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# EVALUATION OF FOOD PREFERENCES AND TOLERANCE OF SLUGS *DEROCERAS RETICULATUM*, *ARION LUSITANICUS* AND *ARION RUFUS* (I GROUP OF PLANTS) WITH REFERENCES TO VARIOUS HERBS

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**Abstract:** Evaluation of palatability of 20 plant species as a food source for slugs *Deroceras reticulatum* (Müller), *Arion lusitanicus* (Mabille) and *Arion rufus* (Linnaeus) was performed under laboratory conditions in tests with multiple choices and without choice. Rate and degree of damage of seedlings and leaves of matured plants of herbs and winter oilseed rape were calculated. Based on conducted experiments, plant species preferred and rejected by particular slug species were defined. Plants that were preferred by all examined slug species were the following: *Brassica napus*, *Conium maculatum* and *Lamium amplexicaule*. Rejected plants were *Polygonum nodosum* and *Plantago lanceolata*. Slugs have showed differentiated preferences towards the remaining plant species.

**Key words**: slugs, *D. reticulatum*, *A. lusitanicus*, *A. rufus*, herbs, preferences, tolerance

## INTRODUCTION

Slugs are major pests of arable crops (Glen et al. 1993; Barrat et al. 1994; Moens and Glen 2002). In Poland, they cause the highest amount of damage on vegetables, winter oilseed rape and winter wheat (Kozłowski 2002; Kozłowski and Kozłowska 2002). *Deroceras reticulatum* (Müller) is the most severe pest among slug species. Considerable damage, particularly on edges of cultivated fields, results from *Arion lusitanicus* (Mabille) and *Arion rufus* (Linnaeus) feeding. Protection of young plants, sensitive at early growth stages with molluscicide pellets often fails and can be hazardous to useful fauna. This stimulates a search for alternative effective methods in the inhibition of slug feeding. One of these methods is utilization, as alternative

food source, plant species that are palatable to slugs (Cook et al. 1997; Frank and Friedli 1999; Kozłowski and Kozłowska 2000). Application of plant extracts or chemical compounds of plants are another option in protection of arable crops (Webbe and Lambert 1983; Molgaarrd 1986; Briner and Frank 1998; Barone and Frank 1999).

The presented results refer to preferences and tolerance revealed by examined slug species to selected herb species and winter oilseed rape. The collected results on plants' palatability can play an important role in further surveys on alternative methods of control of harmful slugs.

## MATERIAL AND METHODS

Investigations on slug feeding preferences were carried out with 20 plant species in controlled conditions (daily temp. 19°C, night temp. 16°C, RH 93% and day length 15 h). Tests with multiple choices were set up in semi-transparent plastic containers (80 × 50 × 20 cm) 1/3 filled with soil and divided into 40 plots. The containers were closed and equipped with two holes covered with mill gauze. 19 herb species and winter oilseed rape were sown in each container. Each plant species was sown on two plots (2 × 5 seeds). Time of sowing was chosen in accordance with germination and development rate of each plant species, so that plant material amounts would be even for the tests. While plants reached a growth stage of 2–3 leaves and were 5–8 cm tall, 10 starved (48 h without food) and unmatured slugs of one species were placed in the containers. Mean weight of slugs was for *D. reticulatum* – 0.6 g, *A. lusitanicus* – 2.1 g and *A. rufus* – 1.8 g. On 30 successive days, the percentage of plant area consumed by slugs was estimated, using a 5-degree scale (0% = no damage, 25%, 50%, 75% and 100% of consumed plant area). There were 20 plant species tested with 5 seedlings of each and 6 replications for each slug species.

Tests without choice were carried out in plastic and closed containers (22x18x13 cm) with small ventilate holes and filled with 5 cm layer of soil. In each container 10 seeds of each plant species (totally 20 plant species examined) were sown. When plants reached growth stage of 2–3 leaves and were 5–8 cm tall, one starved slug (48 h without food) was placed. Mean weight of slugs was for *D. reticulatum* – 0.4 g, *A. lusitanicus* – 1.4 g. On 15 successive days, the percentage of plant area consumed by slugs was estimated, as in a similar previous experiment. There were 10 seedlings tested for each of 20 plant species in 10 replications.

