 1 and Crespa de Capão Bonito exhibited the shortest development times (1.0-1.20 days).

Second instar larvae fed with the genotypes Manteiga de Mococa, Pires 2 de Campinas, Verde Escura, Pires 1 de Campinas, Verde Claro, Manteiga de São José, Roxa I-919 and Geórgia 2 showed the longest development times (2.91 to 3.10 days). The opposite was observed for the second instar of insects fed with the genotypes Manteiga de Jundiaí, Manteiga de Tupi, Vale das Garças, Couve Arthur Nogueira 1, Couve Arthur Nogueira 2, Hortolândia, Manteiga I-1811, Manteiga de Ribeirão Pires I-2620, Manteiga de Monte Alegre, Geórgia 1 and Gigante I-915, whose development times ranged from 1.97-2.25 days.

Insects fed with the genotypes Manteiga de Mococa, Pires 2 de Campinas, Vale das Garças, Orelha de Elefante, Manteiga de São José and Couve Comum had the longest development time at the third instar stage. For the 4th instar, insects fed with the genotype Couve Arthur Nogueira 1 had the longest development time. The genotypes Manteiga de Mococa, Couve Arthur Nogueira

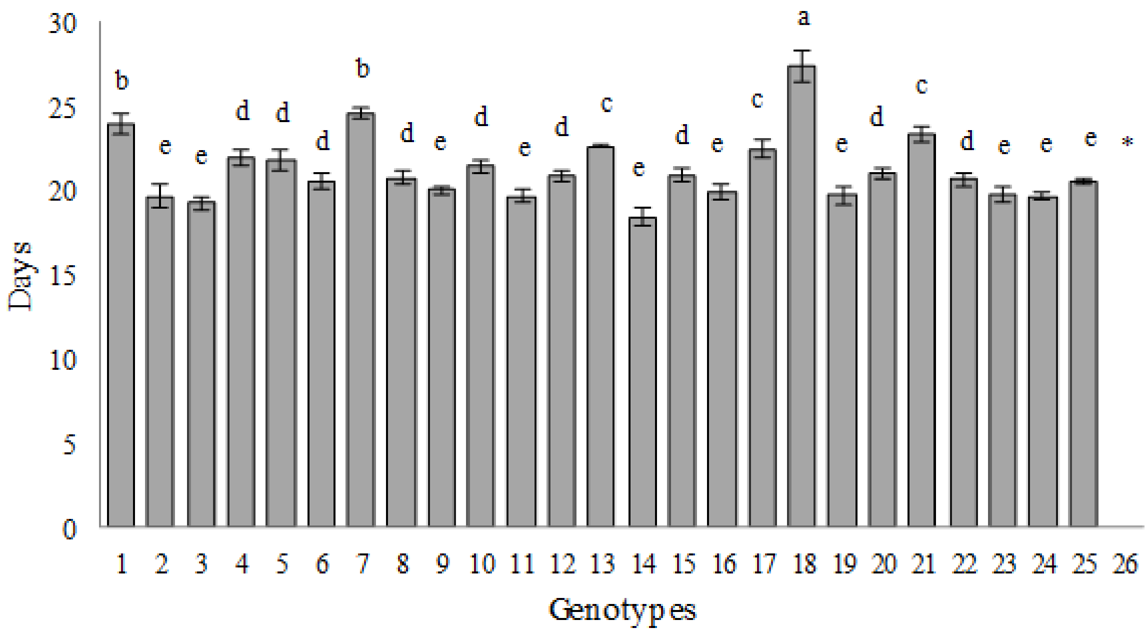

Figure 1. Development time (mean ± standard error) of the total life cycle of *Ascia monuste orseis* (Lepidoptera: Pieridae) in kale genotypes (grown at 25°C, 70% RH and14 h photophase). Urutaí, Goiás States, Brazil. Means followed by the same letter in the columns do no differ statistically by the Scott Knott test. [2]Caterpillars fed with these genotypes did not complete their life cycle (no variance). F (treatment) = 17.72** and C. V(%) = 4.97. Genotypes: **1.** Manteiga de Mococa; **2.** Manteiga de Jundiaí; **3.** Manteiga de Tupi; **4.** Pires 2 de Campinas; **5.** Vale das Garças; **6.** Crespa de Capão Bonito; **7.** Couve Arthur Nogueira 1; **8.** Couve Arthur Nogueira 2; **9.** Hortolândia; **10.** Orelha de Elefante; 11. Crespa I-918; **12.** Manteiga I-1811; **13.** Manteiga de Ribeirão Pires I-1811; 14. Manteiga de Ribeirão Pires I-2620; 15. Verde Escura; **16.** Pires 1 de Campinas; **17.** Verde Claro; **18.** Manteiga de São José; **19.** Manteiga de Monte Alegre; **20.** Roxa I-919; **21.** Couve Comum; **22.** Manteiga de São Roque I-1812; **23.** Manteiga de Jaboticabal; **24.** Geórgia 1; **25.** Geórgia 2; and **26.** Gigante I-915. *Caterpillars fed with these genotypes do not complete their cycle (no variance).

1, Manteiga de São José and Couve Comum resulted in the longest development time for the 5th instar, and insects fed with the genotype Gigante I-915 did not complete their cycle.

