



Universidad de Oviedo



Nº5

NEST BOXES TO INCREASE PEST CONTROL BY BIRDS

Lever of action 4: Top down processes

Status: Ready to use solution

Experiment leaflet



BACKGROUND

Apple crops are subject to intensification with negative effects for bird communities. For example, cavity-nester birds have more problems in establishing themselves in modern orchards because trees are grown on dwarfing rootstock and they are cavity-poor habitats compared to traditional orchards (Grüebler *et al.*, 2013). The provision of nest boxes is one of the strategies in the ecological restoration of these agroecosystems (Lindell *et al.*, 2018).

We hypothesised that providing nest boxes for insectivorous birds can increase the biological control of arthropod pests by birds (García *et al.*, 2021).



Leaflet authors: M. Miñarro, SERIDA; D. García, University of Oviedo. Design & coordination: A. Alaphilippe, INRAE; Design & layout: B. Rosies, C. Goutines, INRAE. Photos M. Miñarro ©

TARGET PESTS

Many apple pests:

Aphids, weevil, codling moth, tortricids etc.



EXPERIMENT OBJECTIVES

- To assess **nest box occupation by insectivorous birds.**
- To assess **the effect of occupied nest boxes on insectivory** and, particularly, **pest predation.**
- To assess if the various occupying **bird species differ in their role as natural enemies** of apple pests.

EXPERIMENT PROTOCOL

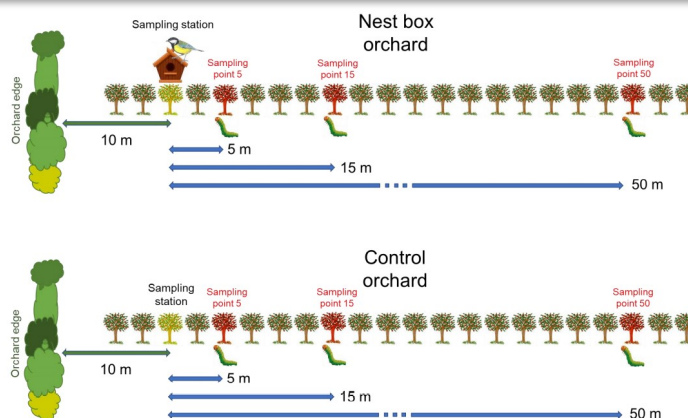
Experimental design

24 cider apple orchards were divided into two groups of 12 orchards each: the nest box group, with 10 nest boxes each, and the control group, without nest boxes.

Each nest box occupied by breeding birds was considered a sampling station, that had in turn three sampling points that were single trees at 5, 15 and 50 m from the occupied nest box.

Nest boxes were made of wood, measured 21.5 × 14.5 × 15.0 cm, and had a 2.6 or 3.2 cm radius entrance hole.

For each nest box orchard, an equivalent sampling design was replicated in its paired control orchard.



Sampling method

We estimated the effects of insectivorous birds in each sampling point through two complementary methods:

- 1) Estimates of bird insectivory based on bird attack on a sentinel pest, mimicked by plasticine green caterpillars
- 2) Measurements of the abundance (biomass and number) of arthropods, and particularly of apple pests, in beating samples from apple trees.

Complementary to the experiments, we took pictures of adult birds to identify the arthropod prey captured for feeding nestlings.

All nest boxes were checked for occupation of breeding birds at the end of April.

EXPERIMENT OVERVIEW

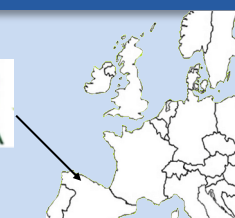
Duration: 2018-2020

Soil: Several types (24 orchards)

Climate: Temperate oceanic

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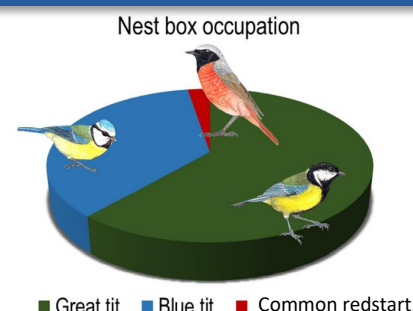


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BIRDS OCCUPY NESTBOXES

Birds occupied for breeding 25.0%, 29.8% and 33.3% of nest boxes in 2018, 2019 and 2020 respectively. The percentage of occupied boxes per orchard and year ranged from 10 to 80%.

Great tit (*Parus major*) was the dominant species in every year (61.4% in total), followed by Eurasian blue tit (*Cyanistes caeruleus*; 36.0%). The occurrence of the common redstart (*Phoenicurus phoenicurus*) was somewhat secondary (2.6%).