Investigations on slug tolerance of matured leaves were performed in tests without choices. Experiments were set up in laboratory conditions in darkness at a temperature of 16°C. Disks of 346 $mm^2$ area or parts of leaves with total area of 346 $mm^2$ were cut out from leaves of 20 plants species collected in terrain. Three disks of each plant species were placed on moistened filter paper in tightly closed semi-translaminar plastic container (capacity 0.5 l and 10 cm in diameter). Slugs had been unfed for 24 h prior to beginning of the tests. Directly before the tests, each slug was weighted so the sum of their weights was similar for each plant species. The mean mass of the slugs was *D. reticulatum* – 0.5 g, *A. lusitanicus* – 1.4 g and *A. rufus* – 1.9 g. One slug was placed in each container and after 12 h was removed and the uneaten leaf area was measured with millimeter ruled paper. Collected data

was transferred to percentage values that were analyzed statistically using analysis of variance and Tukey's test at $\alpha=0.05$. Six replications were performed for each slug and plant species.

## RESULTS

### *Deroceras reticulatum*

In tests with multiple choices after one day of *D. reticulatum* feeding, damage degree was similar for all plant species (Tab. 1). Significant differences were recorded after 2 days of feeding. *Brassica napus* L. var. *oleifera* L. seedlings were severer damaged than seedlings of *Polygonum nodosum* Pers., *Chelidonium maius* L. and than seedlings *Plantago maior* L., *Euphorbia helioscopia* L., *Myosotis arvensis* L. Hill. and *Tripleurospermum inodorum* (L.) Schults-Bip. Differences increased along with an increase time of slug feeding. After 6 days of feeding, seedlings of 15 plant species were consumed on average in 80% –100%. Significantly less damaged were *Plantago maior* L. (32.5%), *M. arvensis* (34.2%) and *Sinapis arvensis* L. (52.5%), while *P. nodosum* (1.7%) was lightly injured and *C. maius* (0%) stayed intact. On eight successive days, slugs kept feeding on seedlings of *P. maior*, *M. arvensis* and *S. arvensis*. After 14 days of slug feeding, the damage degree amounted to 85.8%, 87.5% and 90.8%, respectively. By the end of experiment (after 21 days) plants of 18 species were completely destroyed or damaged in almost 100%. On the contrary *P. nodosum* seedlings were injured only in 14% and there was not symptoms of feeding on *C. maius* plants.

In no choice tests (Tab. 1) after 1 day of *D. reticulatum* feeding, the severest damage was recorded on seedlings of *B. napus* and *Lamium amplexicaule* L. This slug species showed not interest in *E. helioscopia* plants and slightly injured seedlings of *C. maius*, *P. nodosum* and *Plantago lanceolata* L. After 2 days, the severest damage was observed on *B. napus* and *L. amplexicaule* and the smallest on *C. maius* and *E. helioscopia*. After 6 days of testing slug feeding preferences, *L. amplexicaule* and *B. napus* seedlings showed the severest damage, 84% and 76%, respectively. The least severe injures were recorded on *C. maius* (3.5%) and *E. helioscopia* (8%) seedlings. Such a tendency was observed until the last observation. The results collected after 14 days of feeding revealed that *D. reticulatum* injured the most plants of *B. napus* (97%), *L. amplexicaule* (97%) and *P. lanceolata* (92.5%), significantly less *C. maius* (4%) and *E. helioscopia* (12.5%). Seedlings of *P. nodosum* were also damaged at slight degree (38%).

In tests on tolerance of leaves of matured plants, *D. reticulatum* consumed the most *Thlaspi arvense* L. leaves (14%) (Tab. 4). In addition, slugs eagerly fed on leaves of *B. napus* (13%) and *Chenopodium album* (L.) (13%). *D. reticulatum* slightly chewed leaves of *P. maior* (0.3%), *P. lanceolata* (0.6%), *Rumex acetosa* L. (0.8%), *S. arvensis* (1.0%) and *Rumex acetosella* L.(1.2%) and did not feed on leaves of *C. maius* at all.

