UDC 674.048

N. V. Mazanik, PhD (Engineering), senior lecturer (BSTU)

COMPARATIVE ANALYSIS OF STATISTICAL CHARACTERISTICS OF EXPERIMENTAL DATA WHILE USING VARIOUS TEST METHODS OF CHEMICAL PROTECTION MEANS OF WOOD AGAINST BIOLOGICAL DAMAGES

The article describes the current testing methods of inhibitory ability of compositions for chemical protection of wood against biological damage. The width histograms of *Coniophora puteana* growing area on the impregnated samples and on the samples treated with antiseptic XM-11 are considered. Analysis of the assessment criterion impact of the protective means on the validity of test results is given.

Introduction. The means of wood chemical protection been created, the question arose about their efficiency estimation possibility. The first known protective means tests consisted in supervision over the conditions of integral impregnated assortments which were exploited alongside with the unimpregnated ones in the same service conditions. Such full-scale and ground tests have considerable disadvantages – they are very long and have extremely low reproducibility. The uncontrollable species composition of fungi does not allow correct estimation of relative toxicity of various antiseptics. Carrying out of protective means tests in laboratory conditions permitted to use pure fungi cultures for experiments. Nevertheless the matter of reliability, reproducibility and especially of correctness of the laboratory research results usage to predict immunity of wood assortments in real operation conditions remains open. This is due to the fact that the tests results and their statistical characteristics depend considerably on the experiment technique and on the accepted efficiency estimation criterion of the protective means.

Main part. In XX century the so-called "agar" test method of the fungicide inhibitory abilities was widely used. It consists in the following: antiseptic in different concentrations is introduced into agar nutrient solutions at their preparation. After that the solutions are contaminated with pure fungus culture and observations are made, marking the dependence of speed and intensity of the fungus development on concentration of the toxic solution. The agar method is simple; it permits to provide high uniformity of the experiment conditions. The tests duration does not exceed 2–3 weeks. However in the process of experimental data accumulation the disadvantages of this method have also come to light. Researchers noticed precipitation of antiseptic at the Petri dish bottom and that allows a fungus to spread on the solution surface without contact with the poison, and also chemical reactions of some antiseptics with nutrient solution components. Besides, protecting doses of antiseptics received on the agar solution practically in all cases were much lower than at the wood substratum tests. To eliminate this discrepancy it was offered to apply the correction factors but they turned out to be different for different antiseptics and of little use in practice. Thus, the agar method permits to define only relative toxicity of various antiseptics.

Now the most widespread kind of laboratory researches of protective means is the test with the usage of the protection object – wood (the so-called "wood blocks method"). According to this method the pure fungi cultures are grown up on the artificial nutrient solution. Then they put the samples impregnated with the antiseptic of various concentration and unimpregnated (control) samples on the well grown cultures. At the expiration of the test period the wood protection efficiency by the antiseptic is estimated according to the affect degree of the impregnated samples in comparison with the control ones. Numerous variations of this method differ in the form and dimensions of the wood samples, in the composition of nutrient solutions, in the maintenance modes of wood humidity, in the test cultures of fungi, in the samples inoculation modes, in the test duration, and also in the estimation criterion of the degree of wood damage by fungi.

Now in overwhelming majority of researches the intensity accounting method of the fungi reaction is used. In particular while testing efficiency of the protective means in relation to the wood-damaging fungi the most widespread is the estimation of wood damage rate on weight reduction of wood samples. However protective action of the antiseptic can also be estimated according to the change of physical-mechanical properties of wood such as impact strength, modulus of elasticity, tensile or bending strength, frequency of samples free vibrations, etc.

An important tests aspect is also the choice of the nutrient solution and the samples contact mode with the test culture. The nutrient solution should contain all necessary elements for fast accumulation of the fungus biomass and that will permit to model the most unfavourable service conditions of wood, and also to regulate effectively the samples humidity which should be kept at the optimum for the test culture level throughout the test. The method variant of wood blocks in which the underlying substratum is the agar is accepted as the standard one in the European Union countries [1].

Statistical characteristics of experimental data

Wood samples	Average value of the zone width, mm	Dispersion	Root mean square deviation	Variation coefficient	Asymmetry index	Excess index	Root mean square deviation of asymmetry	Root mean square deviation of excess
Unimpregnated	24.08	0.48	0.69	2.89	0.04	0.96	0.30	0.58
Impregnated by XM-11	3.75	0.76	0.87	23.29	0.06	0.34	0.30	0.58

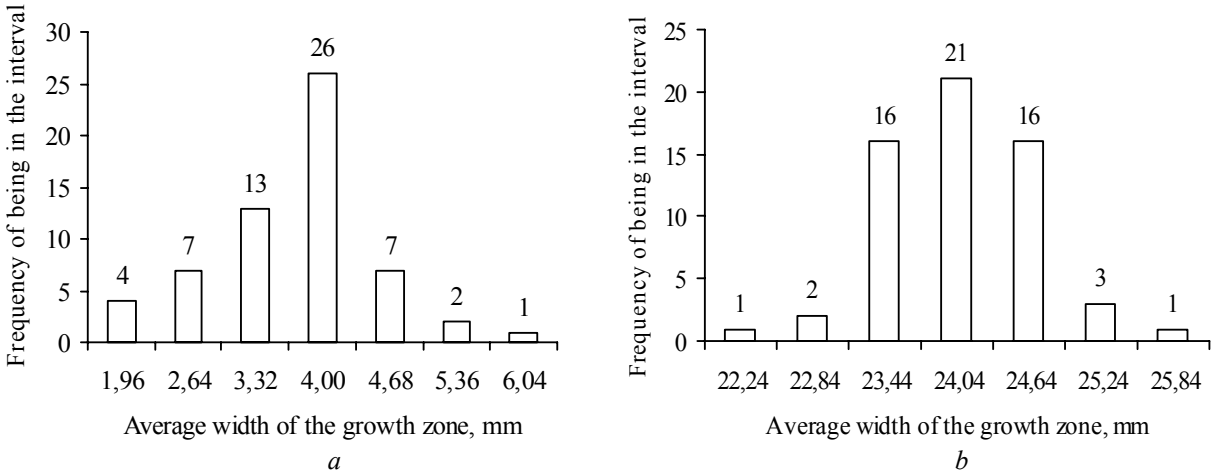
The variant using the earth substratum is applied on the territory of the former USSR, in the countries of the American continent and Australia [2]. In the Republic of Belarus the method of wood blocks was standardised as the efficiency estimation mode of protective means against basidiomycetes [3].

