SRYAHWA PUBLICATIONS

Annals of Ecology and Environmental Science
ISSN: 2637-5338 | Volume 6, Issue 2, 2024
https://doi.org/10.22259/2637-5338.0602006

SHORT COMMUNICATION

The Mole Cricket (*Gryllotalpa orientalis*) Preys on Underground Weed Seeds

Inagaki Hidehiro*, Yonechi Yu, Nakada Haruyuki, Kunwar Ishwor Jung, Inako Rina, Matsuda Sae, Naruse Hiroyuki, Naruse Kazuko

Faculty of Agriculture, Shizuoka University, Japan.

Received: 05 November 2024 Accepted: 10 December 2024 Published: 19 December 2024

Corresponding Author: INAGAKI Hidehiro, Faculty of Agriculture, Shizuoka University, Japan.

Abstract

In recent years, predation pressure from seed predators that reduces weed populations has garnered attention as a significant ecosystem service for integrated weed management (IWM). However, previously reported seed predator species feed only on seeds on the ground surface. In contrast, this study indicates that the mole cricket (*Gryllotalpa orientalis*) preys on seeds buried underground.

This study observed that adult mole crickets did not demonstrate a clear preference between preying on seeds and seedlings, whether on the surface or underground. In contrast, the larvae preyed more on the seedlings than on the seeds. Additionally, underground seeds and seedlings were preyed upon more often than those on the surface. In a preference test using ryegrass and clover, adult mole crickets preyed more on the ryegrass, whereas larvae exhibited individual differences and no clear preference.

1. Introduction

To achieve sustainable agriculture, increasing beneficial biodiversity through ecosystem services is gaining attention (Moonen and Bàrberi, 2008). To date, research on functional biodiversity has primarily focused on using native natural enemies that prey on insect pests. Additionally, in recent years, predation pressure from seed predators that reduces weed populations has been recognized as a significant ecosystem service in integrated weed management (IWM) (Bàrber et al. 2010; Westerman et al. 2003, 2005). Previous studies have identified arthropod predators of weed seeds, including ground beetles, crickets (Stinner and House 1987; Ichihara et al. 2011), ants (Baraibar et al. 2009; Mares and Rosenzweig 1978), pill bugs (Saska 2008), and millipedes (Koprdová et al. 2010). However, these arthropods primarily feed on seeds at the ground surface (Abramsky 1986; Yamashita and Kobayashi 2007; Ichihara 2014). This is a limitation when considering seed bank reduction (Reichman 1979).

This study reports that the subterranean mole cricket (*Gryllotalpa orientalis*) is a seed predator that preys on seeds buried underground.

2. Materials and Methods

2.1 Study Field

This study was conducted in a greenhouse at the Center for Education and Research in Field Sciences, Shizuoka University (Kariyado, Fujieda City, Shizuoka Prefecture, Japan; 34°54’18.8” N, 138°16’19.7” E). Watering in the greenhouse was performed once daily.

2.2 Study Species and Sample

The oriental mole cricket (*Gryllotalpa orientalis*) (Orthoptera: Gryllotalpidae) is widely distributed across Japan, China, the Korean Peninsula, and Taiwan (Townsend 1983). This species has two forms—macropterous (LW) and brachypterous (SW) (Endo 2006). Mole crickets captured in Shizuoka and Gifu prefectures in Japan were divided into 6, 5, 2, and 12 LW males, LW females, SW females, and

Citation: INAGAKI Hidehiro, Yonechi Yu, Nakada Haruyuki, *et al*. The Mole Cricket (*Gryllotalpa orientalis*) Preys on Underground Weed Seeds. Annals of Ecology and Environmental Science. 2024; 6(2): 73-76.

larvae, respectively. No SW males were observed among the captured specimens. The body length and weight of each individual were measured before the experiment.

2.3 Plant Materials

Italian ryegrass (*Lolium multiflorum*) and red clover (*Trifolium pratense*) were used. Seeds and pre-germinated seedlings (5–10 cm) were prepared for both the species. Although these plants are used as pasture grasses, they have become weeds in agricultural fields and along roadsides in Japan.

2.4 Exp 1. Understanding the Relationship between Mole Cricket Traits and Seed Predation Ability

Wagner pots (1/2000a) were filled with field-collected light-colored Andosol soil to a depth of 23 cm. Ryegrass seeds and seedlings (20 each) were planted 3 cm deep in the same pot. Adult mole crickets (13) and larvae (12) were released (one per pot). Subsequently, the pots were covered with insect nets. The remaining ryegrass seeds and seedlings were counted on alternate days for seven days from the start of the experiment (November 3, 2023).

