

# EDUCATIONAL TECHNOLOGY IN DEVELOPING PUBLIC AWARENESS OF TREE PESTS AND PATHOGENS

## TEHNOLOGIJA PODUČAVANJA U RAZVOJU SVIJESTI JAVNOSTI O BOLESTIMA I ŠTETNICIMA DRVEĆA

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### Summary

A survey of the level of knowledge and public awareness among visitors to The 19<sup>th</sup> International Horticulture Fair in Belgrade was conducted using a self-completion questionnaire. Public awareness and knowledge of alien invasive species is required of residents, teachers, tree professionals and other stakeholders to enable the early detection and a 'stop the spread' strategy in the management of alien invasive species. The research on public awareness and knowledge about five selected tree pests and pathogens revealed that 83.30% of respondents have no knowledge. Respondents were asked to show their practical knowledge by matching the pest or pathogen with the symptoms on a tree, and only 4-11% were able to give correct answers. The public's attitude towards plant health issues is positive and almost all the respondents only buy their plants from registered nursery or distributors. Over half do not buy imported plants and are aware of the likelihood that more invasive alien species could come into our country and region via this pathway. Respondents use multiple sources to gain their knowledge regarding tree pests and pathogens. The most frequent sources used are the internet, face-to-face learning from educational establishments (lectures, seminars etc.), newspapers and trade journal articles. Respondents are motivated to gain knowledge about pests and pathogens and the pathways of their introduction, from the preferred formats of: the internet, TV programmes, printed brochures and books. Educational technology should be applied in order to facilitate education and lifelong learning, raise public awareness about pests and pathogens and improve professional practices.

**KEY WORDS:** public awareness, tree pests and pathogens, pathways, educational technology, lifelong learning

### INTRODUCTION UVOD

Biological invasions have, during the past few decades, been the focus of scientific research, with alien invasive species considered to be the second most important factor of di-

versity endangerment, after habitat destruction. Invasive tree pathogens and pests all over the world are directly correlated with live woody plants (plants for planting), such as nursery stock grown for forests or for ornamental purposes (Kenis et al., 2009; Kenis and Branco, 2010; Liebhold et al., 2012; Liebhold et al., 2013; Pilarska et al., 2010; Roques,

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2010, Santini et al., 2012). As a result of human activity, alien pests and diseases are exported out of their natural environment by following their hosts e.g. plants for planting or a variety of commodities (Glavendekic and Roques, 2009). The trade and transportation of ornamental plants are recognised as the most important pathways for the introduction of alien pests. Research on the biological patterns and determinants of invasion by pathogens in Europe has been compiled into a large database on invasive forest pathogens. Alien forest pathogens were already being recorded in Europe from the period of 1830 to 1859 as affecting the health of forest trees together with cryptogenic and native European forest pathogens. Their influence on forest health increased over time and they were dominant in the period from 1920 to 2008. Moreover, besides the above mentioned times, in the period from 1980 – 2008 hybrid forest pathogens were also recorded (Santini et al., 2013). The recent publication by Matošević i Pajač Živković (2013) presents evidence that, in Croatia, there are 101 phytophagous alien species associated with woody plants. Although only 15% of alien insects in Croatia invaded natural habitats, it is evident that more than a half of the invaded habitats represent agricultural land, followed by urban green infrastructure (parks and gardens) and woodland and forests.

This suggests that a tightly coordinated set of actions to combat new arrivals is needed. Tree professionals dealing with tree health or the growing of plants in nurseries have a key position in the pathways of introduction of alien tree pests and diseases. They are involved in actions such as inspections, monitoring and surveillance of pests and pathogens, tree purchasing, planning, silviculture and the maintenance of green infrastructure, which are crucial for plant health and the biosecurity of forests and urban greenery. It is expected that their knowledge and awareness of the significance of pests and diseases are both extensive and up to date.

## MATERIALS AND METHODS

### MATERIJALI I METODE

We used a self-completion questionnaire survey of visitors to Belgrade Fair on the occasion of The 19<sup>th</sup> International Horticulture Fair, April 3<sup>rd</sup> – 6<sup>th</sup>, 2014. Hard – copy questionnaires designed to assess public awareness were distributed by hand to visitors with a detailed explanation given by students of the Faculty of Forestry University of Belgrade. Respondents originated from various regions of Serbia, so the demographic distribution was somewhat uniform. About 70% of those visitors who were asked to complete the questionnaire accepted. The primary targets of the survey were randomly selected visitors to the fair, regardless of their profession. The main objective was to understand the public's attitude towards tree diseases and

pests through a survey of people involved in the horticulture sector, such as hobby gardeners, school teachers, students, nursery growers or other businesses related to trees and plants for planting.

