THE PROBABILITY OF OCCURRENCE OF DEER DAMAGE IN NORWAY SPRUCE STANDS

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The goals of the research is to quantify the probability of occurrence of deer damage in Norway spruce stands: a). highlighting the distribution of the deer damage on elemental areas; b). determining the probability of a certain number of random sampling containing zero to six tress damaged by deer, in the affected Norway spruce stands characterized by a certain frequency of the damage.
It has been found on that as the percentage of damaged trees in artificial Norway spruce stands increases, the distribution of deer damage inside the stands on elementary areas becomes more uniform, in that the weight of the damage categories characterized by damage values of over 81 % increases.
From the point of view of the occurrence of random samplings containing zero to six deer damaged trees in the Norway spruce stands affected, characterized by a certain frequency of the damage is done according to the binomial law.

Key words: Norway spruce; Deer damage.

INTRODUCTION

When analyzing the evolution in time of the forestry in our country and abroad, the following main aspects, common as for the spruce ecosystems damaged by deer, can be remarked: a) the problems of the forests damaged by deer in certain forest areas; b) the causal relationship which have led to the occurrence of the deer damage to spruce stands; c) measures necessary to prevent deer damage in plantations and stands; d) management plans on ecological bases, of the spruce stands damaged by deer.[7–10, 16, 17]

The causal relationship which have led to the occurrence of the deer damage in spruce stands has been established based on a close interdependence between forests and deer, which makes it compulsory for the forestry to know both the biology and the management of the deer, as well as the steps to be taken in order to prevent or eliminate the unfavourable effects.[5, 15, 12]

Connected to the deer damage in the artificial spruce ecosystem is the issue of determining the structural elements specific to these forests[2–4, 14, 13], as well as the typical management resources.[1, 11, 13]

The targets of the present research are: a) highlighting the distribution of deer damage on elemental areas in spruce stands; b) determining the probability of occurrence of a certain number of random samplings containing zero to six trees damaged by deer, in affected spruce stands characterized by a certain age and a certain frequency of the damage.

MATERIALS AND METHOD

In order to highlighting the distribution of deer damage on elemental areas within the spruce stands, as research material four experimental sites of 10000 m^2 have been used, each of them being in spruce stands for the 41 to 60 years old with different damage frequency (Table 1).

Table 1

Identification data's for the studied spruce stands damaged by deer

Stand number	Age	d_{gM} (cm)	h_{gM} (m)	Site type	Forest type	Altitude (m)	Slope (^{0})	Damage frequency
58 A	60	40,6	30,0	3333*	1111**	810	24	31
58 C	60	36,2	28,7	3333	1111	850	18	52
56 A	60	39,1	27,4	3333	1411***	900	17	79
56 B	60	40,5	27,5	3333	1411	990	15	88

* Mountain mixed of spruce, beech and fir by superior productivity
** Pure Norway spruce stands
*** Mixed of spruce and fir stands

Within the permanent sites, elementary test areas of 100 m^2 (10 m/10 m) have been established; for the 41 to 60 years old stands which has been studied, 100 elemental areas have been fixed. In these test sites both, the deer damaged and the undamaged trees have been inventoried, it was calculate the percentage of damage for each of elementary test areas and finally it was made cartograms of the damage produce by deer in affected spruce stands. The method used in order to point out, to quantify the probability of occurrence of deer damage in damage in spruce stands damaged by deer, was determining the number of random samplings containing zero to six deer damaged trees correlated with the age of the stands and with the damage frequency, using a specific working method.

The investigation method consisted of placing random samplings including six trees (Prodan method)[6] within the permanent experimental areas established. The sampling points are situated in the center of the elementary area and at the intersection of them (Fig. 1).

