European Commission

Science for Environment Policy

Pollination and pest controls can work together to intensify agriculture ecologically

Pollination and pest control are essential to global food production. This study shows that — as well as their individual benefits — they have synergistic effects on yield. Their joint effect increased the yield of oilseed rape by 23%, and the economic benefit from their combined effects was almost twice that of their individual contributions. These findings have implications for sustainable agricultural policy.

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Source: Sutter, L. and Albrecht, M. (2016) Synergistic interactions of ecosystem services: Florivorous pest control boosts crop yield increase through insect pollination. *Proceedings of the Royal Society B: Biological Sciences* 283 (1824): 20152529. DOI: 10.1098/rspb.2015.2529.

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Ecosystem services, the goods and services provided by nature, are crucial for human wellbeing. Rather than acting alone, scientists are beginning to recognise that ecosystem services are interconnected. This means that changes to one service can lead to synergies or trade-offs with another.

Understanding the relationship between ecosystem services could help to increase their delivery. In the agricultural context, this could contribute to long-term food security by increasing crop production, without the threat to ecosystems from more intensive methods of increasing yield, which have been linked to biodiversity loss[1].

This study focused on two ecosystem services that are critical to agriculture: animal-mediated pollination and pest control. Pollination increases and stabilises the yield of around 70% of the world's most important crops (at an estimated value of €153 billion each year), while pests are responsible for the loss of around one third of the potential global crop yield.

Although the individual importance of both pollination and pest control is well recognised, their interactive effects are not well understood. This study investigated their combined effects on oilseed rape (*Brassica napus*), one of the most economically important crops worldwide and a common crop in central Europe. Oilseed rape is efficiently pollinated by insects and has suffered yield losses due to the pollen beetle (*Meligethes aeneus*). The researchers quantified the relative importance of the two factors — as well as their interactive effects — on the quality (measured via the oil content of the seeds) and yield of the crop.

The experiment was conducted in the spring of 2014 in Zurich, Switzerland on a 0.9-hectare area of land sown with oilseed rape in September 2013. The researchers applied four treatments to the area: two pollination treatments (insect pollination or no insect pollination, based on the presence or absence of bumblebee hives) and two pest control levels (experimentally manipulated to be 'weak' and 'strong' based on the number of pollen beetles introduced[2] — the focus here was on the outcome of pest control and not the agent). A total of 24 separate cages were established, which were randomly assigned one of these treatments, allowing six replicates for each treatment. The cages were covered with a fabric that stopped bees and pollen beetles entering or exiting the cages, although there was still the possibility for wind pollination.

Together, insect pollination and pest control increased yield by 23%. Their synergistic effects (10%) contributed more than either of their individual contributions (which were 7% for pollination and 6% for pest control). The researchers also found significant synergistic effects on the oil content of seeds — a marker of quality. Oil content increased by 15 grams (2.2%), which, although a small increase, is economically relevant given the large areas of Europe planted with this crop.

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1. http://www.sciencedirect.com/science/article/pii/S0301479701904736

2. The numbers of beetles in both treatments were at realistic levels for the site.

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The researchers quantified the potential economic value of these effects. The economic benefit for a farmer from their combined effects (a 12% increase in economic gain) was almost twice that of their individual contributions.

They suggest the reason for these strong interactive effects is that pests (beetles) cause the early withering of the plant's flower. This reduces the average number of pollinator visits a flower receives during its lifetime — which is associated with a decline in the number of seeds it produces.

These findings show that insect pollination and pest control can interact in non-linear ways. In other words, their combined value is greater than the sum of their parts. This has significant implications for the yield and economic value of crops. More generally, the findings highlight the importance of considering synergistic effects when calculating the value of ecosystem services.

The findings also have implications for sustainable ecosystem management and future food production. The researchers suggest that measures to enhance crop pollination may not improve yield unless pest-control services are addressed at the same time. They say the integrated management of multiple ecosystem services (exploiting the synergies among them) could be an effective method of 'ecological intensification' (i.e. increasing crop yield without having negative effects on biodiversity or the environment) and recommend more research to understand the interactions between ecosystem services.

They also suggest that future work should address other potential pathways of interactions on a larger scale (field or landscape), including direct interactions between pollinating and pest-control-providing organisms/agents, which may reveal additional pathways for pollination–pest control effects.

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