Nevertheless in practice extremely low reproducibility of the tests results is confirmed, in these tests the estimation of the wood damage rate according to the weight reduction of pine samples is used as the criterion. Such measurements error is explained by a variety of reasons. First of all it is inconstancy of test conditions. In particular, pine wood samples density heterogeneity leads to unequal antiseptic concentration in the sample bulk. Decrease in the sample weight occurs basically because of destruction of the poorly impregnated zones the volume fraction of which as well as concentration of protective means in them is impossible to take into account. Different destruction rate of latewood and summerwood plays an important role. Nonuniform sample destruction by a fungus leads to distortion of the experiment result. Estimation of the wood sample weight after the test completion is made after clearing of its surface from the fungus mycelium. And the mycelium weight remaining in the sample thickness is not taken into consideration. Besides, if the sample is destroyed a great deal, its surface clearing is inevitably interfaced with separation of small and large wood fragments and it influences the weighing result. The results error is considerably influenced by the samples humidity inconstancy during the test, and also by absence of controllability of the inoculum contacting the sample.

We carried out research of the usage possibility of the test cultures on samples of the wood veneer impregnated with the antiseptic in comparison with the unimpregnated one as the efficiency criterion of protective means of zone width of the mycelium growth. During the test the veneer is in contact with the agar medium not containing sources of carbon and providing constant wood humidity. Specially developed technology of the inoculum obtaining provides the constancy of quantity and growth phase of the inoculum put on the samples.

The experiment purpose was to reveal the character of distribution of values of the zone width of the mycelium growth of *Coniophora puteana* on 60 unimpregnated birch veneer samples and on 60 samples impregnated with a solution of antiseptic XM-11 with average absorption of 9.8%, and also the comparative analysis of this test results with the data received by other test methods. Calculation results of statistical characteristics of experimental data are given in the Table. The calculated statistical characteristics were used to check the normalcy of distribution of the measured quantity by Kolmogorov's criterion. It was shown that the normalcy of distribution conditions are met for the tests results of unimpregnated samples and of the samples protected by XM-11. Thus, it is possible to draw a conclusion about the absence of reasons causing a unilateral deviation of the measured quantity, i.e. causing occurrence of regular errors. Histograms of distribution of the measured quantity are shown in the figure.

At introduction into wood of the protective means the distribution character of the measured quantity undergoes some changes. The results variation of parallel measurements relative to the average value increases. Distribution though remains normal becomes more asymmetric as a result of non-equiprobable influence of the antiseptic presence on the fungus growth. The described behaviour of the distribution histogram of the measured growth width of the fungus mycelium on the wood sample does not contradict the behaviour of histograms characterising the loss of weight by the wood samples in the experiments made by Belenkov. It was shown by him that with the increase of absorption and, accordingly, degree of wood protection the distribution of the measured criterion complies with the law of normal distribution only before the beginning of the samples selection disintegration into two groups – samples affected by the fungus in various degrees and non-affected samples. After the selection disintegration into groups the distribution loses properties of being normal and the data received with the help of the method used by the author can be considered only estimating. The variation coefficient of the mycelium growth width of the fungus *Coniophora puteana* on the unimpregnated birch wood amounted to 2.89%, it is considerably lower than the variation coefficient of the pine samples weight loss received by Belenkov (11.1%) and by Mazur (13–18%), and also of the variation coefficient of the weight loss of unimpregnated birch samples which was received by Miller and Meyer (5%) [4].



The results distribution histograms of the width estimation of the mycelium growth zone on the samples: *a* – impregnated by XM-11; *b* – unimpregnated

It is also important that in the offered test method the measured criterion complies with the normal distribution law with sufficiently high degree of wood protection. It is shown at the average absorption of protective means XM-11 – 9.8%.

Conclusion. The experiment results testify to advantages of use of the mycelium growth criterion in comparison with the estimation of destructive fungus activity on the sample weight loss.

References

1. Wood preservatives – Test method for determining the protective effectiveness against wood destroying basidiomycetes: EN 113. – Activated 01.12.96. – Brussels: European Committee for Standardization: Central Secretariat, 1996. – 32 p.

2. Standard Test Method for Wood Preservatives by Laboratory Soil-Block Cultures: ASTM D1413 – 07e1. – Activated 01.04.07. – West Conshohocken, Pa: ASTM International, 2007. – Book of Standards. – Vol. 4. – 8 p.

3. Средства защитные для древесины. Метод испытания токсичности: ГОСТ 16712–95. – Введ. 01.07.96. – Минск: Межгос. совет по стандартизации, метрологии и сертификации: Белорус. гос. ин-т стандартизации и сертификации, 1996. – 12 с.

4. Беленков, Д. А. Вероятностный метод исследования антисептиков для древесины / Д. А. Беленков. – Свердловск: Урал. ун-т, 1991. – 176 с.

Received 14.03.2012