The survey was initially designed by social researchers at the Forests Research Institute, Northern Research Station, Roslin & Alice Holt Lodge, Farnham, UK and then enhanced by specialists in forest entomology and pathology within the framework of the COST Action FP1201 (PERMIT). In order to compare the gathered data with previous research conducted in nine European countries, the set of questions was the same with the addition of specific pests relevant to Serbia. The survey consisted of 23 questions. Respondents were asked to make judgments about their own level of knowledge regarding selected pathogens and pests, the significance of trees and forests, the level of effectiveness of measures and policy related to tree health and to express their opinion about the likelihood of further introductions of pathogens and pests in Serbia. The survey was also designed to gather data regarding the sources of information on pathogens and pests and to show a willingness to share information and the demographics of respondents.

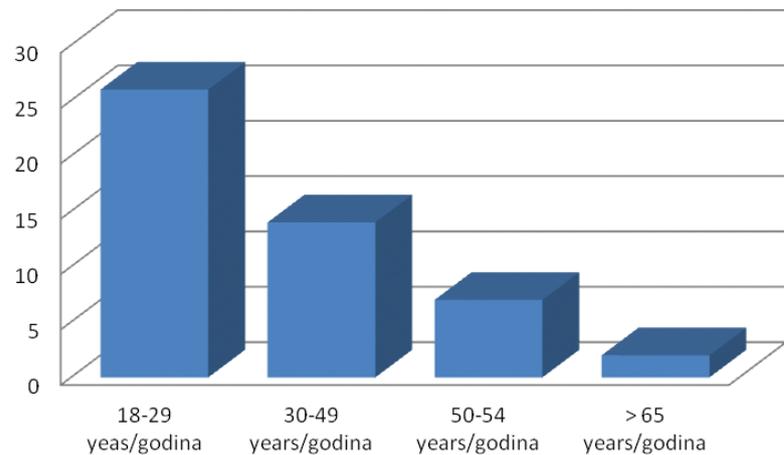
The gathered data was subjected to descriptive statistical information and tests. For some open questions which generated qualitative data, responses were given in the form of short text. Data was collected and analysed thematically, focusing on changing negative behaviours regarding tree health. Analysis of the questions focused on information about pathogens and pests, documenting the formats of information that respondents need and the most preferred format of that information.

## RESEARCH RESULTS

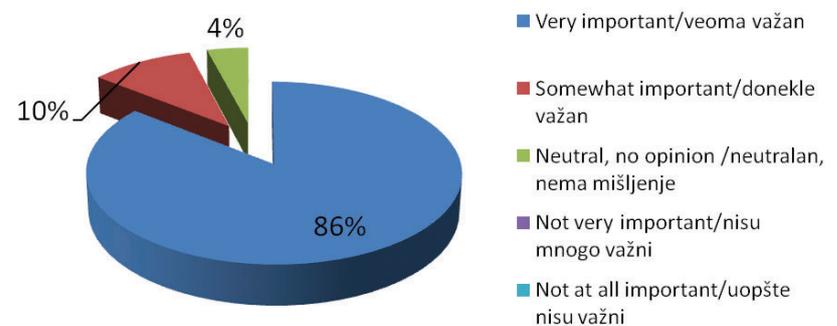
### REZULTATI ISTRAŽIVANJA

Our research generated data from 63 respondents. Concerning their gender, 47% are males and 49% females, allowing gender balance to be respected. Only 4% did not answer the question regarding gender. Almost one half of respondents belong to the age group 18-29 years. The second largest group is 30-49 years, whilst respondents over 50 years make up less than 10 % of the survey (Figure 1).