### *Arion lusitanicus*

In tests with multiple choices after one day of feeding, *A. lusitanicus* fed on almost all plant species, excluding *Polygonum nodosum* and *Plantago lanceolata* (Tab. 2). After 2 days of feeding, significant differences in damage degree were recorded for particular plant species. Seedlings of *Conium maculatum* L. were injured the most, as plants

Table 1. Rate of seedling damage of different herb species and oilseed rape by *Deroceras reticulatum* in test with multiple choices or in test without choices and results of Tukey's test at $\alpha=0.05$

| Plant species | Day of feeding in test with multiple choices | | | | Day of feeding in test without choices | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 6 | 14 | 1 | 2 | 6 | 14 |
| *Amarantus retroflexus* | 3.3 a | 20.0 abc | 80.0 a | 96.7 a | 14.0 bc | 25.5 bc | 50.0 cd | 67.0 abcdef |
| *Brassica napus* | 20.0 a | 55.0 a | 100.0 a | 100.0 a | 29.5 a | 45.0 a | 76.0 a | 97.0 a |
| *Capsella bursa-pastoris* | 3.3 a | 47.5 abc | 96.7 a | 100.0 a | 20.0 ab | 32.0 ab | 56.0 bc | 83.5 abc |
| *Chelidonium maius* | 0.0 a | 0.0 c | 0.0 c | 0.0 b | 1.0 d | 2.0 e | 3.5 g | 4.0 h |
| *Chenopodium album* | 1.7 a | 26.7 abc | 80.0 a | 90.0 a | 4.5 cd | 10.5 de | 45.0 cde | 71.5 abcde |
| *Conium maculatum* | 24.2 a | 50.8 ab | 96.7 a | 100.0 a | 5.0 cd | 11.0 cde | 34.0 cdef | 56.5 cdef |
| *Euphorbia helioscopia* | 0.0 a | 3.3 bc | 90.0 a | 100.0 a | 0.0 d | 0.5 e | 8.0 g | 12.5 gh |
| *Lamium amplexicaule* | 13.3 a | 16.7 abc | 100.0 a | 100.0 a | 26.5 a | 40.5 a | 84.0 a | 97.0 a |
| *Lamium purpureum* | 6.7 a | 33.3 abc | 100.0 a | 100.0 a | 4.5 cd | 8.5 de | 24.0 efg | 59.0 cdef |
| *Melandrium album* | 13.3 a | 26.7 abc | 92.5 a | 100.0 a | 6.0 cd | 10.5 de | 36.5 cdef | 79.0 abcde |
| *Myosotis arvensis* | 0.8 a | 3.3 bc | 34.2 b | 87.5 a | 5.5 cd | 8.0 de | 24.5 defg | 52.0 def |
| *Plantago lanceolata* | 0.0 a | 20.0 abc | 83.3 a | 99.2 a | 2.5 d | 8.5 de | 54.0 bc | 92.5 ab |
| *Plantago maior* | 0.0 a | 2.5 bc | 32.5 b | 85.8 a | 8.0 cd | 12.5 cde | 25.0 defg | 62.5 bcdef |
| *Polygonum nodosum* | 0.0 a | 0.0 c | 1.7 c | 9.2 b | 2.0 d | 6.0 de | 20.0 efg | 38.0 fg |
| *Rumex acetosa* | 12.5 a | 27.5 abc | 87.5 a | 100.0 a | 6.0 cd | 8.5 de | 17.5 fg | 50.0 ef |
| *Rumex acetosella* | 8.3 a | 22.5 abc | 86.7 a | 100.0 a | 10.5 bcd | 17.0 cd | 40.5 cdef | 68.5 abcdef |
| *Sinapis arvensis* | 14.2 a | 20.0 abc | 52.5 b | 90.8 a | 6.5 cd | 11.0 cde | 20.0 efg | 81.0 abcd |
| *Stellaria media* | 1.7 a | 18.3 abc | 80.0 a | 100.0 a | 8.0 cd | 18.0 bcd | 53.0 bc | 82.5 abcd |
| *Thlaspi arvense* | 23.3 a | 45.0 abc | 94.2 a | 100.0 a | 10.5 bcd | 20.5 bcd | 53.5 bc | 76.5 abcde |
| *Tripleurospermum inodorum* | 0.0 a | 6.7 bc | 83.3 a | 100.0 a | 14.0 bc | 17.5 bcd | 44.0 cde | 56.5 cdef |

Values within each column, followed by the same letter are not significantly different