In general, throughout the larval stage, *A. monuste orseis* caterpillars that fed on the genotypes Manteiga de Mococa, Couve Comum, Manteiga de São José, Couve Arthur Nogueira 1, Manteiga de Ribeirão Pires I-1811 and Verde Claro showed the longest larval stage. The slowest larval development in these genotypes may have occurred due to the presence of glucosinolates or other factors that cause such resistance (Thuler et al., 2007; Baldin et al., 2014).

The presence of glucosinolates in brassicas has been previously related to resistance of these plants to *Pieris rapae* (Linnaeus, 1758) and *Plutella xylostella* (Linnaeus, 1758) as reported by Renwick and Kimberly (1999) and Thuler et al. (2007). A longer larval development time in *A. monuste orseis* is characteristic of kale genotypes that present antibiosis and/or antixenosis type resistance (Smith, 2005; Baldin et al., 2014).

Plant resistance may also be related to the waxiness of the leaf surface and the levels of secondary compounds such as sinigrin and alkane in Brassicaceae (Ulmer et al. (2002). Antibiosis type resistance was observed by Fancelli and Vendramim (1992) in the genotype Manteiga de Tupi. It has been observed that a longer larval development time in insects that fed with the genotypes Arthur Nogueira 1, Cabocla, Japonesa and Manteiga de Mococa (Baldin et al., 2014). However Verde-escura, Crespa de Capão Bonito, Couve de folhas Manteiga 900 Legítima Pé Alto, Gigante I-915 and the genotype Manteiga Ribeirão Pires I-2446 reduced the larval weight. Gigante I-915 produced high larval mortality. Pupae reared in the genotype Pires 1 de Campinas did not reach the adult stage and the genotypes Japonesa and Arthur Nogueira 1 prolonged the development time from egg to adult of *A. monuste orseis*. These data corroborate the results of the current study in which the larval stage of *A. monuste orseis* caterpillars that fed on the genotype Manteiga de Mococa was extended.

A. monuste orseis caterpillars fed with the genotypes Manteiga de São José, Couve Arthur Nogueira 1, Manteiga de Mococa and Couve Comum had the longest life cycles, with mean values ranging from 23.39 to 27.39 days (Figure 1).

Table 2. Larval and pupal weight and viability (mean±standard error) of *Ascia monuste orseis* (Lepidoptera: Pieridae) in kale genotypes (25°C, 70% RH and 14% photophase).