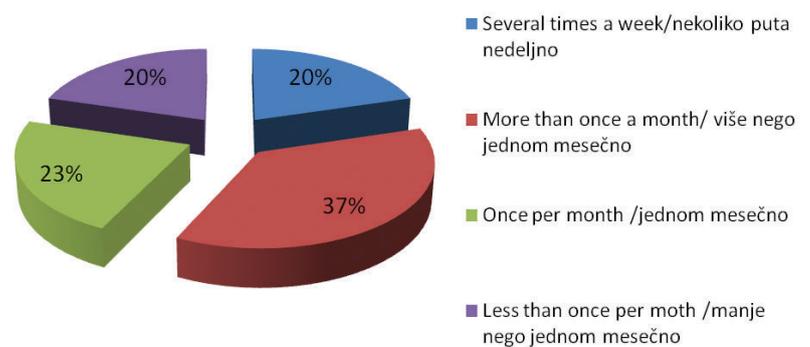
The occupations of the respondents cover a diverse range. The majority are forestry engineers, horticulturists and agriculturists, landscape architects, nursery growers and floriculture growers whose occupations are close to the sector of ornamental horticulture and they attend horticulture fairs regularly because of their business. Included among those visitors of The 19<sup>th</sup> International Horticulture Fair who participated in the survey are other professions such as: vocational secondary school teacher, lawyer, mechanical engineer, geological engineer, technological engineer, eco-



**Figure 1.** Age of respondents  
**Slika 1.** Starost ispitanika



**Figure 2.** Importance of trees, woodland and forests for respondents  
**Slika 2.** Značaj drveća, šumskih predjela i šuma za ispitanike



**Figure 3.** Answers to the question about how frequently respondents visit woodland or forest  
**Slika 3.** Odgovori na pitanje koliko često ispitanici posjećuju šumske predjele ili šumu

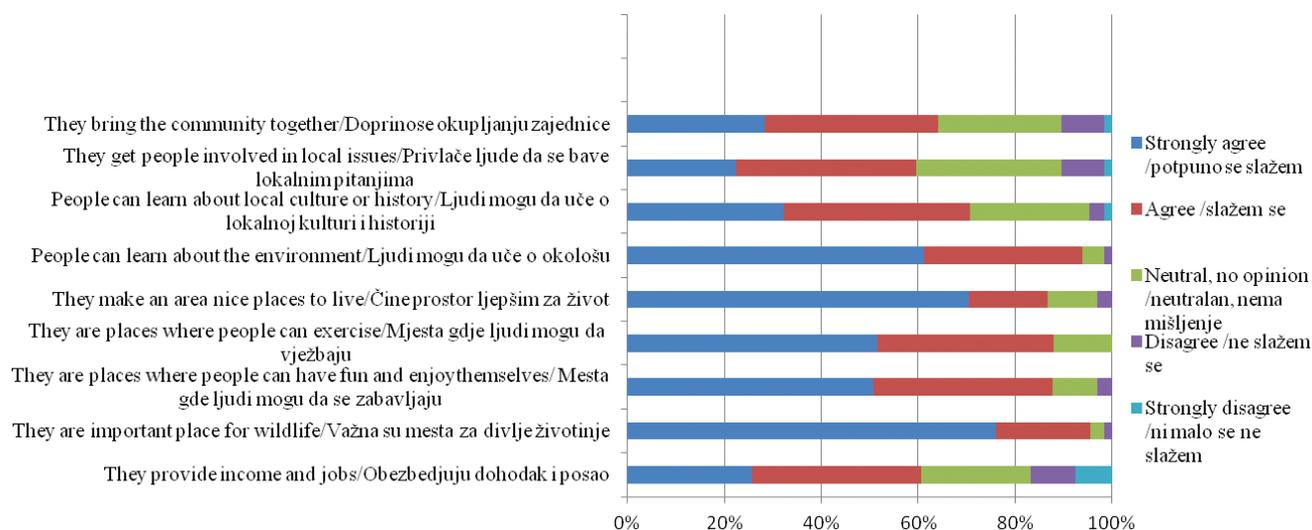
nomist, tourism worker, environmental protection inspector, air transport inspector, medical worker, fitness trainer, biologist, beekeeper, farmer, trader and others.

A large majority of respondents (71%) claimed that their way of life is connected with trees, landscapes and forests. When asked to judge the importance of trees, woodland and forests, the majority of respondents (86%) considered them as 'very important' (Figure 2). None had the opinion that they are 'not very important' or 'not at all important'.

Compared to the above consideration of forests as very important, they have a surprisingly low frequency of visits to woodland and forests. Only one fifth visit woodland and forest several times a week (20%). Additionally, 37% of res-

pondents visit forests 'more than once a month', meaning that more than a half of visitors to The 19<sup>th</sup> International Horticulture Fair visit woodlands and forests frequently (Figure 3).