Table 2. Rate of seedling damage of different herb species and oilseed rape by *Arion lusitanicus* in test with multiple choices or in test without choices and results of Tukey's test at $\alpha = 0.05$

| Plant species | Day of feeding in test with multiple choices | | | | Day of feeding in test without choices | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 6 | 14 | 1 | 2 | 6 | 14 |
| *Amarantus retroflexus* | 10.8 a | 30.8 bcdef | 79.2 a | 100.0 a | 15.0 defg | 22.0 defg | 53.5 cde | 86.5 abcd |
| *Brassica napus* | 34.2 a | 49.2 abcd | 94.2 a | 100.0 a | 14.0 defg | 22.0 defg | 50.0 cde | 83.5 abcd |
| *Capsella bursa-pastoris* | 27.5 a | 55.8 abc | 95.0 a | 100.0 a | 12.5 defg | 29.0 defg | 65.5 bcd | 89.5 abcd |
| *Chelidonium maius* | 8.3 a | 12.5 cdef | 30.8 bc | 56.7 b | 5.0 fg | 19.0 efg | 47.0 def | 71.0 cde |
| *Chenopodium album* | 16.7 a | 33.3 abcdef | 80.8 a | 99.2 a | 9.0 efg | 17.5 efg | 49.5 cde | 92.5 abc |
| *Conium maculatum* | 32.5 a | 76.7 a | 100.0 a | 100.0 a | 28.0 bcd | 52.0 bc | 87.5 ab | 100.0 a |
| *Euphorbia helioscopia* | 1.7 a | 5.0 ef | 17.5 bc | 22.5 c | 15.5 defg | 33.5 cdef | 69.0 bcd | 84.5 abcd |
| *Lamium amplexicaule* | 22.5 a | 31.7 bcdef | 85.0 a | 100.0 a | 40.0 b | 66.0 ab | 91.0 ab | 100.0 a |
| *Lamium purpureum* | 26.7 a | 52.5 abc | 95.0 a | 100.0 a | 5.0 fg | 7.5 g | 21.0 f | 44.5 f |
| *Melandrium album* | 32.5 a | 66.7 ab | 98.3 a | 100.0 a | 23.0 cde | 38.0 cde | 58.0 cde | 82.5 abcd |
| *Myosotis arvensis* | 20.8 a | 47.5 abcde | 87.5 a | 100.0 a | 34.0 bc | 62.0 b | 88.5 ab | 97.0 ab |
| *Plantago lanceolata* | 0.0 a | 6.7 def | 41.7 b | 70,8 b | 3.5 g | 14.0 fg | 37.5 ef | 87.5 abcd |
| *Plantago maior* | 9.2 a | 18.3 cdef | 45.0 b | 75.0 b | 12.0 defg | 21.0 defg | 50.5 cde | 75.5 bcd |
| *Polygonum nodosum* | 0.0 a | 0.0 f | 0.8 c | 21.7 c | 12.0 defg | 19.0 efg | 31.0 ef | 49.5 ef |
| *Rumex acetosa* | 16.7 a | 45.0 abcde | 85.8 a | 97.5 a | 18.5 cdefg | 35.5 cdef | 49.0 de | 83.0 abcd |
| *Rumex acetosella* | 16.7 a | 47.5 abcde | 86.7 a | 100.0 a | 20.0 cdef | 24.5 defg | 57.0 cde | 79.5 abcd |
| *Sinapis arvensis* | 5.0 a | 24.2 bcdef | 86.7 a | 100.0 a | 17.5 defg | 25.0 defg | 50.0 cde | 93.0 abc |
| *Stellaria media* | 22.5 a | 32.5 bcdef | 81.7 a | 100.0 a | 22.5 cde | 34.5 cdef | 58.0 cde | 87.5 abcd |
| *Thlaspi arvense* | 19.2 a | 48.3 abcde | 91.7 a | 100.0 a | 24.5 bcde | 41.5 cd | 77.0 abc | 100.0 a |
| *Tripleurospermum inodorum* | 25.8 a | 50.8 abc | 98.3 a | 100.0 a | 57.0 a | 86.0 a | 98.5 a | 100.0 a |