Genotype (G)	Weight (mg)		Viability (%)	
	Larval	Pupal	Larval	Pupal
Manteiga de Mococa	344.2±3.87a	337.6±1.78c	45.00±0.95g	43.20±1.88i
Manteiga de Jundiaí	311.2±4.97b	294.6±2.79f	63.40±2.34d	72.47±1.47d
Manteiga de Tupi	318.2±7.89b	309.4±4.13e	70.40±2.20c	76.56±1.61c
Pires 2 de Campinas	302.8±5.05c	345.2±1.83b	90.40±1.36b	97.10±0.51a
Vale das Garças	312.4±5.55b	312.2±1.66e	76.00±1.38c	67.60±1.36e
Crespa de Capão Bonito	297.0±3.98c	333.8±5.47c	93.12±1.09b	97.28±0.43a
Couve Arthur Nogueira 1	307.2±5.58b	295.8±3.63f	63.40±0.68d	60.40±0.51f
Couve Arthur Nogueira 2	295.4±5.27c	353.4±5.18a	51.00±1.67f	52.42±0.48g
Hortolândia	298.2±4.87c	292.2±1.66f	96.44±0.54a	97.09±0.59a
Orelha de Elefante	296.4±2.54c	338.6±2.99c	95.54±1.00a	97.07±0.49a
Crespa I-918	290.8±3.80c	284.2±2.03g	93.78±0.44b	95.44±0.50a
Manteiga I-1811	287.0±4.82d	344.6±1.91b	67.82±1.45c	66.26±0.82e
Manteiga de Ribeirão Pires I-1811	269.4±4.08e	288.2±3.60g	96.74±0.36a	96.97±0.52a
Manteiga de Ribeirão Pires I-2620	289.0±4.72c	315.4±2.38e	20.40±1.29h	14.08±0.74m
Verde Escura	283.2±5.81c	330.0±1.30d	65.35±0.90d	65.08±3.07e
Pires 1 de Campinas	298.6±1.47c	298.6±0.81f	02.60±0.40i	02.40±0.51n
Verde Claro	304.4±7.35c	336.8±1.46c	22.32±0.83h	28.02±1.56l
Manteiga de São José	245.8±6.41g	308.0±1.60e	67.82±1.43c	65.84±0.82e
Manteiga de Monte Alegre	292.0±3.00c	290.2±1.85g	63.98±1.68d	55.60±0.75g
Roxa I-919	297.0±5.21c	338.6±1.40c	70.03±0.96c	73.64±0.78d
Couve Comum	262.0±2.02f	325.4±1.96d	61.52±1.36d	45.34±0.91i
Manteiga de São Roque I-1812	236.2±2.67g	329.6±0.51d	55.60±0.97e	48.73±1.43h
Manteiga de Jaboticabal	223.4±3.71h	345.2±2.31b	62.22±1.52d	58.88±2.13f
Geórgia 1	223.6±3.47h	353.4±3.39a	22.76±0.68h	34.20±0.66j
Geórgia 2	215.0±4.81h	349.0±4.82b	94.44±0.29a	86.00±0.55b
Gigante I-915	203.6±1.81i	-2	-2	-2
F (G)	57.51**	65.57**	451.74**	498.92**
C.V. (%)	3.72	1.95	4.27	4.17

Means followed by the same letter in the columns do not differ statistically according to Skott Knott test. **Significant at 1% probability level. [2]Caterpillars fed with these genotypes do not complete their cycle (no variance).

According to Lara (1991), the extension of the insect life cycle reduces the number of generations over time, thus reducing the population size and increasing the pest exposure to natural enemies. Therefore, the genotypes Manteiga de São José, Couve Arthur Nogueira 1, Manteiga de Mococa and Couve Comum, which extended the life cycle of *A. monuste orseis*, are promising alternatives for the integrated management of this pest in the field because these genotypes showed resistance to *A. monuste orseis*. The durations of the life cycle of insects fed the above mentioned genotypes are similar to those reported by Baldin et al. (2014), who observed a total life cycle of 22.8 and 33.3 days for caterpillars fed on the genotypes Verde Escura and Japonesa, respectively.

Regarding the larval and pupal weight and viability, both of these biological parameters showed significant differences for insects fed with the different kale genotypes (Table 2). *A. monuste orseis* caterpillars fed on the genotype Manteiga de Mococa had the highest larval weight (344.2 mg). Conversely, caterpillars reared on the genotype Gigante I-915 had the lowest larval weight (203.6 mg) and did not reach the pupal stage. The genotypes Geórgia 1 and Couve Arthur Nogueira 2 produced the greatest pupal weight (353.4 mg), while insects fed with the genotypes Crespa I-918, Manteiga de Ribeirão Pires I-1811 and Manteiga de Monte Alegre had the lowest pupal weights, with mean values ranging from 284.2-290.2 mg.