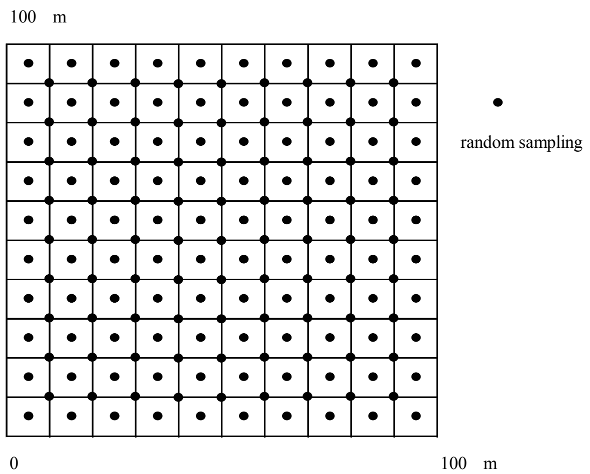

Fig. 1. Random sampling emplacement.

181 such random samplings have been fixed for each of the permanent areas determined in which an inventory an evaluation of the trees was made, form the point of view of the presence or the absence of the deer damage. The result is 1086 trees evaluated for each of the permanent experimental sites established in the researched stands.

In order to highlighting the probability of occurrence of the deer damage in spruce stands, the binomial law was used, which has a crucial importance in study of the alternative variance, in this case shown by the presence or absence of the trees damaged by deer. The expression of the frequency function of the binomial distribution used to adjust the experimental distribution generated by the presence of the number of the random samplings having zero to six trees damaged by deer, correlated with the age of the stands and with the frequency of the damage, is (Giurgiu, 1972):

$$f(x) = \frac{n!}{x! \cdot (n-x)!} \cdot p^x \cdot q^{n-x} \qquad (1)$$

where: n is the number of independent unit considered (number of trees in a random sampling); x – variable (number of trees damaged by deer); p and q – parameters of binomial distribution.

RESULTS

Figure 2 shows the cartograms of the stands analyzed which have an average frequency of deer damages in spruce stand between 31 % and 88 %.

Figure 3 shows the frequency of occurrence (%) of the deer damage in elemental areas as compared to the value of the average frequency of the deer damage on the stand.

