Cover crop choice in dry agricultural regions – A trade-off between farmer and earthworm demands

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Introduction

Seeding cover crops over winter is a farming practice used mainly to impede soil erosion and to suppress weeds (Büchi et al., 2020; De Baets et al., 2011). In addition, cover crops provide food and habitat for soil fauna such as earthworms (Euteneuer et al., 2020). These ecosystem services of cover crops are achieved by covering the soil with plant biomass. Nevertheless, in areas with low precipitation such as North-East Austria, farmers are reluctant to apply cover crops, to reduce seeding costs and to save soil water. Therefore, a trade-off between farmer demands and soil fauna conservation can assist sustainable agriculture.

Materials and methods

To determine the impact of soil moisture on earthworm populations, three annual field trials with different irrigation regimes (irrigated vs rain-fed) have been conducted from 2019–2022 at the University of Natural Resources and Life Sciences, Vienna (Austria). The two irrigation treatments were considered as separate trials and were in complete randomised block design with four replicates for both irrigation regimes.

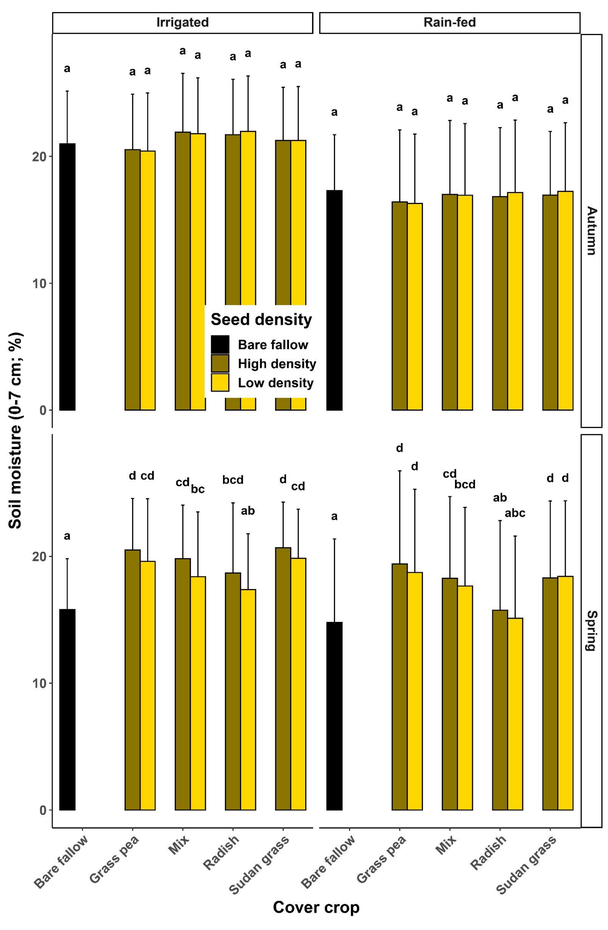

Figure 2: Mean topsoil moisture from August to November (Autumn) and March (Spring) under different cover crop treatments with high or low seed density and two irrigation regimes. Cover crop treatments within irrigation regimes and having no letters in common are significantly different (4-way LMM; Tukey; $P < 0.05$).

