Crown condition of *Quercus robur* in Flanders (Belgium)

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Abstract: In 2005, 23.2% of the oaks (*Quercus robur*) in the level I survey were damaged with an average leaf loss of 22.4%. There is a significant relation between defoliation and damage by defoliators. Before 2006 only the extent of the insect damage was taken into account, not the intensity of the damage. Trees were classified into 4 damage classes according to the part of the crown being affected: no damage (0%), slight damage (1-20%), moderate damage (21-40%) and severe damage (>40%). Defoliation scores increased significantly when more than 20% of the crown was affected. A correlation was found between insect damage and fungal infection. In 2005, 80% of the trees with moderate to severe insect damage were also infected by fungi, especially by powdery mildew (*Microsphaera alphitoïdes*). The infection has a less important influence on the defoliation score than the insect damage. The international method for biotic damage assessment (Manual ICP-forests - Visual Assessment of Crown Condition), uses more classes and the damage by insects is better correlated with the defoliation score. Data collected with the previously used, regional method are difficult to translate into the new classes and vice versa.

Introduction

Flanders is one of the most densely populated regions in Europe. Only 8.5% of the area is covered with forest, this is about 145 000 ha. Looking at the homogeneous stands (cover of dominant tree species ≥ 80%), *Quercus robur* is the main tree species after *Pinus sylvestris*, *Populus sp.* and *Pinus nigra subsp. laricio*. About 5% of all forest stands are homogeneous *Q. robur* stands. This species is frequently mixed with other broad-leaved species. *Q. rubra* and *Q. petreae* are two other oak species in the Flemish forests, but they are less common (resp. 1.4% and 0.2% of the homogeneous stands). Oak forests are used for wood production but also their ecological and recreational function is of high interest. INBO is monitoring the forest condition in the Flemish Region using a 4x4 km grid. The level I survey is carried out on 72 plots with 1728 trees. With a proportion of 31% of the sample trees, *Quercus robur* is the main species in the survey.

Crown condition (Level I survey)

In 2005, the share of damaged trees in the forest condition survey was 21.3%, with a mean leaf loss of 21.6%. The condition of *Q. robur* was worse than the overall mean. 23.2% of the oaks were damaged. The mean leaf loss was 22.4%. The mortality rate was 0.2%, both for oak and the total sample.

68% of the oaks were infected by fungi (mostly powdery mildew, *Microsphaera alphitoïdes*) and 76% of the trees showed insect damage. Before 2006 only the extent of the insect damage was taken into account, not the intensity of the damage. 21% of the trees showed moderate to severe insect damage, with more than 20% of the tree crown being

affected (tab. 1). Most of the insect damage on oak trees is caused by defoliators as *Operophtera brumata*, *Erannis defoliaria* and/or *Tortrix viridana*. Some oak plots in the Northern part of Flanders suffer from damage by caterpillars of *Thaumetopoea processionea*.

Tab. 1: Quantification of insect damage (method used in the regional Level I survey until 2005)

class	extent	damage
0	0	none
1	1 - 20%	slight
2	21 - 40%	moderate
3	> 40%	severe

Evolution 1987-2005

The crown condition of *Quercus robur* deteriorated between 1990 and 1995 (fig. 1). From 1998 to 2002, defoliation decreased slowly. After 2002, the share of damaged trees and the mean leaf loss slowly increased again.

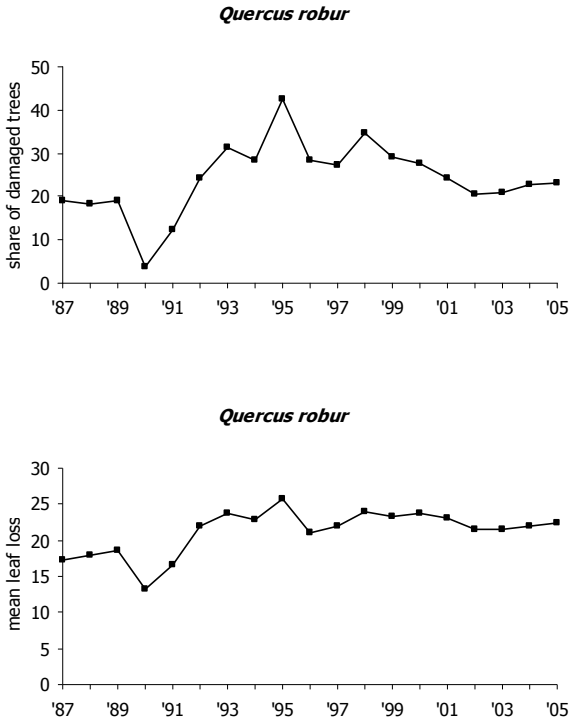

Fig. 1: Share of damaged *Q. robur* (above) and mean leaf loss *Q. robur* (under) (data 1987-2005)