The results obtained by Baldin et al. (2014) are similar to those found in the present study. The authors observed that *A. monuste orseis* caterpillars fed on the genotype Gigante I-915 did not reach the pupal stage. This pattern demonstrates the antibiosis or antixenosis

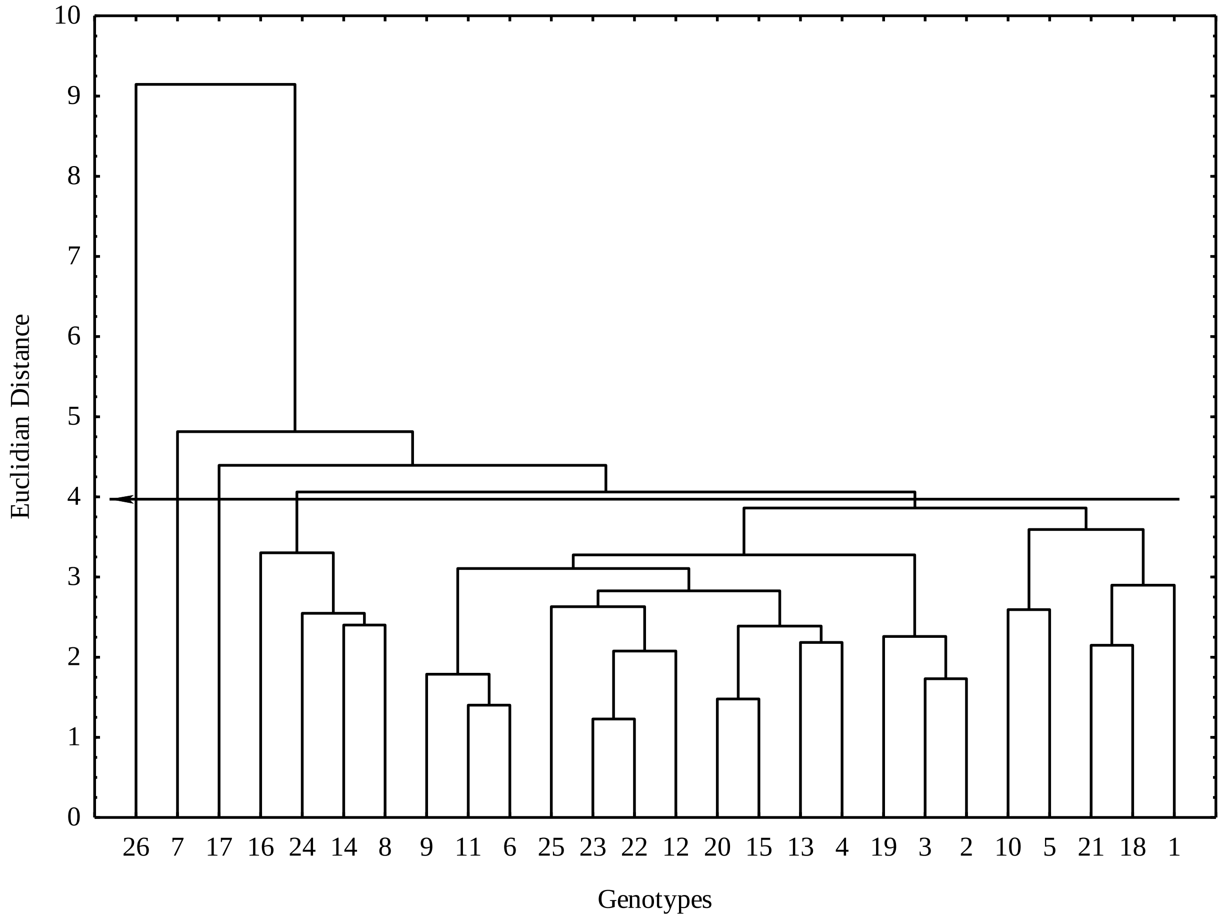

Figure 2. Dendrogram based on biological parameters of *Ascia monuste orseis* (Lepidoptera: Pieridae) in twenty-six kale genotypes. The method of agglomeration was used with UPGMA dissimilarity measure of Euclidean distance. Urutaí, Goiás States, Brazil. Genotypes: **1.** Manteiga de Mococa; **2.** Manteiga de Jundiaí; **3.** Manteiga de Tupi; **4.** Pires 2 de Campinas; **5.** Vale das Garças; **6.** Crespa de Capão Bonito; **7.** Couve Arthur Nogueira 1; **8.** Couve Arthur Nogueira 2; **9.** Hortolândia; **10.** Orelha de Elefante; **11.** Crespa I-918; **12.** Manteiga I-1811; **13.** Manteiga de Ribeirão Pires I-1811; **14.** Manteiga de Ribeirão Pires I-2620; **15.** Verde Escura; **16.** Pires 1 de Campinas; **17.** Verde Claro; **18.** Manteiga de São José; **19.** Manteiga de Monte Alegre; **20.** Roxa I-919; **21.** Couve Comum; **22.** Manteiga de São Roque I-1812; **23.** Manteiga de Jaboticabal; **24.** Geórgia 1; **25.** Geórgia 2; and **26.** Gigante I-915.

type resistance of this kale genotype to *A. monuste orseis* caterpillars. This resistance can be associated with chemical or physical factors (Ulmer et al., 2002; Thuler et al., 2007; Baldin et al., 2014).

The insects fed with the genotypes Hortolândia, Orelha de Elefante, Manteiga de Ribeirão Pires I-1811 showed the highest larval and pupal viability. In contrast, the genotypes Manteiga de Ribeirão Pires I-2620 and Pires 1 de Campinas generated the lowest viability.

Studies have shown that the genotype Pires I de Campinas produced feeding non-preference in *A. monuste orseis* (Schlick-Souza et al., 2011). The genotype Pires I de Campinas, which caused the lowest larval and pupal viability in the present study, has compounds that exert a deterrent effect and manifest different types and levels of resistance to *A. monuste orseis*.