2.5 Exp 2. Survey on Mole Cricket Preferences for Various Weed Species

Wagner pots and mole crickets were prepared under conditions similar to those used in experiment 1. In total, 250 ryegrass and 250 clover seeds were sown on the soil surface in each pot. The number of seedlings for each weed species was counted after 13 days. The experiment was conducted on November 11, 2023.

2.5 Data Analysis

The data obtained in this study were analyzed using Bell Curve for Excel 5.0 (Social Survey Research Information Co., Ltd.). An analysis of variance (ANOVA) was performed, and Tukey's multiple range test was conducted to identify significant differences among the treatments, with a 95 % confidence interval (CI) ($\alpha = 0.05$).

3. Results and Discussion

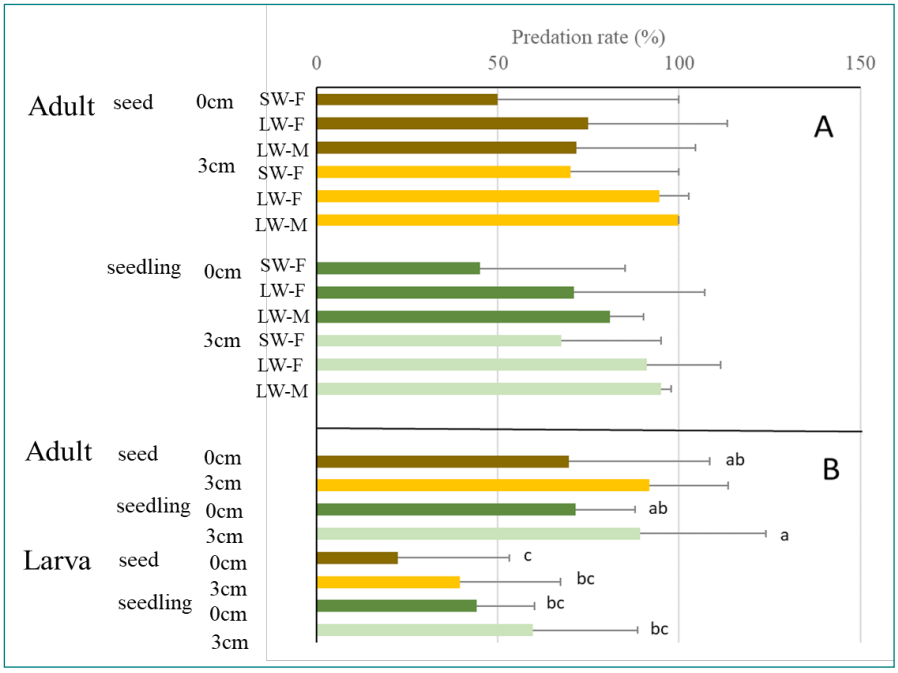

Figure 1. *The relationship between mole cricket traits and seed predation.*

A: Comparison by adult type. SW-F: brachypterous type-female, LW-F: macropterous type-female, and LW-M: macropterous type-male.

B: Comparison of larvae and adults.

Bars represent the standard deviation. Different lowercase letters indicate significant differences based on Tukey's multiple test at the 5 % significance level.

Both adult and larval mole crickets preyed on the seeds and seedlings at both the surface (0 cm) and 3 cm depths. This confirms that mole crickets are seed predators of weeds. Notably, mole crickets consume seeds both on the surface and below the ground. In cultivated fields, weed seeds are distributed both underground and on the soil surface (Kobayashi et al. 2005). However, numerous arthropods, such as ground beetles, crickets, and ants, feed only on surface weed seeds and cannot access those buried underground (Abramsky 1986; Yamashita and Kobayashi 2007; Ichihara 2014). In contrast, our data indicate that mole crickets feed on seeds buried in the soil.

In comparison of the types, SW females preyed less than that of LW females and males (Fig. 1A). The LW type may prey more because of their higher energy requirement for migration and dispersal. However, this tendency was unclear because there were only two SW females in this study. Moreover, no differences were observed in the amount of prey consumed by the LW males and females (Fig. 1A).