From 1995 to 2005 the share of *Q. robur* with insect damage was higher than 60%. The amount of trees in damage classes 2 and 3, with moderate to severe damage, was between 8% and 37% (fig. 2). In 1998 the highest share of trees with moderate to severe damage

was reached. From 1999 till 2003 insect damage was lower, and this contributed to a better crown condition. In 2004 and 2005 the share of trees with severe damage increased again.

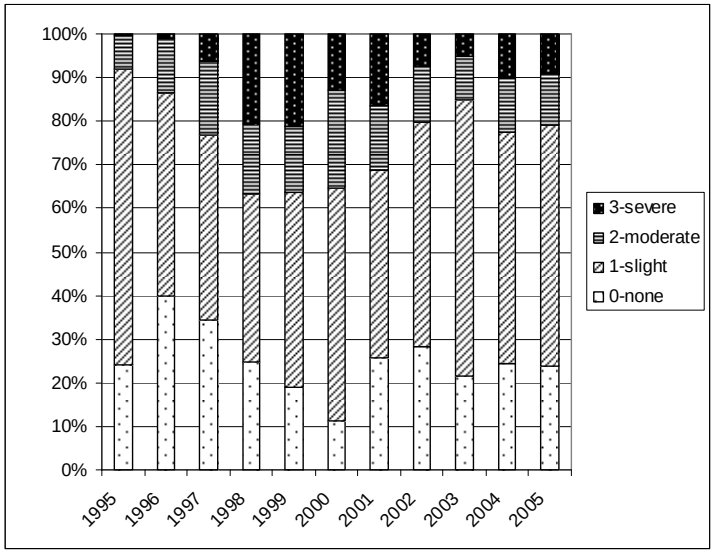

Fig. 2: Share of *Q. robur* with insect damage (quantification method before 2006), period 1995-2005

Overall, the mortality rate in the level I survey varies between 0% and 0.5%, for *Q. robur* from 0% to 0.9% (tab. 2). The cause of this mortality is not always clear. Most of the dead oaks showed a bad crown condition many years before they died. Secondary damage causes, like *Agrilus biguttatus*, can cause a sudden death of weakened trees.

Tab. 2: Mortality rate in the level I survey from 1995 to 2005

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
all trees	0	0.2	0.1	0.5	0.2	0.5	0.5	0.2	0.5	0.2	0.2
Quercus robur	0	0	0	0.6	0.2	0.6	0.6	0.2	0.9	0.2	0.2

Crown condition and insect damage

There is a significant relationship between the extent of the insect damage and the defoliation score (tab. 3). The median of the leaf loss does not differ for insect damage classes 0 to 1. When insect damage is observed on more than 20% of the crown, the defoliation score increases significantly. The median of the leaf loss is 30% for damage class 2 and 35% for damage class 3.

Tab. 3: Relationship between insect damage and defoliation: mean leaf loss (+median) for each insect damage class (Kruskal Wallis test, data 2005)

	sign.	class 0 (%)	class 1 (%)	class 2 (%)	class 3 (%)
Quercus robur	***	20.2 (20)	19.5 (20)	28.4 (30)	37.6 (35)

α=0.05, sign.: ***=p<0.001

Insect damage and infection by fungi

Frequency

Powdery mildew infection (*Microsphaera alphitoïdes*) is common on *Q. robur* trees. Until 2005, infection by fungi was only noted as absent or present (0/1). The extent was not assessed. In 2005, 80% of the trees with moderate to severe insect damage showed fungal infection. In the subset with no or only slight insect damage, there was a lower share of trees with powdery mildew infection. 65% of these trees were infected.

Impact on defoliation

In 2005 oaks infected by fungi seemed to have a significant higher defoliation than oaks without fungal infection (tab. 4).

Tab. 4: Relationship between fungal infection and defoliation: mean leaf loss (+median) (Kruskal Wallis test, data 2005)

	sign.	without infection (%)	with infection (%)
Quercus robur	***	19.7 (20)	23.6 (25)

α=0.05, sign.: ***=p<0.001

The correlation between insect damage and powdery mildew infection explains this difference (Spearman rank correlation test; rho=0.29, p<0.001). Oaks are frequently damaged by defoliators in spring. They recover by making new shoots, but these are very susceptible for powdery mildew infection.