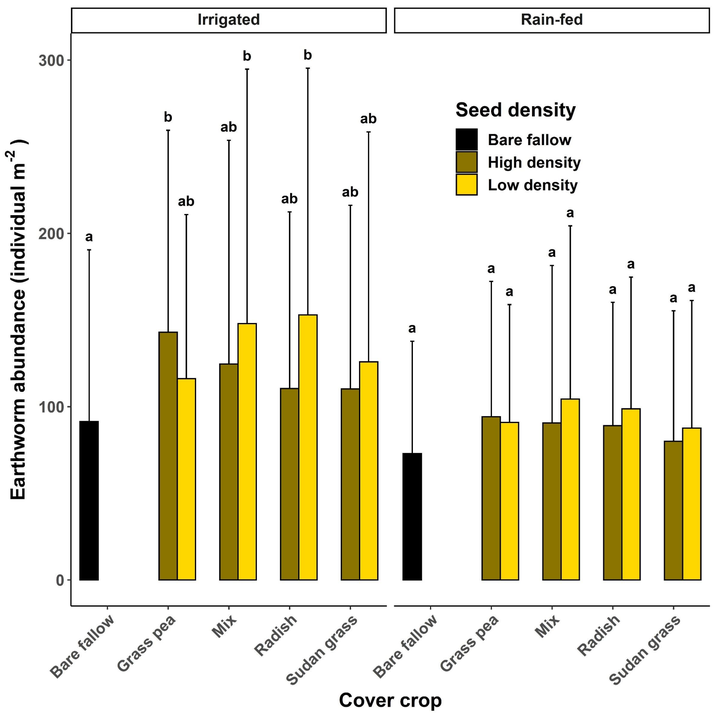

Figure 1: Overall earthworm abundance from autumn 2019 to spring 2022 under different cover crop treatments with high or low seed density and two irrigation regimes. Cover crop treatments within irrigation regimes and having no letters in common are significantly different (3-way LMM; Tukey; $P < 0.05$).

Results and discussion

Preliminary results of earthworm numbers showed interactions of cover crop treatments and seed density with similar abundances among treatments in the rain-fed regime, but highest numbers under irrigation in MIX-LD, RD-LD and GP-HD compared to BF (Fig. 1). Topsoil moisture (0-7 cm) was driest in autumn compared to spring and BF was drier than cover crops except irrigated RD-LD and both rain-fed RDs (Fig. 2). Earthworm numbers and topsoil moisture were linked to cover crop biomass and plant C:N ratio and were also reported by Euteneuer et al. (2020) in a previous trial in the same area. In addition, high cover crop biomass production reduced weed biomass and was affected by year × seed density, while weed biomass showed interactions of cover crop treatments, year and seed density (Fig. 3A). Gfeller et al. (2018) and Wendling et al. (2019) both identified a plant biomass threshold of 3 t/ha to suppress the establishment of weeds and were reached in most of the years (Fig. 3B). An overyielding of MIX compared to sole cover crops as shown by Wendling et al. (2019) was not detected, but MIX-HD showed sufficient weed suppression in all years under irrigated and rain-fed conditions. In a next step, a multivariate analysis could provide further insight and more detailed information about the interaction of cover crops, weeds and earthworm in a dry production area such as North-East Austria.