Values within each column, followed by the same letter are not significantly different

were totally consumed after 5 days on carrying out the test. *Melandrium album* (Mill.) Gke. plants showed also severe damage (66.7%). On the contrary on next 5 days of feeding since the beginning of carrying out observations, slugs did not feed at all on *P. nodosum*. *Euphorbia helioscopia* and *P. lanceolata* were damaged slightly. After 6 days, all examined plants were divided into two groups in accordance with slug feeding preferences. First group (preferred food source) included 15 plant species that were damaged in 80%–100%. The remaining 5 species were damaged slightly. *P. nodosum* was significantly the least damaged (0.8%). Plant species like *E. helioscopia*, *C. maius*, *P. lanceolata* and *P. maior* had relatively slight injuries (18%, 31%, 42%, 45%, respectively). Slug *A. lusitanicus* displayed preference for these 15 plants within 14 days of feeding. After that time almost all plants from the first group were completely destroyed. Less damaged were *P. maior* (75%), *P. lanceolata* (71%) and *C. maius* (57%) and the least *E. helioscopia* (23%) and *P. nodosum* (22%). On the next following days (14 – 30 days of feeding), due to lack of food, slugs fed on plants previously not fully accepted *P. nodosum*, *P. maior*, *P. lanceolata*, *C. maius* and *E. helioscopia*. After 30 days, these plants were injured in 88–99% and only *E. helioscopia* was damaged only just in 30%.

In no choice tests, on the first day *A. lusitanicus* slugs fed on all plant species (Tab. 2). Degree of seedling damage was severely differentiated. After 24 hours, significant injures were recorded on *Tripleurospermum inodorum* seedlings (57%). *Lamium amplexicaule* and *Myosotis arvensis* seedlings were severely injured as well. On the contrary the least damage was observed on *Plantago lanceolata*, *Lamium purpureum* and *Chelidonium maius* (3.5% – 5.0%). After 2 days, damage degree on all examined plant species considerably increased however, the differentiation was similar to data collected after first day. After 6 days, significantly the greatest injuries were recorded on *T. inodorum* (98.5%). Plants of *Conium maculatum*, *Myosotis arvensis* and *Lamium amplexicaule* were damaged at high degree as well (88%, 89% and 91%, respectively). Significantly the least damage was observed on *Lamium purpureum* seedlings (21%). *Polygonum nodosum* seedlings were also slightly injured (31%). Slugs exhibited this feeding tendency until the end of observations (15 days of feeding). After 10 days seedlings of *T. inodorum* and *L. amplexicaule* were damaged in 100%. After 12 days in 100% were consumed seedlings of *Conium maculatum* and *Thlaspi arvense*. After 14 days, seedlings of *L. purpureum* and *P. nodosum* were still injured the least (44.5%, 49.5%, respectively).

In tests on tolerance of leaf disks from matured plants (Tab. 4), slugs consumed *E. helioscopia* leaves in 100% and almost in 100% of *B. napus*. Leaves of *Capsella bursa-pastoris* (L.) Med. were also almost entirely eaten (84%). Slugs consumed significantly the least leaves of *P. lanceolata* (0.2%).

***Arion rufus***

In tests with multiple choices, after 24 hours of *A. rufus* feeding, significant differences in plant injuries were observed (Tab. 3). *Euphorbia helioscopia* plants had no injuries. Damage degree of *Sinapis arvensis*, *Myosotis arvensis* and *Polygonum nodosum* was in a range from 8% to 10%, while *Lamium purpureum* plants were damaged in 59%, *Conium maculatum* in 47% and *Chelidonium maius* in 45%. After 2 days of feeding, seven

Table 3. Rate of seedling damage of different herb species and oilseed rape by *Arion rufus* in test with multiple choices and results of Tukey's test at $\alpha = 0.05$