According to the degree of insect damage and to the appearance of fungal infection, the oak trees can be classified into 4 groups: I0-F0, I0-F1, I1-F0 and I1-F1 (tab. 5).

Tab. 5: Classification of *Q. robur* trees into groups according to insect damage and fungal infection

group	insect damage	fungal infection
I0F0	absent or slight	absent
I0F1	absent or slight	present
I1F0	moderate to severe	absent
I1F1	moderate to severe	present

The differences in defoliation between these groups are explained by the extent of the insect damage. Trees with moderate to severe damage show no significant differences whether they are infected by fungi or not.
When there is no or only slight damage by insects, trees infected by powdery mildew show a higher defoliation score. The difference between I0F0 and I0F1 however is not statistically significant and under the assessment accuracy of 5%.

Tab. 6: Relationship between insect damage, infection by fungi and defoliation: differences in mean leaf loss (+median) between combined classes of insect damage and fungal infection (Kruskal Wallis test, data 2005)

	sign.	I0F0 (%)	I0F1 (%)	I1F1 (%)	I1F0 (%)
Quercus robur	***	17.7 (17.5)	20.7 (20)	32.5 (30)	32.7 (30)

α=0.05, sign.: ***=p<0.001

Assessment of insect damage: new versus old method

In 2006 the new manual for the assessment of damage causes was used in all Level I and Level II plots in Flanders. For reason of comparison, both methods were used in one Level I plot in the northern part of Flanders (Campine region). In this plot, *Q. robur* was damaged by the oak processionary moth (*Thaumetopoea processionea*), with defoliation scores from 25% to 75% (tab. 7). Caterpillar nests were found on all the sample trees.

The old method classifies the trees into 4 insect damage classes (0: 0%, 1: 1-20%, 2: 21-40%, 3: >40%) without taking into account the effective leaf area being affected. Only the affected part of the crown is important. The new manual for biotic damage assessments uses 8 classes (0: 0%, 1: 1-10%, 2: 11-20%, 3: 21-40%, 4: 41-60%, 5: 61-80%, 6: 81-99%, 7: 100%). The extent is now the percentage of the leaf area which is lost due to the action of the caterpillars. Not only the extent of the insect damage is taken into account, but also the intensity of the damage.

Tab. 7: Defoliation of 24 *Q. robur* trees in the same plot, damaged by *Thaumetopoea processionea*: insect damage classes according to the old regional method and the new method for biotic damage assessment - data 2006

tree number	leaf loss (%)	insect damage class (old method)	insect damage class (new method)
1	50	3	4
2	60	3	4
3	55	3	4
4	50	3	3
5	35	2	3
6	45	3	4
7	40	3	3
8	30	2	3
9	30	2	2
10	50	3	3
11	65	3	4
12	25	1	1
13	35	2	3
14	60	3	4
15	30	2	2
16	35	3	3
19	75	3	5
20	35	2	3
21	30	2	2
22	25	1	1
23	45	2	3
24	45	3	4
25	70	3	4
26	40	3	3

According to the previously used method, 8% of the trees in the plot were slightly damaged by insects (class 1), and 92% of the trees showed moderate to severe damage (classes 2 and 3). With the new method, the extent of the damage is 0-10% on 8% of the trees, 11-20% on 13%, 21-40% on 42% , 41-60% on 33% and 61-80% on 4% of the sample trees.

The new extent classes are more accurate and there is a better correlation with the defoliation score, especially for the classes replacing the old extent classes 'moderate' and 'severe' damage. In this case study, trees which were classified according to the old method in class 2, are now in class 2 or 3. Oaks with severe damage (class 3), are now in classes 3, 4 or 5. There are only a few oaks with slight damage (class 1) and these trees stay in the same class using the new method.

Conclusion

The crown condition of oak is worse than the overall mean in Flanders. Almost every year dead oak trees appear and in some years the mortality rate is higher than for all trees. Defoliators are important biotic agents influencing the crown condition. The appearance of fungal infections like powdery mildew (*Microsphaera alphitoïdes*) is a less important factor. In 2006, the new method for the assessment of damage causes was introduced in the regional level I survey in Flanders. The data from previous surveys cannot (or only partly) be translated to the new classification system and vice versa.

In Flanders, crown condition monitoring will be continued with the new method for the assessment of damage factors. Hopefully this will also be the case on a European scale. The data collected in this monitoring network are useful for different scientific studies.

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