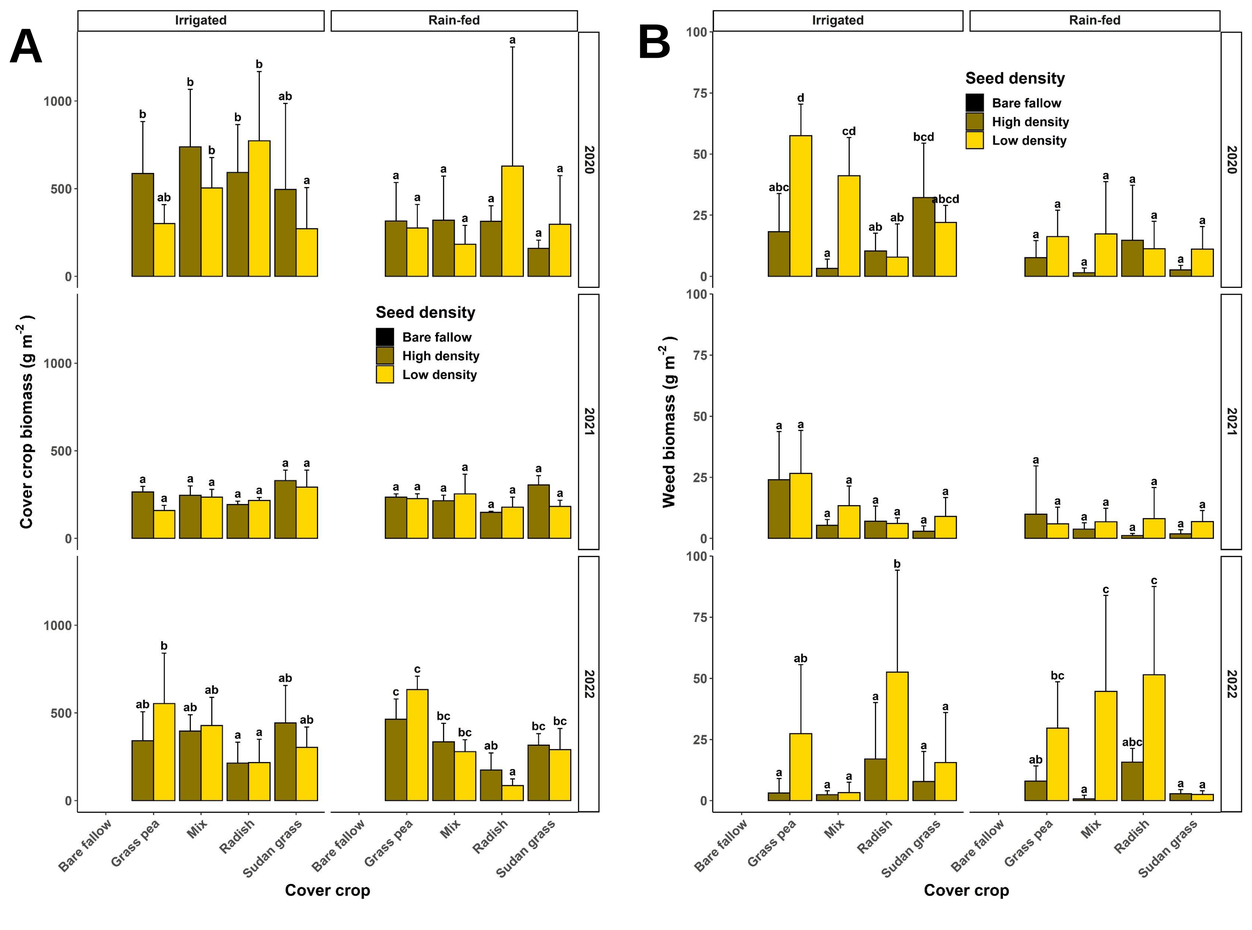

Figure 3: Plant biomass of A) cover crops in high or low seed density under two irrigation regimes and related B) weed biomass. Cover crop treatments within irrigation regimes and having no letters in common are significantly different (4-way LMM; Tukey; $P < 0.05$).

Cover crops used were Sudan grass (SG; *Sorghum sudanese*), grass pea (GP; *Lathyrus sativus*), radish (RD; *Raphanus sativus* var. *longipinnatus*) in single stands, compound (MIX), in high (HD) and low seeding density (LD) and bare fallow (BF) serving as control. Cover crop and weed biomass were cut in November 2019-2021 and earthworms were searched for from soil monoliths of 20×20×30 cm in October 2019-2021, in April 2020, March 2021 and 2022.

Conclusion

Overall, cover crop species with high biomass gains reduced weed biomass, increased topsoil moisture and/or earthworm abundance. MIX combines these benefits and outlines a practicable solution for soil and soil fauna conservation in dry areas.

Büchi, L., Wendling, M., Amossé, C., Jeangros, B., Charles, R., 2020. Cover crops to secure weed control strategies in a maize crop with reduced tillage. Field Crops Res. 247, 107583. https://doi.org/10.1016/j.fcr.2019.107583
De Baets, S., Poesen, J., Meersmans, J., Serlet, L., 2011. Cover crops and their erosion-reducing effects during concentrated flow erosion. CATENA 85, 237–244. https://doi.org/10.1016/j.catena.2011.01.009
Euteneuer, P., Wagentristl, H., Steinkellner, S., Fuchs, M., Zaller, J.G., Piepho, H.-P., Butt, K.R., 2020. Contrasting effects of cover crops on earthworms: Results from field monitoring and laboratory experiments on growth, reproduction and food choice. Eur. J. Soil Biol. 100, 103225. https://doi.org/10.1016/j.ejsobi.2020.103225
Gfeller, A., Herrera, J.M., Tschuy, F., Wirth, J., 2018. Explanations for Amaranthus retroflexus growth suppression by cover crops. Crop Prot. 104, 11–20. https://doi.org/10.1016/j.cropro.2017.10.006
Wendling, M., Charles, R., Herrera, J., Amossé, C., Jeangros, B., Walter, A., Büchi, L., 2019. Effect of species identity and diversity on biomass production and its stability in cover crop mixtures. Agric. Ecosyst. Environ. 281, 81–91. https://doi.org/10.1016/j.agee.2019.04.032