In the perception of respondents, forests are considered as 'important places for wildlife' and that 'they make an area a nicer place to live', with more than 70% answering that they 'strongly agree' with this statement. The minority of respondents was of the opinion that woodlands and forests 'bring the community together', 'they get people involved in local issues', 'provide income and jobs' or 'people can learn about local culture or history' (between 20 and 35%). Regarding to the above mentioned statements, some res-



**Figure 4.** Answers to the question of how important trees, woodlands and forests are for respondents

**Slika 4.** Odgovori na pitanje koliko su drveće, šumski predjeli i šume važni za ispitanike

**Table 1.** Levels of awareness among visitors of The 19<sup>th</sup> International Horticulture Fair in Belgrade

**Tablica 1.** Razini znanja posjetitelja 19. Međunarodnog sajma hortikulture u Beogradu

	KNOWLEDGE AND AWARENESS/ZNANJE I SVIJEST			
	'I have never heard of it'/'Nikada nisam čuo o tome'	'I have heard of it, but know nothing' about it'/'Čuo sam ali ništa ne znam o tome'	'I have some knowledge about it'/'Znam nešto o tome'	'I know a lot about it'/'Znam mnogo o tome'
Anoplophora glabripennis	47%	26%	23%	4%
Cryphonectria parasitica	55%	25%	12%	6%
Bursaphelenchus xylophilus	69%	17%	12%	2%
Agrilus planipennis	69%	23%	8%	0%
Hymenoscyphus pseudoalbidus	63%	24%	6%	7%
Median Degree of Awareness/ srednji stepen svijesti	60.3%	23%	12.5%	3.8%

**Table 2.** Knowledge about pathways of introduction of diseases and pests

**Tablica 2.** Znanje o putevima unošenja bolesti i štetnika

	A. glabripennis	A. planipennis	B. xylophilus	C. parasitica	H. pseudoalbidus
On imported plants/na uveženim biljkama	38	38	30	39	37
On imported wood/na uveženom drvetu	27	19	21	20	19
Natural dispersal/prirodno rasprostranjenje	10	18	23	19	22
On firewood/ na ogrevnom drvetu	7	7	7	10	7
Via water/pomoću vode	2	4	4	3	5
Via animals/pomoću životinja	5	6	8	5	3
Via humans/pomoću ljudi	11	8	7	4	7

pondents (less than 10%) expressed disagreement and strong disagreement (Figure 4).

The respondents were asked to give a statement about what the main reasons were for their visits to forests and woodlands. The majority visit woodland for recreational purposes,

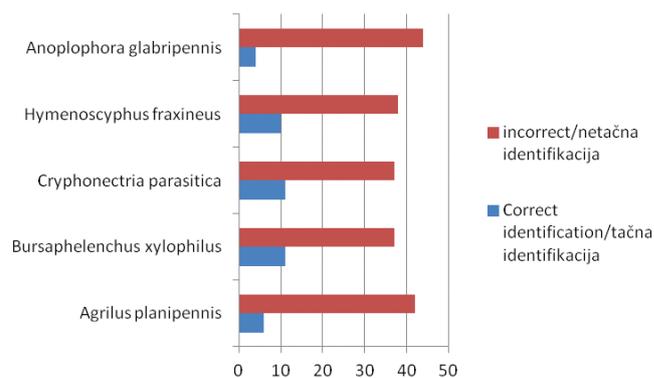
to find peace and solitude or for a holiday. Other reasons for visits were given as beekeeping, to learn about plants and animals, to learn about biology, to attend scout camps etc.

One of the questions for respondents was to estimate their level of knowledge about some pests and diseases. A four

point scale was offered from 'I have never heard of it' to 'I know a lot about it'. As is shown in Table 1, the level of knowledge is either low or very low. The best knowledge and awareness (approximately 27%) was estimated by respondents in the case of *Anoplophora glabripennis* (Motschulsky) (Coleoptera: Cerambycidae), a quarantine pest in Serbia. The lowest level of knowledge (8%) was for the alien insect *Agrilus planipennis* Fairmaire (Coleoptera: Buprestidae), which is also a quarantine species. A surprisingly low level of knowledge was estimated for *Cryphonectria parasitica* (Murrill) Barr (Diaporthales: Cryphonectriaceae), fungus of Asian origin, which is common in Serbia on chestnut trees and forests. Only 16.30% of respondents feel that they 'know a lot' about the selected pests and diseases. The majority of respondents (60.30%) answered that they have never heard of these tree pests and pathogens. According to their self estimated levels of awareness, 83.30% of respondents are not at all familiar with those pests and diseases which could pose the highest threat to our forests.