The adult mole crickets demonstrated no clear preference between seeds and seedlings at either 0 or 3 cm (Fig. 1B). However, preying at 3 cm was slightly higher than that at 0 cm. (Fig. 1B). In contrast, the larvae preyed less on 0 cm seeds and slightly more on 3 cm seeds. Additionally, seedlings were consumed more than seeds (Fig. 1B), with a higher preference for 3 cm seedlings over 0 cm seedlings (Fig. 1B). This indicates that the larvae prefer seedlings over seeds and favor underground seeds and seedlings rather than those on the surface. Numerous aspects of the biology of underground mole crickets are unknown. However, our data indicate that mole cricket larvae are less active on the surface and spend more time underground than the adults. Additionally, mole cricket larvae preferred to feed on soft-germinated seedlings rather than on hard seeds. In comparison, adults consumed significantly more prey than that of the larvae, whether seeds or seedlings.

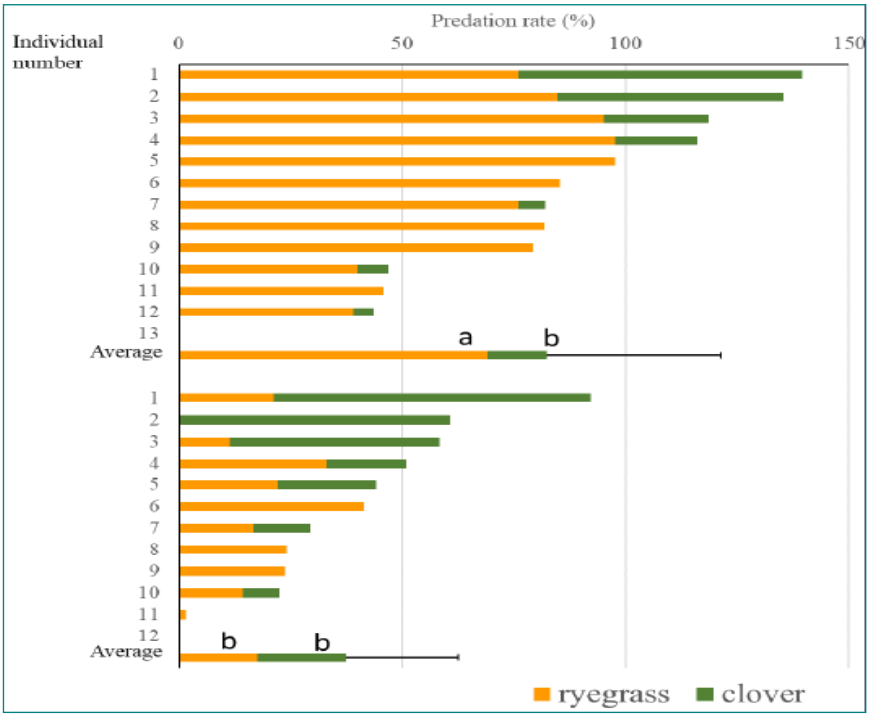

Figure 2. *Mole cricket preferences for ryegrass and clover.*

A: Comparison by adult type. SW-F: brachypterous type-female, LW-F: macropterous type-female, and LW-M: macropterous type-male.

B: Comparison of larvae and adults.

Bars represent the standard deviation. Different letters indicate significant differences based on Tukey's multiple test at the 5 % significance level.

All adult mole crickets preyed more on ryegrass (Poaceae) than clover (Leguminosae), indicating a preference for seed predation. In Japan, Poaceae weeds on cultivated land are a serious issue because they serve as breeding sources for stink bugs, which are pests of rice paddies (Inagaki et al. 2020). Therefore, mole crickets are anticipated to contribute to the control of harmful weed populations.

However, while larvae 4–11 preferred feeding on barley grass over clover, larvae 1–3, which preyed more, preferred ryegrass over clover, indicating individual differences in preference. The preferences of seed predators have been studied in herbivorous beetles, with seed size and surface structure being influential factors (Lundgren and Rosentrater 2007; Zhang et. al. 1997). The factors influencing seed preference in mole crickets remain a topic for future research.

Our results confirm that mole crickets are seed predators that prey on weed seeds both on the ground surface and underground. However, because mole crickets are omnivorous and are sometimes considered

pests in root vegetable fields, caution is advised. However, the effects of seed predation by mole crickets on weed populations remain unclear.