| Plant species | Day of feeding | | | |
|---|---|---|---|---|
| | 1 | 2 | 6 | 14 |
| *Amarantus retroflexus* | 21.7 abc | 43.3 abcd | 97.5 ab | 100.0 a |
| *Brassica napus* | 29.2 abc | 52.5 abc | 100.0 a | 100.0 a |
| *Capsella bursa-pastoris* | 17.5 abc | 37.5 abcd | 98.3 a | 100.0 a |
| *Chelidonium maius* | 45.0 abc | 72.5 abc | 100.0 a | 100.0 a |
| *Chenopodium album* | 35.0 abc | 63.3 abc | 98.3 a | 100.0 a |
| *Conium maculatum* | 46.7 ab | 83.3 a | 100.0 a | 100.0 a |
| *Euphorbia helioscopia* | 0.0 c | 0.0 d | 79.2 bc | 100.0 a |
| *Lamium amplexicaule* | 29.2 abc | 70.0 abc | 100.0 a | 100.0 a |
| *Lamium purpureum* | 59.2 a | 80.0 ab | 100.0 a | 100.0 a |
| *Melandrium album* | 38.3 abc | 54.2 abc | 100.0 a | 100.0 a |
| *Myosotis arvensis* | 10.0 bc | 24.2 cd | 67.5 c | 100.0 a |
| *Plantago lanceolata* | 16.7 abc | 26.7 cd | 70.0 c | 100.0 a |
| *Plantago maior* | 32.5 abc | 63.3 abc | 97.5 ab | 100.0 a |
| *Polygonum nodosum* | 10.8 bc | 30.8 bcd | 71.7 c | 93.3 b |
| *Rumex acetosa* | 18.3 abc | 40.8 abcd | 95.0 ab | 100.0 a |
| *Rumex acetosella* | 36.7 abc | 56.7 abc | 94.2 ab | 100.0 a |
| *Sinapis arvensis* | 8.3 bc | 26.7 cd | 95.8 ab | 100.0 a |
| *Stellaria media* | 30.0 abc | 66.7 abc | 100.0 a | 100.0 a |
| *Thlaspi arvense* | 27.5 abc | 50.0 abcd | 96.7 ab | 100.0 a |
| *Tripleurospermum inodorum* | 15.0 abc | 41.7 abcd | 100.0 a | 100.0 a |

Values within each column, followed by the same letter are not significantly different

Table 4. Percentage of consumed area of leaves of different herb species during 12 h by three slug species and results of Tukey's test at $\alpha = 0.05$

| Plant species | Slug species | | |
|---|---|---|---|
| | *D. reticulatum* | *A. lusitanicus* | *A. rufus* |
| *Amarantus retroflexus* | 4.7 abcd | 14.4 efg | 18.3 bc |
| *Brassica napus* | 13.7 ab | 99.5 a | 70.2 ab |
| *Capsella bursa-pastoris* | 11.9 abcd | 83.6 ab | 45.8 abc |
| *Chelidonium maius* | 0.0 d | 78.6 abc | 46.1 abc |
| *Chenopodium album* | 13.2 abc | 23.8 defg | 52.7 abc |
| *Conium maculatum* | 7.6 abcd | 61.1 abcd | 68.4 ab |
| *Euphorbia helioscopia* | 3.4 abcd | 100.0 a | 92.1 a |
| *Lamium amplexicaule* | 7.4 abcd | 43.5 bcdefg | 71.1 ab |
| *Lamium purpureum* | 6.1 abcd | 76.5 abc | 50.9 abc |
| *Melandrium album* | 8.1 abcd | 9.6 fg | 70.2 ab |
| *Myosotis arvensis* | 3.2 abcd | 21.0 defg | 56.2 abc |
| *Plantago lanceolata* | 0.6 cd | 0.2 g | 7.2 c |
| *Plantago maior* | 0.3 d | 24.5 defg | 33.0 bc |
| *Polygonum nodosum* | 3.4 abcd | 47.5 bcdef | 33.8 bc |
| *Rumex acetosa* | 0.8 cd | 40.4 cdfg | 53.8 abc |
| *Rumex acetosella* | 1.2 bcd | 21.2 defg | 24.2 bc |
| *Sinapis arvensis* | 1.0 bcd | 76.5 abc | 29.4 bc |
| *Stellaria media* | 9.5 abcd | 30.1 defg | 44.1 bc |
| *Thlaspi arvense* | 14.1 a | 21.0 defg | 9.1 c |
| *Tripleurospermum inodorum* | 10.0 abcd | 57.5 abcde | 58.6 abc |

Values within each column, followed by the same letter are not significantly different

plant species were damaged in 63%–83%. The severest injuries were noted on *C. maculatum* (83%) and *L. purpureum* seedlings (80%) while there was no symptoms of feeding on *E. helioscopia* plants. After 3 days, plants of *L. purpureum* and *L. amplexicaule* were totally destroyed (100%) and after 4 days also plants of *C. maius*, *C. maculatum* and *Melandrium album*. Slugs damaged either entirely or almost in 100% 10 plant species after 6 days. Significantly the least damage was observed on *M. arvensis* (68%), *Plantago lanceolata* (70%), *P. nodosum* (72%) and *E. helioscopia* (79%). On the following days due to lack of food, slugs consumed *E. helioscopia*, next *P. lanceolata* and *M. arvensis*. Meanwhile, plants of *P. nodosum* were injured in 93%.