Based on the hierarchical cluster analysis, there were diferences among the genotypes, which were divided in five groups according to their similarity levels (Figure 2): Group 1 (Gigante I-915); Group 2 (Couve Arthur Nogueira 1); Group 3 (Verde Claro); Group 4 (Pires 1 de Campinas, Geórgia 1, Manteiga de Ribeirão Pires I-2620 and Couve Arthur Nogueira 2); and Group 5 (Hortolândia, Crespa I-918, Crespa de Capão Bonito, Geórgia 2, Manteiga de Jaboticabal, Manteiga de São Roque, Manteiga I-1811, Roxa I-919, Verde Escura, Manteiga de Ribeirão Pires I-1811, Pires 2 de Campinas, Manteiga de Monte Alegre, Manteiga de Tupi, Manteiga de Jundiaí, Orelha de Elefante, Vale das Garças, Couve Comum, Manteiga de São José and Manteiga de Mococa).

By setting the Euclidean distance at 4.0, the following division of the genotypes into distinct groups according to their levels of resistance is suggested: Gigante I-915, Couve Arthur Nogueira 1, Verde Claro, Pires 1 de Campinas, Geórgia 1, Manteiga de Ribeirão Pires I-2620 and Couve Arthur Nogueira 2 moderately resistant (MR); Hortolândia, Crespa I-918, Crespa de Capão Bonito, Geórgia 2, Manteiga de Jaboticabal, Manteiga de São Roque, Manteiga I-1811, Roxa I-919, Verde Escura, Manteiga de Ribeirão Pires I-1811, Pires 2 de Campinas, Manteiga de Monte Alegre, Manteiga de Tupi and Manteiga de Jundiaí susceptible (S); Orelha de Elefante, Vale das Garças, Couve Comum, Manteiga de São José and Manteiga de Mococa highly susceptible (HS).

Conclusions

The genotypes Gigante I-915 and Pires 1 de Campinas have antibiosis resistance. Gigante I-915 caused high larval mortality and Pires 1 de Campinas resulted in low larval and pupal viability of *Ascia monuste orseis*.

Conflict of interests

The authors did not declare any conflict of interest.

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