BREEDING BIRDS INCREASE INSECTIVORY REDUCING PEST POPULATIONS

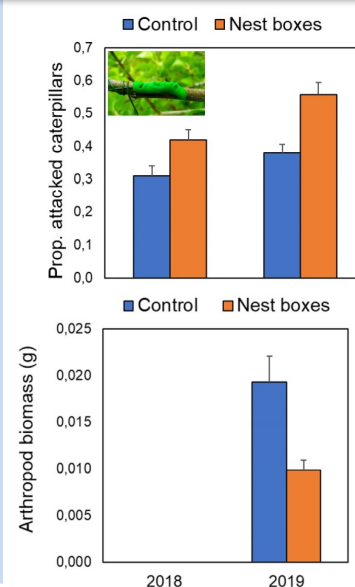
The proportion of replica caterpillars attacked by birds was 35-41% higher in orchards with nest boxes than in control orchards (see first graph right).

In the beating samples, we found that the total biomass of arthropods on the trees was reduced by 51.7% in the nest box orchards in comparison to the control without nest boxes (see second graph). In particular, the probability of the occurrence of apple pests on trees significantly decreased from 60% in the control orchard to 43% in nest box orchards.

No effect of distance in bird insectivory was detected, which means that insectivory was maintained at least up to 50 m from the nest box.

Photos revealed that great tits, blue tits and redstarts caught both herbivores and natural enemies to feed nestlings.

Blue tits had the higher proportion of apple pests in the nestling diet (28.4%), such as woolly, rosy and green aphids and the larvae of blossom weevils.



CONCLUSION AND PERSPECTIVES

We demonstrated the efficacy of installing nest boxes for insectivorous birds as a method of ecological restoration for pest control ecosystem services. We showed that nest boxes placed on apple trees are occupied by birds for breeding and that these breeding birds have an insectivory effect leading to the reduction of arthropods in general, including pest populations.

Here we demonstrated that installing nest boxes produces higher predation activity of natural enemies and a reduced abundance of crop pests, but we did not test a reduction in crop damage. However, we have previously shown, in the same agroecosystem, reductions in foliar damage by aphids associated with predation by birds (García *et al.*, 2018).

FOR MORE INFORMATION

Performance leaflet Nº3.

References:

- García, D., Miñarro, M., Martínez-Sastre, R. (2021). Enhancing ecosystem services in apple orchards: nest boxes increase pest control by insectivorous birds. *Journal of Applied Ecology* 58(3): 465-475.
- García, D., Miñarro, M., Martínez-Sastre, R. (2018). Birds as suppliers of pest control in cider apple orchards: Avian biodiversity drivers and insectivory effect. *Agriculture, Ecosystems and Environment* 254: 233-243.
- Grüebler, M. U., Schaller, S., Keil, H., & Naef-Daenzer, B. (2013). The occurrence of cavities in fruit trees: effects of tree age and management on biodiversity in traditional European orchards. *Biodiversity and conservation*, 22(13-14), 3233-3246.
- Lindell, C., Eaton, R. A., Howard, P. H., Roels, S. M., & Shave, M. E. (2018). Enhancing agricultural landscapes to increase crop pest reduction by vertebrates. *Agriculture, Ecosystems and Environment*, 257, 1-11.



C-IPM Coordinated Integrated Pest Management in Europe

API-Tree (2017-2021) is an ERA-Net C-IPM project coordinated by INRAE with funding from the European Union.





Universidad de Oviedo



Nº3

NEST BOXES TO INCREASE APPLE PEST CONTROL BY BIRDS

Lever of action 4: Top-Down processes

Status: Ready-to-use solution



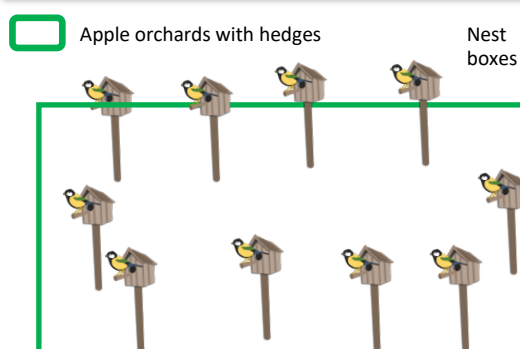
DESCRIPTION OF THE PRACTICE

What? Installation of nest boxes for insectivorous birds within the orchard.

Why? To increase the abundance of breeding birds in the orchard and to enhance bird insectivory in the orchard in spring to reduce apple pest populations.



IMPLEMENTATION TESTED



Nest boxes were placed:

- At a distance of 10 m from the orchard edge (in order to facilitate occupation by forest-dwelling birds)
- On trees separated 15 m from each other.

Conditions for use: All climatic zones.