In tests on leaf tolerance of matured plants (Tab. 4), *A. rufus* slugs consumed the greatest amounts of *E. helioscopia* (92%), next *L. amplexicaule* (71%), *B. napus* (70%), *M. album* (70%) and *C. maculatum* (68%). Slugs fed on *P. lanceolata* and *Thlaspi arvense* significantly the least frequent and consumed leaves only in 7% and 9%, respectively.

## DISCUSSION

Based on conducted surveys it was stated that *D. reticulatum*, *A. lusitanicus* and *A. rufus* slugs revealed differentiated preferences to examined plant species. Considering 20 examined plant species as a food source, all slug species showed higher or lower preferences for *Brassica napus*, *Conium maculatum* and *Lamium amplexicaule* and no interest to plants of *Polygonum nodosum* and *Plantago lanceolata*.

*Deroceras reticulatum* preferred seedlings and leaves of *B. napus* and seedlings of *L. amplexicaule* and entirely rejected seedlings and leaves of *Chelidonium maius*. *D. reticulatum* revealed slight tolerance of *Polygonum nodosum*, *Euphorbia helioscopia*, *Plantago lanceolata* and *Plantago maior*.

*Arion lusitanicus* preferred the most seedlings of *Conium maculatum*, *Lamium amplexicaule* and *Tripleurospermum inodorum*. This slug species severely damaged seedlings of *Brassica napus* in tests with multiple choices, while in no choice tests this plant species was injured considerably less. Also *A. lusitanicus* severely damaged leaves of matured plants of *B. napus* and *Euphorbia helioscopia*. On the contrary the least tolerant were seedlings of *Polygonum nodosum* and seedlings and leaves of *Plantago lanceolata*. Seedlings of *Chelidonium maius* were slightly tolerated as well. In no choice tests seedlings of *Lamium amplexicaule* were slightly accepted and in tests with multiple choices *Plantago maior* seedlings were.

*Arion rufus* preferred plants of *Lamium purpureum*, *L. amplexicaule* and *Conium maculatum*. This species slightly tolerated both seedlings and leaves of *Plantago lanceolata* and seedlings of *Myosotis arvensis* and *Polygonum nodosum*. Plants of *Euphorbia helioscopia* were slightly damaged at seedling growth stage while leaves of matured plants were consumed.

According with collected results examined slug species displayed preferences for the same plant species. *Brassica napus* plants belong to this category. Seedlings of this plant species were severely damaged by different slug species occurring on fields (Glen et al. 1993; Barrat et al. 1994; Kozłowski and Kozłowska 2002). Briner and Frank (1998) in laboratory experiments on palatability of 78 herbal plants proved that plant the most preferred by *A. lusitanicus* was *B. napus*. Their investiga-

tion showed that *Capsella bursa-pastoris* (L.) Med., *Lamium purpureum* and *Sinapis arvensis* plants were favored as well. Frank and Friedli (1999) based on laboratory tests revealed that both *A. lusitanicus* and *D. reticulatum* preferred *B. napus* and *C. bursa-pastoris*. The latter plant is also strongly preferred by *Arion caruanae* (Dirzo 1980). In our investigations *C. bursa-pastoris* was relatively strongly preferred by *D. reticulatum* and *A. lusitanicus*. *Lamium purpureum* plants were preferred by *A. rufus*. *Sinapis arvensis* plants were accepted moderately by all slug species. However, in no choice tests, examined slug species preferred seedlings of *L. amplexicaule* better than *L. purpureum*. *Plantago lanceolata* was a plant species slightly tolerated by most slug species. Similar results referring to *P. lanceolata* tolerance were collected by Dirzo (1980) in studies on feeding preferences of *Arion caruanae*, by Briner and Frank (1998) in studies on *A. lusitanicus* and Molgaarrd (1986) on *Helix pomatia*.