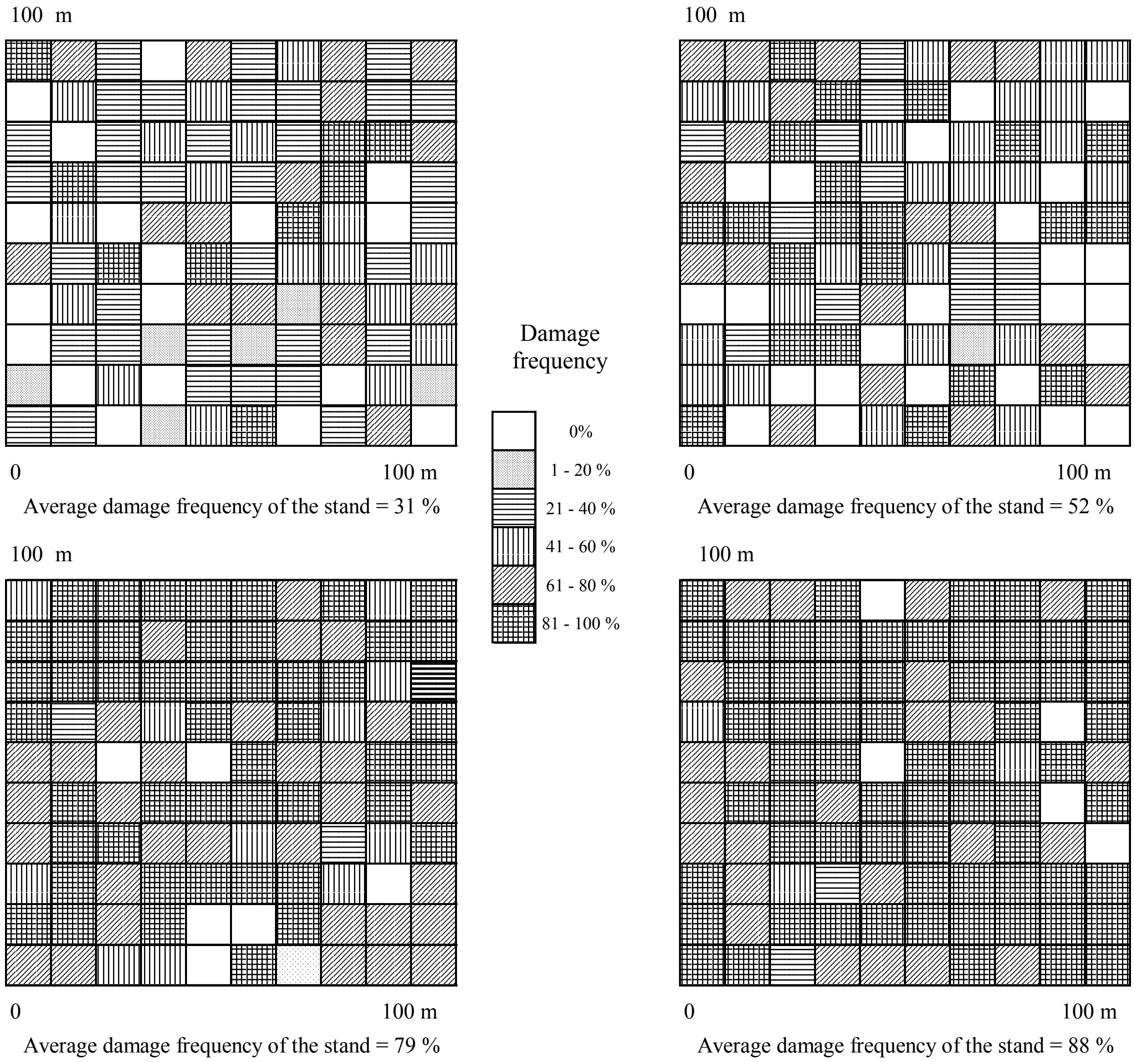

Fig. 2. Cartograms of the spruce stands damaged by deer correlated with medium damage frequency of the stand.

The distribution of the elemental areas by damage categories for a stand having an average deer damage frequency of 31 % shows that the most of them are in class with a percentage of damage about 21 %–40 %. In this category are included 34 % of the elementary areas for researched stand (Fig. 3A).

The distribution of the elemental areas by damage categories for a stand with a high frequency of the deer damages (52 %) has specific aspects in that the undamaged part represent 25 % from total for researched stand. The maximum is found in the category which includes the average percentage of damages (41 %–60 %) and in the category between 81 %–100 % value (Fig. 3 B).

Specific to a stand with a deer damage frequency of 79 % is the fact that elemental areas are distributed differently in all damage categories. The highest frequency is found on the elemental areas characterized by a damage percentage between 81 % and 100 % (Fig. 3 C).

The distribution of the elemental areas by damage categories for a stand with a very high frequency of the deer damages (88 %) has specific aspects in that the highly damaged parts (damage percentage of over 81 %) represent 25 % from total (Fig. 3 D).

Figure 4 shows the way of adjusting the experimental distribution generated by the presence of number of random sampling with zero to six deer damaged trees correlated with the average deer damage frequency corresponding to spruce stand.

As already mentioned the starting point was the hypothesis according to which the distribution of the random sampling as compared to the number of damaged trees in the deer damaged spruce stands is done according to the binomial law.

