

Effect of agroforestry on diversity of insects in organic arable crops

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Introduction

Agroforestry has been proven as an agricultural practice that contributes to space efficiency, carbon sequestration, improved environmental conditions, and biodiversity conservation. However, the effect of agroforestry may not be clear when it is applied along with other practices such as organic farming. This work evaluates the effect of tree lines of different age and structure on spelt wheat and buckwheat productivity, some soil physical properties and insect biodiversity.

Methods

The yields of buckwheat and spelt wheat were determined in several points located at different distances from the trees. The reference unit of distance was a tree height and its multiple. In case of spelt wheat it was 5, 10 and 15m. For buckwheat 10, 20 and 30m. In order to determine the crop yields the biomass samples were taken using a 0.5m² frame. Soil temperature and moisture were measured using an automatic measuring probe placed in the soil from 5 May to the harvest day - 27 July for spelt wheat and 26 August for buckwheat. The probe took a reading every hour. Biodiversity of insects and other arthropods was assessed using yellow bowls set up for a period of one week in both crops, in triplicate for each distance. In addition, the arthropods were collected with an entomological net. For each distance from the trees, harvesting was done in two 10-m transects once a year. The material was preserved with ethanol. Arthropods were labeled to different levels, orders, families and in selected cases to species.



Results

Tab.1 Yields of straw and grain of organic spelt wheat and buckwheat in different distances from trees

Crop	Distance from the trees	Straw yield in [t/ha]	Grain yield in [t/ha]
Spelt wheat	5 m	2,33	2,27
	10 m	2,14	1,39
	15 m	0,96	0,66
Buckwheat	10 m	1,26	0,22
	20 m	3,76	0,66
	30 m	3,99	0,71

The yields of buckwheat and spelt wheat varied according to distance from the trees. In case of spelt wheat, the highest yield was recorded in the immediate vicinity of the trees (tab.1). This was probably due to the fact that the trees were still relatively young, on average 5 m high, and did not compete with the crop. In case of buckwheat, the trees were mature and exceeded 10 m in height. In the immediate vicinity of the trees, the yield was much lower than in the middle of the field (Tab.1).

For both spelt wheat and buckwheat, the higher soil moisture and the lower temperature were measured near the trees. In buckwheat the average soil moisture was 11,9% at the distance of 10 m from trees, 12,7% at 20 m, and 7,5% at 30 m (Fig. 1). In spelt wheat differences were even larger, in spite of relatively young trees: 5m=17,6%, 10m=13,8%, 15m=9,7. The soil temperature was the same in buckwheat at the distance of 10 and 20 m from trees = 18,1 °C, however at the distance of 30 m it was already 19,9 °C (Fig. 2). In spelt wheat average soil temperature was 17,6 at 5m, 18,5 at 10 m and 19,0 °C at 15m. Differences between temperatures were statistically significant.

The performance of biodiversity indicators did not change significantly with distance to the trees, a slight decrease was found towards the middle of the field. It was observed that the larger distance from trees the higher number of pests. However, the number of natural enemies of pests was higher in the vicinity of the trees (Fig. 3).

