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Notes and Comments

# Can dehydrated sewage sludge, used as fertilizer, affect arthropods on *Platycyamus regnellii* (Fabaceae)?

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Sewage sludge is a byproduct of sewage treatment, rich in N and P, which can be used as soil fertilizer in forest plantations and in degraded areas recovery (Mota et al., 2021). *Platycyamus regnellii* (Benth) (Fabales: Fabaceae) is a tree used in environmental recovery and its hardwood is used in home construction (Ferreira et al., 2015). Tree development and growth are essential to assess the recovery of an environment, because the structure, biomass, and diversity of vegetation are related to ecosystem functions and fauna colonization (Monteiro et al., 2019). The arthropod biodiversity is susceptible to environmental conditions and the presence of some functional groups is an indicator of the success of environmental recovery (Burgio et al., 2015). There is a lack of studies evaluating *P. regnellii* on recovery of degraded areas and the arthropod fauna feeding and/or living on this plant. The objective was to evaluate, for 24 months, the ecological indices of arthropods on *P. regnellii* saplings (young trees) in a degraded area using or not dehydrated sewage as a fertilizer.

The study was carried out in a degraded area on the campus of the "Universidade Federal de Minas Gerais" in Montes Claros, Minas Gerais, Brazil (latitude 16°51' S, longitude 44°55' W, altitude 943 m) from March 2018 to February 2020. The experimental design was completely randomized with two treatments (20 L of dehydrated sewage sludge per plant or without it), with 24 replications and one plant each. Information on climatic conditions, soil, characteristics of the dehydrated sewage sludge, seedling production, spacing between plants in the field, irrigation, and fertilization in this area are available (Gomes, 2018). The leaves per branch were measured monthly by visual observation on 48 *P. regnellii* saplings. Insect defoliation was evaluated visually by the leaf area losses on a 0–100% scale with 5% increments for removed leaf area (Mota et al., 2021). The sum of data (i.e. 12 leaves/sapling/survey) from a single sapling was used. Ecological indices (abundance, diversity, and species richness) were calculated per group of arthropods (i.e. coleopterans and spiders) and treatment (fertilization or not with dehydrated sewage sludge). Abundance and species richness were the total number of individuals and species, respectively, per sapling. The diversity was calculated using Hill´s formula per sapling. The abundance, diversity, and species richness of arthropods, and leaves per branch were submitted to the non-parametric statistical hypothesis Wilcoxon signed-rank test ($P < 0.05$).

*Platycyamus regnellii* saplings fertilized with dehydrated sewage sludge produced significantly ($P < 0.05$) more leaves/branch per sapling (7.56 ± 0.29) compared to unfertilized ones (5.58 ± 0.23). The defoliation, abundance and species richness of chewing insects, species richness of natural enemies, and number of *Eumolpus* sp. (Coleoptera: Chrysomelidae), Araneidae (Araneae), *Oxyopes salticus* Hentz (Araneae: Oxyopidae), and tending ants (Hymenoptera: Formicidae) were higher on *P. regnellii* saplings fertilized with dehydrated sewage (Table 1).

These results may be due to the greater biomass (leaves) as a result of fertilization, a food resource with high quality for these chewing insects, attracting their natural enemies (predator following prey). Insect herbivore populations may also have a positive association with N and P levels in the soil (Joern et al., 2012). Differences in plant quality reflect the availability of soil nutrients which may affect plant morphology and quality (Chau and Heinz, 2006). This influences the preference of these insects (Sarfraz et al., 2009), attracting a higher number of natural enemies, as on *Acacia mangium* (Fabaceae) trees fertilized with sewage sludge (Silva et al., 2020). Natural enemies (e.g., spiders) prey insects and thus are important, in natural and agricultural systems (Sunderland and Samu, 2000), reducing pest numbers such as reported for *Epiphyas postvittana* Walker (Lepidoptera: Tortricidae) on *Malus domestica* (Borkh.) Borkh. (Rosales: Rosaceae) (Hogg et al., 2017). This fact may explain the low rate of herbivory (≈5%) observed in fertilized *P. regnellii* saplings. Spiders may reduce herbivory, even when they

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**Table 1.** Abundance, diversity, and species richness of arthropods (Indices), the number of individuals/species of herbivore, natural enemies, and pollinators per *Platycyamus regnelli*/sapling (mean ± SE) fertilized or not, with sewage sludge.