4. References

1. Abramsky, Z. (1983). Experiments on seed predation by rodents and ants in the Israeli desert. Oecologia, 57, 328–332.
2. Baraibar, B., Westerman, P. R., Carrión, E., and Recasens, J. (2009). Effects of tillage and irrigation in cereal fields on weed seed removal by seed predators. Journal of Applied Ecology, 46(2), 380–387. https://doi.org/10.1111/j.1365-2664.2009.01614.x
3. Bàrber, P., Burgio, G., Dinelli, G., Moonen, A. C., Otto, S., Vazzana, C., and Zanin, G. (2010). Functional biodiversity in the agricultural landscape: relationships between weeds and arthropod fauna. Weed Research, 50(5), 388–401. https://doi.org/10.1111/j.1365-3180.2010.00798.x
4. Endo, C. (2006). Seasonal wing dimorphism and life cycle of the mole cricket *Gryllotalpa orientalis* (Orthoptera: Gryllotalpidae). European Journal of Entomology, 103(4), 743–750.
5. Ichihara, M., Maruyama, K., Yamashita, M., Sawada, H., Inagaki, H., Ishida, Y., and Asai, M. (2011). Quantifying the ecosystem service of non-native weed seed predation provided by invertebrates and vertebrates in upland wheat fields converted from paddy fields. Agriculture, Ecosystems & Environment, 140(1–2), 191–198. https://doi.org/10.1016/j.agee.2010.12.002
6. Ichihara, M., Uchida, S., Fujii, S., Yamashita, M., Sawada, H., and Inagaki, H. (2014). Weed seedling herbivory by field cricket *Teleogryllus emma* (Orthoptera: Gryllidae) in relation to the depth of seedling emergence. Weed Biology and Management, 14(2), 99–105. https://doi.org/10.1111/wbm.12035
7. Inagaki, H., Saiki, C., Ichihara, M., Matsuno K., Tanno, Y., Yamashita, M. and Sawada, H. 2020. Effect of Mowing Height on Dominance of Annual Poaceae Plants. Journal of Ecological Engineering. 21(1), 8-13 https://doi.org/10.12911/22998993/113627
8. Koprdová, S., Saska, P., Honěk, A., and Martinková, Z. (2010). Seed consumption by millipedes. Pedobiologia, 54(1), 31–36. https://doi.org/10.1016/j.pedobi.2010.08.005
9. Lundgren, J. G., and Rosentrater, K. A. (2007). The strength of seeds and their destruction by granivorous insects. Arthropod-Plant Interactions, 1, 93–99.
10. Mares, M. A., and Rosenzweig, M. L. (1978). Granivory in north and south American deserts: rodents, birds, and ants. Ecology, 59(2), 235–241. https://doi.org/10.2307/1936368
11. Moonen, A.C., and Bàrberi, P. (2008). Functional biodiversity: An agroecosystem approach. Agriculture, Ecosystems & Environment, 127(1–2), 7–21. https://doi.org/10.1016/j.agee.2008.02.013
12. Reichman, O. J. (1979). Desert granivore foraging and its impact on seed densities and distributions. Ecology, 60(6), 1085–1092. https://doi.org/10.2307/1936954
13. Saska, P. (2008). Granivory in terrestrial isopods. Ecological Entomology, 33(6), 742–747. https://doi.org/10.1111/j.1365-2311.2008.01026.x
14. Stinner, B. R., and House, G. J. (1987). Arthropods in conservation tillage Systems. Miscellaneous Publications of the Entomological Society of America. https://doi.org/10.4182/IOSY8312.65.v
15. Townsend, B.C. (1983). A revision of the Afrotropical mole crickets (Orthoptera: Gryllotalpidae). Bulletin of the British Museum (Natural History), Entomology, 46(2), 175–203.
16. Westerman, P. R., Wes, J. S., Kropff, M. J., and Van Der Werf, W. (2003). Annual losses of weed seeds due to predation in organic cereal fields. Journal of Applied Ecology, 40(5), 824–836. https://doi.org/10.1046/j.1365-2664.2003.00850.x
17. Westerman, P. R., Liebman, M., Menalled, F. D., Heggenstaller, A.H., Hartzler, R.G., and Dixon, P.M. (2005). Are many little hammers effective? Velvetleaf (*Abutilon theophrasti*) population dynamics in two- and four-year crop rotation systems. Weed Science, 53(3), 382–392. https://doi.org/10.1614/WS-04-130R
18. Yamashita, N., and Kobayashi, H. (2007). Carabid beetle (*Harpalus sinicus* Hope) predates barnyardgrass seeds on the soil surface, but hardly does the seeds buried under soil. Tohoku weed Journal, 7, 17–20.
19. Zhang, J., Drummond, F. A., Liebman, M., and Hartke, A. (1997). Insect predation of seeds and plant population dynamics. MAFES Technical Bulletin 163, 1–32.