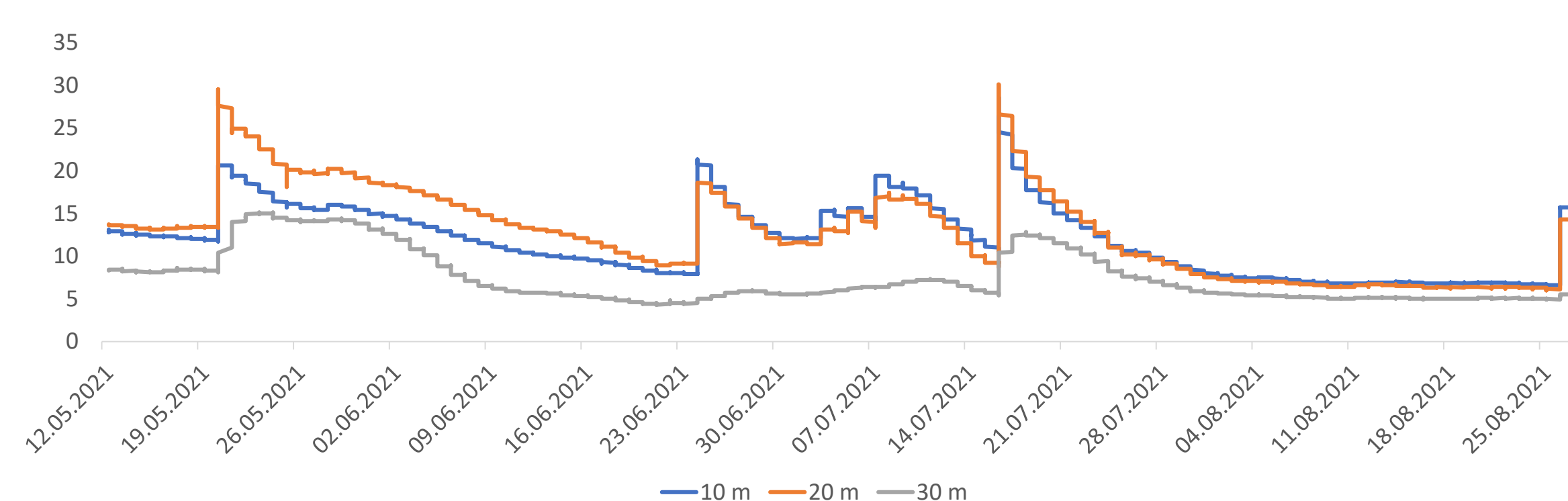


Fig. 1. Soil moisture [%] at 15 cm in buckwheat measured at the different distances from the trees. Differences are significant, $F=1231$, $df=2$, $p<0,01$

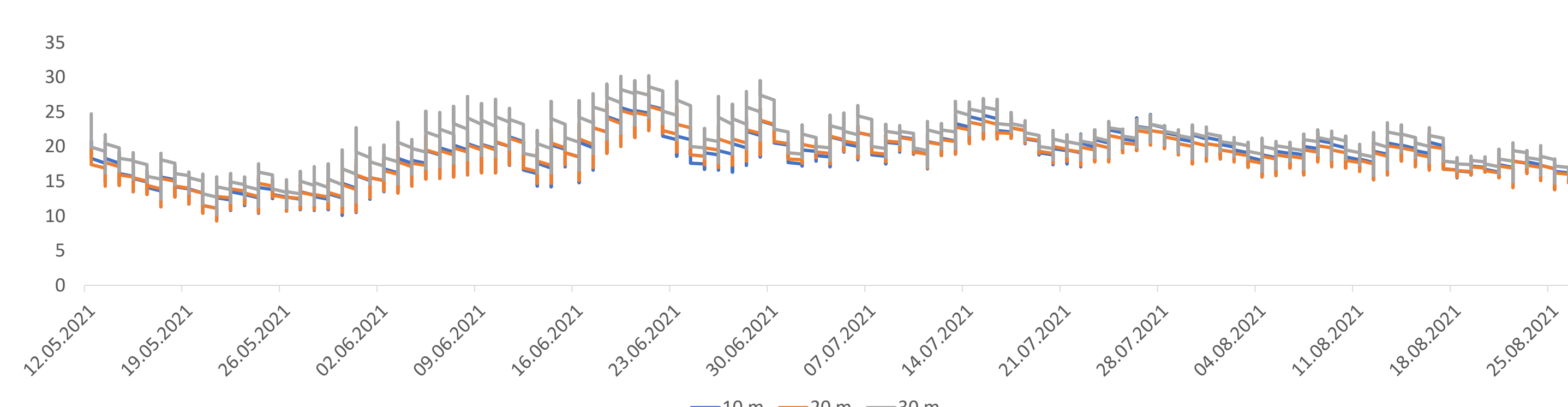
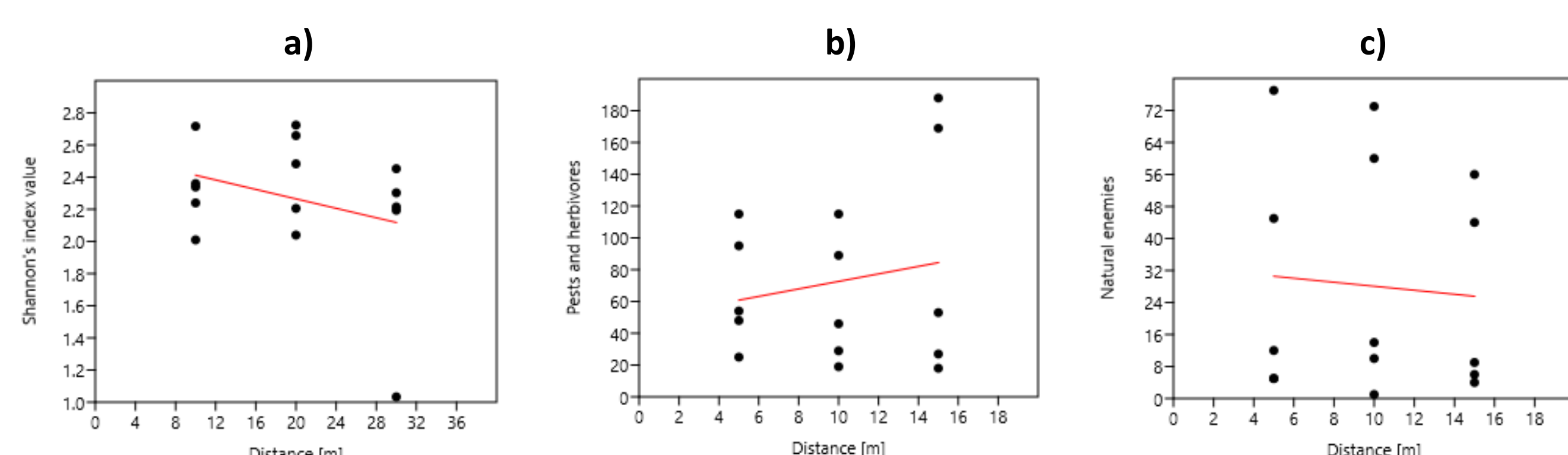