Possible interactions: Broad-spectrum pesticides could have a toxic effect on birds. Birds also prey on natural enemies, but the overall effect is of pest reduction. The use of smaller entrance holes (2.6 cm radius) selected blue tits.

PRACTICE PERFORMANCE

In comparison with low-input orchards without nest boxes.



Pest regulation level: Birds breeding in nest boxes make it possible to reduce arthropod numbers in general and pest populations in particular (blossom weevils and aphids).

AGRONOMY & ENVIRONMENT

No pesticide reduction but limits the risk of pest pullulation. Breeding birds reduce abundance of spring crop pests such as aphids and weevils.

Increased biodiversity in terms of both richness and abundance. Birds also prey on natural enemies, but the overall effect is on pest reduction.

No effect on yield and fruit quality. There is no risk of fruit attacks by birds since fruits are not ripe during the breeding season. Reduction in crop damage not tested.

Pesticide reduction

Biodiversity

Apple production

Ease to implement

Ready to use

No specific skills are needed and it is an available and widespread practice.

It is a ready to use solution with a partial effect on several pests attacking apple trees in spring.

OPERATIONALITY

COSTS & BENEFITS

Investment cost

Nest boxes are easily built or cost around €15-20 each with 10 nest boxes per hectare. They can last 10 years.

Time to set up

Installation of nest boxes is done just once and does not require any special skill.

Time to manage

Annual cleaning during winter to remove old nests and parasites is recommended (less than 2 hours per year).

Other value

Contributes to preserving bird diversity by facilitating nesting in the orchard for cavity-nesters.



Positive outcome



Neutral to positive outcome



Room for improvement



Critical points

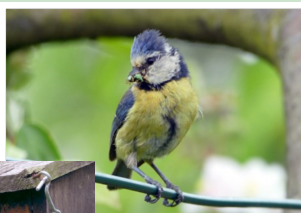
INFORMATION ABOUT TARGET PESTS

Numerous pest arthropods are eaten by tits. Many apple pests attack different apple tree parts in spring. Apple blossom weevils and some lepidopteran pests attack blossoms. Aphids (rosy aphids and green aphids) and leafrollers feed on growing shoots. Woolly apple aphids and codling moth cocoons can be found in bark crevices.

Breeding birds particularly reduce the abundance of spring crop pests such as aphids and weevils.



Blue tit



Great tit



Common redstart

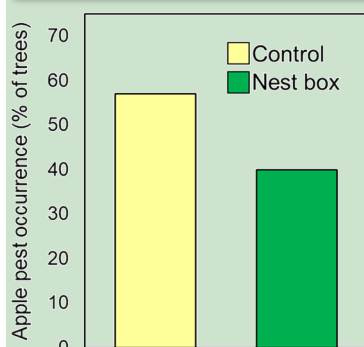


INFORMATION ABOUT NATURAL ENEMIES

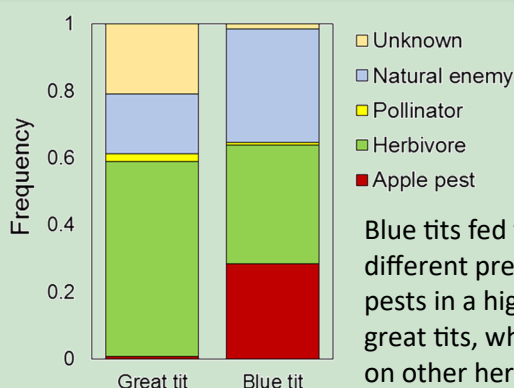
Insectivorous birds using nest boxes for breeding are present in the orchard throughout the year. But during the spring, the breeding season, their lives are frenetic as they feed their nestlings with arthropods. A couple of blue tits can visit the nest box more than 70 times per hour, carrying more than one prey in 30% of the visits. The aim of the practice is to provide nesting sites for these birds within the orchard in order to increase their population.

- Nest boxes are mainly used by great and blue tits.
- Blue tits are the authentic apple pest killers (great tits seem to eat more other insects in the surrounding landscape).
- Nest boxes with smaller holes encourage blue tits.

RESULTS OF THE EXPERIMENTS



Placing nest boxes in orchards increases biological control of pests by birds. For example, the proportion of apple trees attacked by pests was lower in orchards with nest boxes.



Blue tits fed their nestlings with different prey, including apple pests in a higher proportion than great tits, which mostly preyed on other herbivores.

For more information

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Experiment leaflet Nº5.

Reference:

García, D., Miñarro, M., Martínez-Sastre, R. (2021). Enhancing ecosystem services in apple orchards: nest boxes increase pest control by insectivorous birds. *Journal of Applied Ecology* 58(3): 465-475.

EXPERIMENT CONDITIONS

Scale:



Validity:



Duration: 2018 –2020

No. of repetitions:

24 orchards over 2 years