Sewage sludge application affects the fecundity of the Rose Grain aphid

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Introduction

The recycling of sewage sludge by its application to agricultural soils is economic both in terms of direct costs and off-setting some of the cost of inorganic fertiliser through the addition of useful amounts of N and P to the soil.

Amending soil with sewage sludge can also have beneficial effects on arthropod species within agroecosystems (1), but detrimental effects can also occur due the presence of potential toxic elements such as Cd and Zn in sludges. This work investigates the effect of amending soil with sewage sludge on the fecundity of an important pest of cereal crops, the rose grain aphid.

Figures

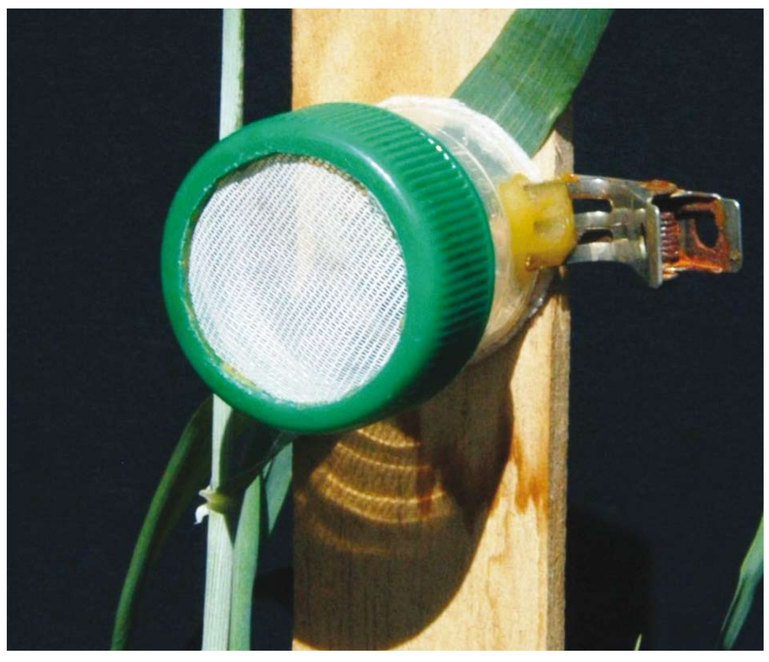

Figure 1 - Clip cage setup used to isolate mature aphids

Figure 2 - A mature and offspring inside the cage.

The experiment

A sandy loam soil was amended with digested sewage sludge 'cake' at four treatment rates (0, 10, 30 or 100 t (dry solids) ha^{-1}). Six 7.5 litre pots were filled with the soil from each treatment before seeding with winter wheat (*Triticum aestivum* L. cv. Challenger). One hundred rose grain aphids (*Metopolophium dirhodum* Walk.) were placed on the plants during tillering. At the same time, 3 clip cages were set up in each pot (Figure 1 & 2) and one adult aphid was isolated in each cage. Pots were then covered with netting and placed in a randomised block in a glasshouse. After 7, 14 and 21 days the number of offspring produced by each aphid was counted and samples of the plant shoots and the aphid populations were taken from each pot. Plant samples were analysed for N content and aphid samples for Cd and Zn concentration.

