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Short communication

Nutritional indices of the Colorado potato beetle, *Leptinotarsa decemlineata* (Col.: Chrysomelidae) on six potato cultivars

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چکیده

سوسک کلرادوی سیب زمینی، *Leptinotarsa decemlineata* (Say)، یکی از آفات مهم سیب زمینی در ایران و جهان است. شاخص‌های تغذیه‌ای لاروهای سن آخر این آفت روی برگ ارقام مختلف سیب زمینی (خاوران، ساوالان، لوتا، سانتا، سانته و آئولا) تحت شرایط آزمایشگاهی (دمای ۱ ± ۲۵ درجه سلسیوس، رطوبت نسبی ۵ ± ۶۵ درصد و دوره نوری ۱۶ ساعت روشنایی و ۸ ساعت تاریکی) بررسی شد. لاروهای پرورش‌یافته روی رقم سانته کم‌ترین کارایی تبدیل غذای خورده‌شده (۱/۰۷ ± ۱۰/۲۱ درصد) و هضم‌شده (۱/۰۸ ± ۱۰/۲۷ درصد) را داشتند. طبق نتایج به‌دست آمده، رقم سانته میزبان نامناسبی برای تغذیه این آفت بود.

Due to the economic importance of the Colorado potato beetle, *Leptinotarsa decemlineata* (Say), on potato (Hare, 1990), studying the resistance of host cultivars could improve management programs of this pest. It is generally accepted that an insect's performance on a host plant is reflected by its ability to digest and convert food into body mass (Price *et al*., 1980). Therefore, analyses of the nutritional indices are important factors determining antibiosis resistance in host plants to insects (Rayapuram & Baldwin, 2006; Kianpour *et al.*, 2013). There is little information available concerning the nutritional indices of the Colorado potato beetle on various potato cultivars. Cloutier *et al.* (2000) examined the effects of transgenic potato plants on food consumption of this pest and stated that the nutritional stress to females feeding on oryzacystatin I-transgenic foliage was evident. Biological parameters of *L. decemlineata* on various potato cultivars by Fathi & Fakhretaha (2011) indicated that the longest development time of immature stages was on the cultivar Savalan.

The objective of this research was to study the influence of different potato cultivars on nutritional responses of the last instar larvae of *L. decemlineata*. The results of this study help to identify a potato cultivar with adverse effect on the feeding of this pest.

Tubers of six potato cultivars of Khavaran, Savalan, Luta, Santa, Sante and Aula were obtained from Agricultural and Natural Resources Center of Moghan (Ardabil, Iran), and were grown in the research field of the University of Mohaghegh Ardabili (Ardabil, Iran). The experiments were carried out under laboratory conditions (25 ± 1°C, 65 ± 5% RH, and a photoperiod of 16: 8 (L: D) hours). The beetles were tested on different potato cultivars after being reared for one generation on the same cultivars. Fifty newly hatched larvae were transferred into plastic containers (diameter 16.5 cm, depth 7.5 cm), topped by mesh nets for larval aeration, supplied with young leaves of each cultivar (the petioles of detached leaves were inserted in water soaked cotton to keep freshness). The first instar larvae were reared to fourth instar and placed into separate plastic Petri dishes (diameter 8 cm, depth 1 cm). The weights of the fourth instar larvae were daily recorded before and after feeding until the pre-pupal stage. The primary fresh leaves, the leaves and feces remaining at the end of each experiment were daily weighed. The amount of ingested food was calculated by subtracting the remaining diet at the end of each experiment from the weight of fresh diet. All nutritional indices were gravimetrically calculated via formulae described by Waldbauer (1968):

Consumption index (CI) = E / A

Approximate digestibility (AD) = [(E - F) / E] × 100

Relative consumption rate (RCR) = E / (A × T)

Relative growth rate (RGR) = P / (A × T)

Efficiency of conversion of ingested food (ECI) = (P / E) × 100

Efficiency of conversion of digested food (ECD) = [P / (E - F)] × 100

where, A = dry weight of insect, E = dry weight of food consumed, F = dry weight of feces produced, P = dry weight gain of insect and T = duration of feeding period.

All data were tested for normality and analyzed by one-way ANOVA followed by comparison of the means with LSD test at α = 0.05 using statistical software Minitab 16.0.