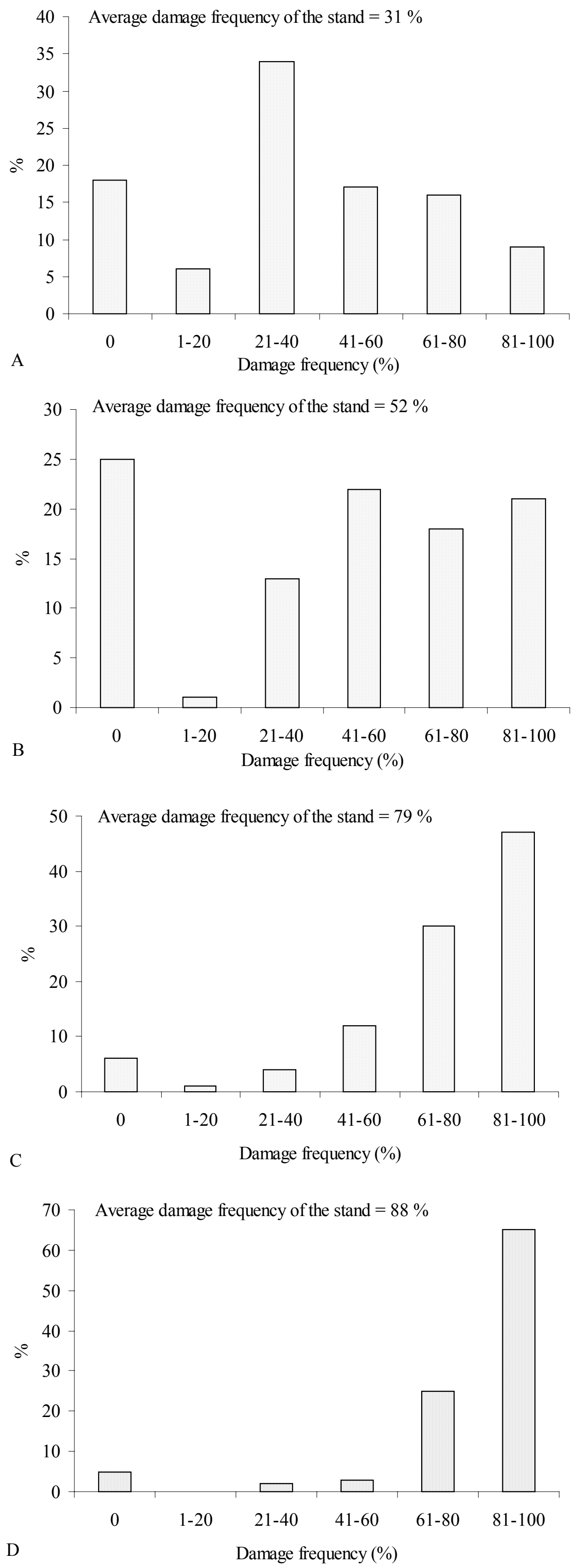

Fig. 3. The frequency of occurrence (%) of the deer damage in elemental areas as compared to the value of the average frequency of the deer damage of the stand.

