Responses of soil ecosystem functions to tillage and fertilization in a 35-years' vineyard experiment

Martin Pingel, Deniz Uzman, Annette Reineke and Ilona Leyer

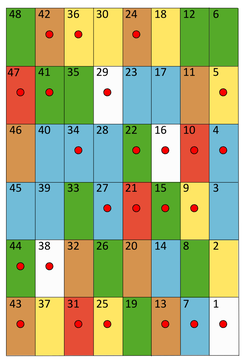
Hochschule Geisenheim University

Introduction

Viticultural soil management techniques such as soil cover treatment and fertilisation have strong effects on soil processes and ecosystem functions. However, large gaps in knowledge exist especially in a long-term context.

We analysed the effects of **cover treatment (tillage vs. permanent cover)** and **nitrogen fertilisation** on litter decomposition, soil organic matter, and soil nutrients, taking advantage of an experimental vineyard, where these practises have been applied constantly for more than 35 years.

Experimental vineyard



The vineyard is located in Winkel in the German grapevine growing region Rheingau (50°00'N, 8°00'E). It is divided in 48 plots (4 rows x 15 m). They reflect 6 levels of yearly nitrogen fertilisation ranging from 0 - 150 N kg/ha. Every second inter-row is covered with permanent vegetation cover, while the other row is tilled two to three times per year.

Soil sampling took place in the two middle inter-rows of 24 plots. Each level of fertilisation was sampled in 4 replicates.

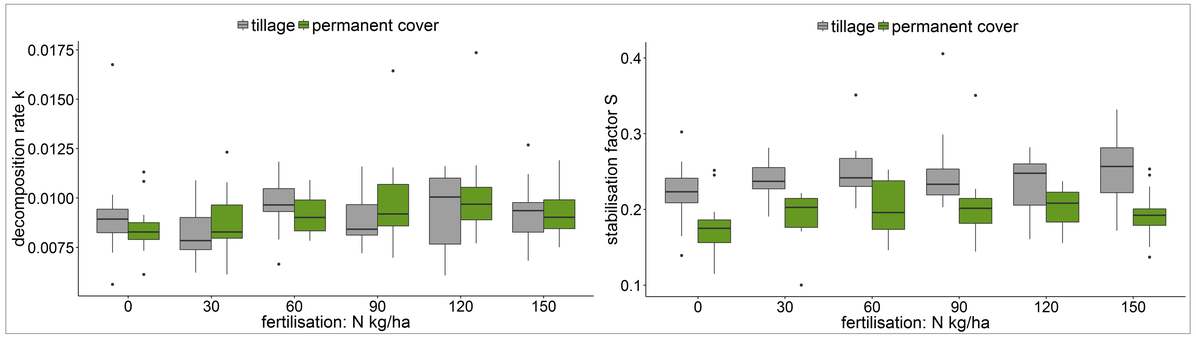
Litter decomposition

Method: The Tea Bag Approach (Keuskamp et al, 2013) has been applied using two types of tea, allowing the calculation of the decomposition rate k as well as the stabilisation factor S. Tea bags were buried at the depth of 10 cm in 5 replicates per management combination for 90 days.

The parameters k and S are influenced by soil biota as well as abiotic factors.

Decomposition rate k describes the slope of the decay in the intermediate stage of the decomposition process.

Stabilisation factor S reflects the alteration of fraction of readily decomposable litter into stable compounds.

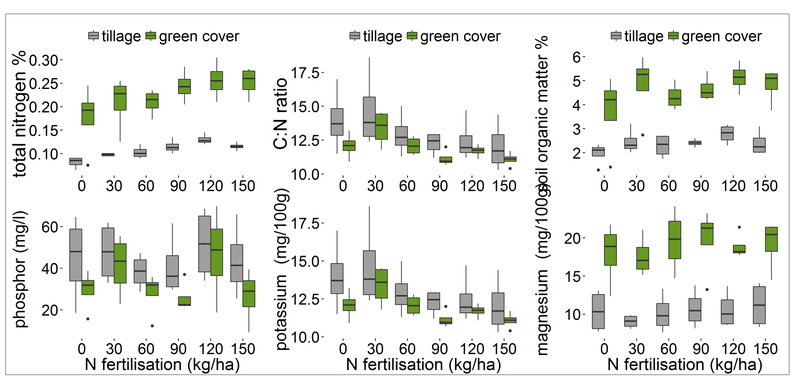


While k does not show any significant response to ground treatment, S is significantly affected by tillage practise ($p = 0.000$). Stabilisation of labile compounds is higher in tilled inter-rows, i.e. litter mass loss in inter-rows with permanent cover is higher. We found no effect of fertilisation.

Soil fertility

Method: One mixed sample of the upper 10 cm top soil were taken per management combination. The samples were analysed for soil organic matter (SOM), total nitrogen (N), and C:N ratios as well as plant available phosphor (P), potassium (K), and magnesium (Mg).

SOM, total N, K, and Mg are significantly higher in inter-rows with permanent cover in comparison to tilled inter-rows ($p < 0.01$). The C:N ratio an P show a contrary pattern ($p < 0.01$). Only total N and C:N ratio respond to nitrogen fertilisation ($p < 0.05$).



Outcome

What do we learn from a long-term vineyard experiment?

1. Tillage of inter-row cover has a much stronger effect on soil ecosystem functions and properties than nitrogen fertilisation.
2. In tilled inter-rows, a higher fraction of readily decomposable litter compounds is transformed to stable compounds.
3. Tilled inter-rows have less soil organic matter, total nitrogen, magnesium, and potassium, but a higher values regarding C:N ratio and plant available phosphor.

References

Keuskamp, J. A., Dingemans, B. J. J., Lehtinen, T., Sarneel, J. M., & Hefting, M. M. (2013). Methods in Ecology and Evolution, 4, 1070–1075. doi:10.1111/2041-210X.12097

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Contact:
Martin Pingel
Geisenheim University, Von-Lade-Str. 1,
65366 Geisenheim, Germany
martin.pingel@hs-gm.de
www.promessing.eu

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