Fig. 1. Soil temperature [°C] at 15 cm in buckwheat measured at the different distances from the trees. Differences are significant, $F=209,6$, $df=2$, $p<0,01$

Spelt wheat



Buckwheat

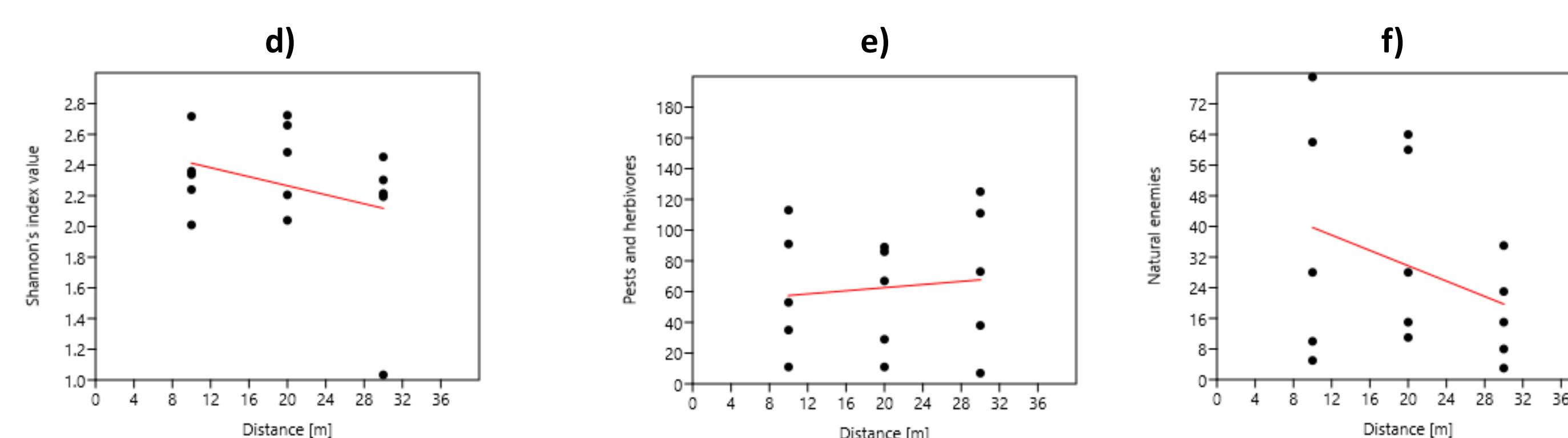


Fig. 3. Correlations between distance from the trees and different insect biodiversity parameters in spelt wheat (a-c) and buckwheat (d-f)

Conclusions

1. For young trees the highest crop yields were noted in their immediate vicinity, while the effect was opposite near mature trees.
2. Higher soil moisture and lower temperature were recorded in the nearest distance from the trees. This may be important in climate change mitigation.
3. There was no significant effect of the tree lines on the insect biodiversity in organic crops. However, a slightly higher number of natural enemies of pests was found near trees in contrast to the number of pests. The tree canopy may improve biological crop protection in organic arable farming.