Agroecology for integrated pest management: impact of shade tree composition and spatial structure on pest infestation in cocoa agroforests.

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Agroecology involves optimizing ecological processes in cropping systems to reduce non-sustainable use of external inputs such as pesticides. Mixed cropping systems are more likely to reduce pest infestations than monocultures. In addition to plant species diversity, their spatial structure may also have an impact on pest infestation. However, very little information is available on this subject. We therefore study the impact of biodiversity, its composition and its spatial structure in pest infestation in complex cocoa agroecosystems.

The mirid *Sahlbergella singularis* is one of the most harmful insects on cocoa trees in Africa. Previous studies have shown that there is less mirid damage in shaded than in unshaded cocoa plantations. Moreover, in complex cocoa agroforestry systems mirid populations are usually aggregated in areas where sunlight is the most intense. Consequently, diffuse and homogeneous shade provided by forest trees is recommended in order to limit sunlit areas, whereas use of more local, and dense shade provided by fruit trees calls for caution. While the horizontal tree structure affects light homogeneity in the understory, its impact on mirid infestation has yet to be tested. Here, we study the impact of forest and fruit tree spatial structures on mirid infestation levels.

This study was conducted in 2012 in eight cocoa agroforestry systems located in the Centre region of Cameroon, selected according to shade tree composition and spatial structure. We distinguished four types of agroforests with two plots in each type. Two agroforest types were mostly composed of forest trees (with a few fruit trees), either with a random (type FoRa) or aggregated tree spatial structure (FoAg). The other two types had a majority of fruit trees, one with a large forest tree component and a random structure for both (FuFoRa), and one with substantially fewer forest trees and regularly distributed fruit trees (FuRe). In all plots, mirid density was sampled in August and mirid damage on cocoa trees was assessed four times over the course of 2012.

FuRe type agroforests were significantly more infested and damaged by mirids than the other agroforests. By contrast, FoRa type agroforests were significantly less infested and damaged than the other agroforests. Lastly, there was no significant difference in mirid infestation and damage between the FoAg and FuFoRa groups, which showed intermediate levels of infestation.

From the results, the recommendation for homogeneous shade provided by large forest trees to reduce mirid impacts seems to be validated. Moreover, a random rather than an aggregated distribution of forest trees reduces mirid impact, probably through the homogeneous shade provided. Lastly, fruit trees can also be associated with cocoa trees, but this association more effectively reduces mirid impacts with randomly distributed forest trees.

This study shows that the spatial organization of plant biodiversity can help in improving integrated pest management schemes and in designing multispecies agroecosystems that minimize pest losses.