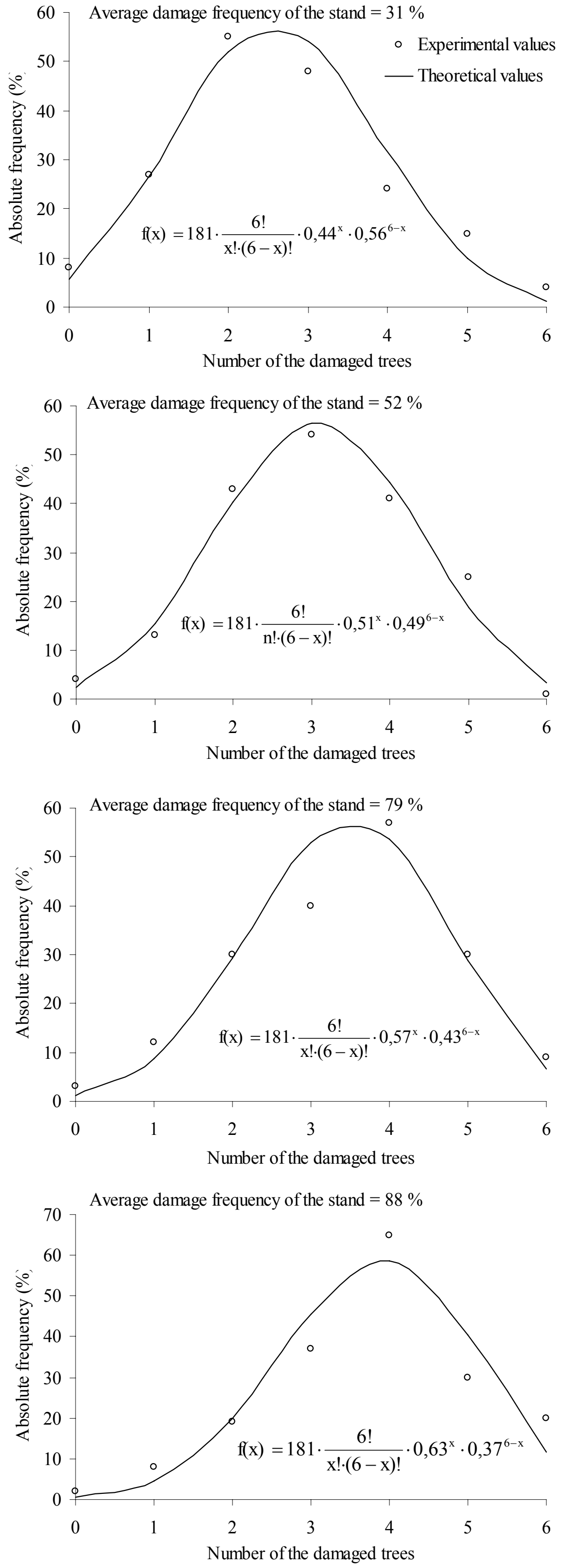

Fig. 4. Adjust the experimental distribution generated by the presence of number of random sampling with zero to six deer damaged trees correlated with the average deer damage frequency corresponding to spruce stand.

Table 2

Examines the significance between experimental distribution and theoretical distribution using χ^2 test

Stand number	Age	Damage frequency	Degrees of freedom (f)	χ^2 experimental	χ^2 theoretic (5 %)	Significance
58 A	60	31	5	0,790	11,070	$\chi^2_{exp.} < \chi^2_{5\%}$
58 C	60	52	5	0,433	11,070	$\chi^2_{exp.} < \chi^2_{5\%}$
56 A	60	79	5	1,104	11,070	$\chi^2_{exp.} < \chi^2_{5\%}$
56 B	60	88	5	1,685	11,070	$\chi^2_{exp.} < \chi^2_{5\%}$

It is done in this way because, together with the Poisson distribution, the binomial distribution is placed in the category of discrete distributions which characterize very well, from a statistical point of view the aspect studied.

The experimental distribution has been compared with the binomial distribution based on the χ^2 test. The result of the analysis of the significance of the difference between the distributions is presented in Table 2.

The χ^2 value calculated for each of the cases presented being lower than the theoretical value (11,070), with a transgression possibility $\alpha = 5$ % and a number of degrees of freedom (f) which equal five the result is that the experimental distribution generated by the presence of the number of random sampling with zero to six deer damaged trees follows the law of the binomial distribution.

CONCLUSIONS

As the percentage of damaged trees in the artificial spruce stands increases, the distribution of deer damage inside the stands on elemental areas becomes more uniform, in that the weight of the damage categories characterized by damage values of over 81 % increases. In the deer damaged stands there are also less damaged parts or even barren parts, as result of the snow breaks in the stands more than 40 years and of the wind falls respectively in the stands with age of over 41 years; consequently the number of trees registered in the elemental areas has decreased.

The distribution of the deer damage inside the stands, characterized from the point of view of the probability of occurrence of random sampling with zero to six deer damaged trees correlated with the age of the stand and with the frequency of deer damage is done according to the binomial law.

The influence of the damage caused by deer upon the symmetry of the theoretical distribution is done by individualizing a right side asymmetry as the number of the deer damaged trees increases.

The finding that the difference between the experimental distribution and the theoretical distribution is insignificance demonstrates that the damaged caused by deer is unevenly distributed within the stands.

There are areas of maximum concentration of the damage but also areas where the damage has a low frequency; this has been highlighting where all the trees are damaged, but also areas where the damage is absent.

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