The investigations also revealed that each from tested slug species displayed specific preferences for supplied plant species. It means that some plant species that are attractive for certain slug species might be deterrent for others. *Myosotis arvensis* is a good example as a plant favored by *A. lusitanicus* and much less by *D. reticulatum* and *A. rufus*. Another plant presenting different attractiveness for slugs is *Chelidonium maius* that was preferred by *A. rufus* and not tolerated well by *D. reticulatum* and *A. lusitanicus*.

Based on collected results a correlation was found between degree of plant tolerance and growth stage of plants. It was revealed that the plant species attractive for slugs at seedling stage became rejected at mature growth stage and vice versa. Plants with these features were *Euphorbia helioscopia* that at growth stage of matured leaves was preferred by *A. lusitanicus* and *A. rufus* while at seedling growth stage mild accepted and *Melandrium album* preferred by *A. lusitanicus* at seedling growth stage and slightly tolerated at growth stage of matured leaves.

The conducted surveys allowed to determine that 3 plant species (*Chelidonium maius, Polygonum nodosum and Plantago lanceolata*) out of 20 tested were not accepted by slugs. These species probably contain plant substances inhibiting or making impossible slug feeding. Numerous plant species contain or produce secondary plant metabolites that act as antifeedants on slugs (Dirzo 1980; Dirzo and Harper 1982; Webbe and Lambert 1983; Barone and Frank 1999). The influence of plant extracts or plant chemical compounds on pest feeding habits gives a possibility to utilize them in protection of arable crops against harmful slugs. Barone and Frank (1999) proved that extracts from *Saponaria officinalis* and *Valeriana locusta* could efficiently protect seedlings of oilseed rape against feeding of *A. lusitanicus*. Perhaps some of distinguished in this work plant species would be used for protection of seedlings of oilseed rape and wheat against slug feeding. However, this subject still requires further detailed studies and numerous tests under laboratory and field conditions.

## CONCLUSIONS

1. Slug species displayed specific preferences for plant species.
2. *D. reticulatum*, *A. lusitanicus* and *A. rufus* slugs preferred plants of *Brassica napus*, *Conium maculatum* and *Lamium amplexicaule* and no interest to plants of *Polygonum nodosum* and *Plantago lanceolata*.
3. Slugs have showed differentiated preferences towards the remaining plant species.

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## POLISH SUMMARY

### OCENA PREFERENCJI I AKCEPTACJI RÓŻNYCH GATUNKÓW ROŚLIN ZIELARSKICH PRZEZ ŚLIMAKI *DEROCERAS RETICULATUM, ARION LUSITANICUS* I *ARION RUFUS* (I ZESTAW ROŚLIN)

Ślimaki są ważnymi szkodnikami warzyw, rzepaku ozimego i pszenicy ozimej w Polsce. Największe szkody wyrządzają w okresie kiełkowania i wschodów roślin. Zwalczanie tych szkodników granulowanymi moluskocydami jest często mało skuteczne i może być niebezpieczne dla fauny pożytecznej. Jedną z alternatywnych metod ograniczania żerowania ślimaków na siewkach roślin uprawnych, będzie wykorzystanie specyficznych właściwości roślin. W celu ich poznania, w warunkach laboratoryjnych wykonano testy z wyborem i bez wyboru nad preferencją i akceptacją 20 gatunków roślin przez ślimaki *D. reticulatum*, *A. lusitanicus* i *A. rufus*. Określono tempo i stopień uszkodzenia siewek i liści dojrzałych roślin zielnych i rzepaku oleistego. Na podstawie przeprowadzonych eksperymentów, wyznaczono gatunki roślin preferowane i nie akceptowane przez poszczególne gatunki ślimaków. Stwierdzono, że gatunki ślimaków wykazują zróżnicowaną preferencję w stosunku do badanych gatunków roślin. Spośród 20 gatunków roślin, wszystkie gatunki ślimaków preferowały rośliny *Brassica napus*, *Conium maculatum* i *Lamium amplexiculate*, a nie akceptowały roślin *Polygonum nodosum* i *Plantago lanceolata*. W stosunku do pozostałych gatunków roślin preferencje poszczególnych gatunków ślimaków były silnie zróżnicowane.