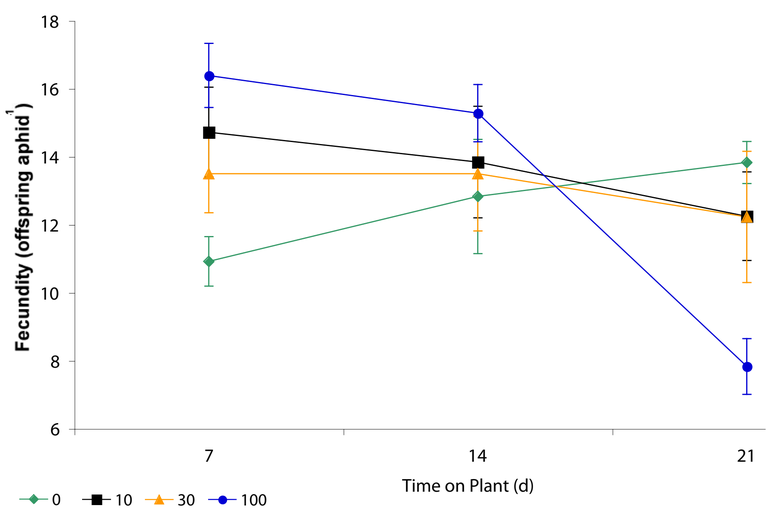

Figure 3 - Fecundity of rose grain aphids following the amendment of soil with sewage sludge at rates of 0, 10, 30 and 100 t ha^{-1} (error bars ± 1 SE).

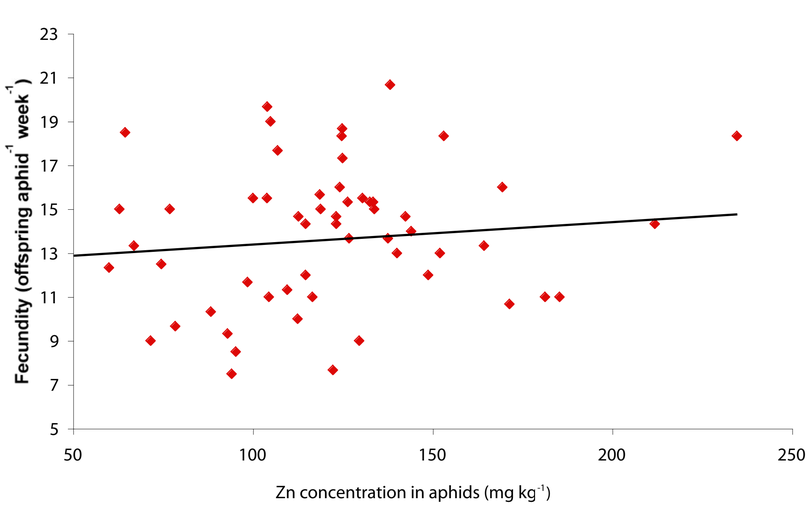

Figure 4 - The relationship between fecundity of rose grain aphids and the Zn concentration in the aphid populations.

Findings

- During the first 7 days, fecundity was highest in the 100 t ha^{-1} sludge treatment, but between days 14-21 this treatment had the lowest fecundity (Figure 3)
- Significant differences in fecundity were found among treatments between days 0 - 7 ($F = 4.76$, $P = 0.12$) and days 14 - 21 ($F = 4.46$, $P = 0.016$).
- Significant change in fecundity over time was found in the 100 t ha^{-1} treatment only ($F = 28.7$, $P < 0.001$).
- There was no significant relationship between fecundity and shoot N concentration ($r = 0.07$, $P = 0.60$) or between fecundity and Cd concentration in the Aphids ($r = 0.04$, $P = 0.77$)
- A small, positive relationship was found between fecundity and the concentration of Zn in aphids (Figure 4: $r = 0.26$, $P = 0.04$).

Discussion and Conclusions

- The fecundity of aphids has been reported to be positively correlated with the N content of the plant (2), but this parameter could not explain the changes in fecundity observed in the present study.
- The observed pattern of fecundity in the 100 t ha^{-1} sludge treatment suggests that the aphids accumulated a toxic substance(s) over time to a point where their ability to effectively detoxify the substance(s) is exceeded and toxicity reduces fecundity.
- The potentially toxic elements Cd and Zn are readily transferred through the soil-pant system and are biomagnified in aphids (3). However, the accumulation of these metals was not negatively correlated with fecundity.
- It has been suggested that defensive secondary metabolites can have an accumulative toxic effect on aphids (4) and they have been shown to reduce aphid fecundity (5).
- We therefore speculate that the pattern of fecundity observed in the 100 t ha^{-1} treatment was due to the increased nutrient supply to the plant provided by the sludge. This initially increased aphid fecundity by increasing the food quality of the plant, but eventually the accumulation of defensive secondary metabolites by the aphids reduced fecundity.

References
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