| Indices and number of individuals/species | Sewage sludge | | WT* | |
|---|---|---|---|---|
| **Herbivore insects** | **With** | **Without** | ***VT*£** | ***P*** |
| Abundance of Coleoptera | 0.46 ± 0.13 | 0.29 ± 0.11 | 1.0 | 0.17 |
| Diversity of Coleoptera | 0.18 ± 0.09 | 0.18 ± 0.09 | 0.0 | 0.50 |
| Species richness of Coleoptera | 0.38 ± 0.11 | 0.25 ± 0.09 | 0.7 | 0.24 |
| Abundance of chewing insects | 6.08 ± 3.68 | 4.83 ± 4.18 | 1.8 | 0.03 |
| Diversity of chewing insects | 0.83 ± 0.34 | 0.76 ± 0.33 | 0.1 | 0.47 |
| Species richness of chewing insects | 1.17 ± 0.20 | 0.71 ± 0.18 | 1.7 | 0.04 |
| Defoliation (%) | 5.51 ± 0.44 | 1.70 ± 0.16 | 7.2 | 0.00 |
| Coleoptera: Chrysomelidae: *Alagoasa* sp. | 0.08 ± 0.08 | 0.00 ± 0.00 | 1.0 | 0.16 |
| *Eumolpus* sp. | 0.13 ± 0.06 | 0.00 ± 0.00 | 1.8 | 0.04 |
| *Walterianella* sp. | 0.08 ± 0.05 | 0.13 ± 0.06 | 0.5 | 0.32 |
| *Wanderbiltiana* sp. | 0.08 ± 0.05 | 0.13 ± 0.09 | 0.0 | 0.48 |
| Curculionidae: *Lordops* sp. | 0.08 ± 0.05 | 0.04 ± 0.04 | 0.6 | 0.28 |
| Isoptera:Termitidae: *Nasutitermes* sp.§ | 4.79 ± 3.70 | 4.17 ± 4.16 | 0.5 | 0.29 |
| Lepidoptera | 0.00 ± 0.00 | 0.04 ± 0.04 | 1.0 | 0.16 |
| Orthoptera: Romaleidae: *Tropidacris collaris* (Stoll) | 0.46 ± 0.15 | 0.17 ± 0.07 | 1.0 | 0.08 |
| Tettigoniidae | 0.38 ± 0.14 | 0.17 ± 0.07 | 1.0 | 0.14 |
| Natural enemies and pollinators | | | | |
| Abundance of spiders | 2.75 ± 1.89 | 0.58 ± 0.16 | 0.9 | 0.19 |
| Diversity of spiders | 0.60 ± 0.30 | 0.46 ± 0.19 | 0.1 | 0.47 |
| Species richness of spiders | 0.83 ± 0.21 | 0.50 ± 0.14 | 1.0 | 0.15 |
| Abundance of natural enemies | 3.67 ± 1.90 | 0.96 ± 0.23 | 1.5 | 0.07 |
| Diversity of natural enemies | 2.33 ± 0.95 | 1.02 ± 0.34 | 0.5 | 0.31 |
| Species richness of natural enemies | 1.63 ± 0.36 | 0.75 ± 0.16 | 1.9 | 0.03 |
| Araneae: Anyphaenidae: *Teudis* sp. | 0.00 ± 0.00 | 0.04 ± 0.04 | 1.0 | 0.16 |
| Araneidae | 2.08 ± 1.86 | 0.00 ± 0.00 | 2.3 | 0.01 |
| Arachnida: *Tmarus* sp. | 0.08 ± 0.05 | 0.00 ± 0.00 | 1.4 | 0.08 |
| Salticidae | 0.04 ± 0.04 | 0.00 ± 0.00 | 1.0 | 0.16 |
| *Aphirape uncifera* (Tullgren) | 0.08 ± 0.05 | 0.13 ± 0.09 | 0.0 | 0.48 |
| *Uspachus* sp. | 0.00 ± 0.00 | 0.08 ± 0.05 | 1.4 | 0.08 |
| Sparassidae: *Quemedice* sp. | 0.04 ± 0.04 | 0.17 ± 0.09 | 1.1 | 0.15 |
| Oxyopidae | 0.04 ± 0.04 | 0.04 ± 0.04 | 0.0 | 0.50 |
| *Oxyopes salticus* | 0.21 ± 0.08 | 0.04 ± 0.04 | 1.7 | 0.04 |
| Tetragnathidae: *Leucauge* sp. | 0.08 ± 0.08 | 0.08 ± 0.08 | 0.0 | 0.50 |
| Thomisidae: *Aphantochilus rogersi* O. P.-Cambridge | 0.08 ± 0.05 | 0.00 ± 0.00 | 1.4 | 0.08 |
| Hymenoptera: Apidae: *Apis mellifera* L. | 0.04 ± 0.04 | 0.00 ± 0.00 | 1.0 | 0.16 |
| Braconidae | 0.04 ± 0.04 | 0.00 ± 0.00 | 1.0 | 0.16 |
| Formicidae: tending ants | 0.63 ± 0.18 | 0.25 ± 0.13 | 2.1 | 0.02 |
| Vespidae: *Polybia* sp. | 0.04 ± 0.04 | 0.00 ± 0.00 | 1.0 | 0.16 |

*WT = Wilcoxon test. £VT = value of the test. § = observed in trunk.

not prey, because herbivore insects avoid plants with a high density of predators, choosing other host plants (Bucher et al., 2015). The number of tending ants was higher on fertilized saplings, probably due to the greater number of spiders on these plants. Some ant species recruit workers on plants with clues left by spiders (e.g. silk webs), to protect herbivores from predation in exchange to some resource (e.g. honeydew) (Bucher et al., 2015). But plants can suppress herbivore populations through varying levels of nutrients. This can be central in natural systems (Wetzel et al., 2016). Thus, this increase in nutrient heterogeneity can be applied to agricultural crops and contribute to the sustainable control of insect pests in agroecosystems (Wetzel et al., 2016).

The fertilization with dehydrated sewage sludge increases ecological indices of insects, including natural enemies (e.g., spiders), on *P. regnellii* saplings, with a low rate of herbivory, and should be used in recovering plans of degraded areas.

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