The results of the nutritional indices of last instar *L. decemlineata* larvae are shown in Table 1. The highest consumption ($P < 0.01$) was in the larvae fed on Santa (0.19 ± 0.01 mg/larva) and the lowest on Luta (0.10 ± 0.01 mg/larva). The larvae fed on cultivar Sante demonstrated a lower weight gain (0.130 ± 0.002 mg), suggesting that this cultivar was least favourable to the pest. The highest value of larval weight gain ($P < 0.01$) was on Luta (0.182 ± 0.002 mg) compared to other cultivars. The highest AD value ($P < 0.01$) was in the larvae reared on Sante (99.74 ± 0.04%). The larvae reared on cultivars Sante (1.36 ± 0.14) and Luta (0.57 ± 0.07) showed the highest and lowest values of CI ($P < 0.01$), indicating that the rate of intake relative to the mean larval weight during the feeding period was the highest on Sante. According to the results, the highest and lowest values of ECI ($P < 0.01$) were in the larvae reared on the cultivars Luta (33.13 ± 4.53%) and Sante (10.21 ± 1.07%), suggesting that the larvae fed on the cultivar Sante were forced to make up for reduced ECI by increasing their CI (Price *et al.*, 1980). The larvae fed on the cultivar Luta demonstrated the highest value of ECD ($P < 0.01$) (43.44 ± 5.99%), while the lowest value was on the cultivar Sante (10.27 ± 1.08%). Lower ECI and ECD values of the last instar larvae feeding on the cultivar Sante suggested lower weight gain of the larvae (table 1), and lower efficiency for the conversion of ingested and digested food to their biomass. The highest and lowest values of RCR ($P < 0.01$) were found in the last instar larvae fed on the cultivars Aula (0.37 ± 0.03 mg/mg/day) and Luta (0.15 ± 0.02 mg/mg/day). Moreover, the lowest RGR value ($P < 0.01$) was observed in the larvae reared on the cultivars Sante and Khavaran (0.03 ± 0.001 and 0.03 ± 0.002 mg/mg/day, respectively). Fathi & Fakhretaha (2011) had found no significant difference in RGR of *L. decemlineata* on various potato cultivars. It is possible that either differences in potato cultivars and examined insect stages or variations in the methods used for the RGR calculation have been the cause for discrepancies. The results suggested that Sante, among different potato cultivars, was unsuitable cultivar in terms of feeding for *L. decemlineata* larvae. Further studies on demographic parameters of this pest in relation to different potato cultivars are required to improve our current knowledge.

Table 1. Nutritional indices of the last instar larvae of *Leptinotarsa decemlineata* on different potato cultivars.

Potato cultivar	Index (mean ± SE)							
	Food consumed (mg/larva)	Weight gain (mg)	CI	AD (%)	ECI (%)	ECD (%)	RCR (mg/mg/day)	RGR (mg/mg/day)
Khavaran	0.12 ± 0.01b	0.129 ± 0.003d	0.94 ± 0.09b	99.08 ± 0.17ab	15.92 ± 1.83c	16.08 ± 1.85c	0.23 ± 0.02cd	0.030 ± 0.002c
Savalan	0.13 ± 0.01b	0.176 ± 0.002a	0.76 ± 0.07b	98.86 ± 0.14bc	25.29 ± 2.58b	26.00 ± 2.39b	0.20 ± 0.02de	0.042 ± 0.001a
Luta	0.10 ± 0.01b	0.182 ± 0.002a	0.57 ± 0.07c	97.79 ± 0.45d	33.13 ± 4.53a	43.44 ± 5.99a	0.15 ± 0.02e	0.043 ± 0.001a
Santa	0.19 ± 0.01a	0.156 ± 0.002b	1.21 ± 0.08a	99.43 ± 0.07ab	13.25 ± 0.83c	13.33 ± 0.84cd	0.29 ± 0.02bc	0.038 ± 0.001b
Sante	0.18 ± 0.01a	0.130 ± 0.002d	1.36 ± 0.14a	99.74 ± 0.04a	10.21 ± 1.07c	10.27 ± 1.08d	0.33± 0.03ab	0.030 ± 0.001c
Aula	0.17 ± 0.01a	0.143 ± 0.002c	1.18 ± 0.07a	98.16 ± 0.37cd	11.70 ± 1.29c	11.83 ± 1.35cd	0.37 ± 0.03a	0.036 ± 0.001b

The means followed by different letters in the same columns are significantly different (LSD, $P < 0.01$).

CI = consumption index, ECI = efficiency of conversion of ingested food, ECD = efficiency of conversion of digested food, RCR = relative consumption rate, RGR = relative growth rate.

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