Concerning public awareness about the pathways of introduction of alien species, a large majority of respondents was of the opinion that imported plants and imported wood are the main pathways for the introduction of alien pests and pathogens (Table 2). Natural dispersion is also a concern of theirs, which is correct for pathogens and some pests. The level of public awareness of pathways is considered to be insufficient.

Respondents were asked to match the pest or pathogen with the symptoms on the infested or infected tree. They were successful in identifying the correct pairs in 4-11% of cases. The worst result was for *Anoplophora glabripennis*, and *Agrilus planipennis*, both quarantine species which could threaten our forest ecosystems once introduced into our country. Respondents were more successful in identifying *Cryphonectria parasitica*, which is already present in our forests. It could be concluded that the knowledge among respondents about the symptoms of alien pests and diseases is very low (Figure 5).



**Figure 5.** Level of knowledge about the symptoms of some pests and diseases on trees

**Slika 5.** Razino znanja o simptomima nekih štetnika i bolesti drveća

Governmental bodies are, by The Plant Health Act and related legislation, obliged to organise monitoring, inspections and to provide information in order to prevent the import and spread of quarantine pests and pathogens. Respondents were asked to give their opinion about the effectiveness of governmental measures (Table 3). The measures listed in the questionnaire were: quarantine, monitoring and surveying, border control, nursery inspections and the provision of information and public awareness. The effectiveness of the measures was considered to be low. According to the mean value of effectiveness, one fifth of respondents judged quarantine, monitoring, information provision and public awareness as effective. The judgment about the effectiveness of border control and health surveys of nursery stock was even lower (18.25% and 18.75%).

Respondents were asked to choose from, and rank, 6 options related to who they would report to if they found a pest or a diseased tree. The options were local authorities, government, conservation groups or agencies, garden centres/nurseries, friends, family and neighbours or nobody. The results show that respondents most trust the nature protection agency, government and local authorities. Garden centres and nurseries and public enterprises managing forests

**Table 3.** Effectiveness of governmental measures

**Tablica 3.** Učinkovitost državnih mjera

	Quarantine/ Karantin	Monitoring and Survey/ Monitoring i nadzor	Border control/ granična kontrola	Health survey of nursery stock/ zdravstveni pregled rasadnika	Information provision and Public awareness/ obavještanje i svijest javnosti
Highly effective /jako efikasno (%)	17	10	30	28	15
Effective / efikasno (%)	20	21	18	21	20
Neutral, no opinion/neutralno, nema mišljenje (%)	23	31	13	12	21
Not effective/ nije efikasno (%)	24	24	12	14	26
Mean effectiveness / srednja efikasnost (%)	21	21.5	18.25	18.75	20.5

were also recognised as being responsible for the health of trees and woodland.

Respondents were asked an open question about who else (an individual or organisation) they would report to if they found a diseased tree or a tree pest. Most respondents chose educational establishments and research institutes (The Faculty of Forestry, The Faculty of Agriculture and The Institute of Forestry) or, in second place, governmental institutions (Ministries, inspectorates, local government or the secretary for nature protection). Some respondents would inform the public enterprise “Srbijasume”, responsible for the management of forests in Serbia and the public enterprise “Zelenilo Beograd”, managing green infrastructure in Belgrade. Only one respondent would share information about new pest or diseased tree on a social network on the internet.

The survey also focused on research concerning the behaviour of respondents. They were asked what actions they already take, or would take in the future, in order to prevent or stop the spread of tree pests and pathogens. Almost all of them answered that they buy plants from registered nurseries or distributors (98.41%). More than half the respondents (52.38%) do not buy imported plants or would be willing to make the decision not to buy imported plants. More than 52% do not dump waste garden plant material and, additionally, 25% would be ready to adopt such behaviour. About 20% of the respondents do not take any action and, in the future, 11% of them would not take any action.

An open question was asked regarding what factors might prevent respondents from changing their behaviour. The majority of answers pointed to a lack of information about pests and pathogens, information on invasive species and education. Some respondents pointed out the importance of legislation related to plant protection and the effective, strict surveying of invasive alien species.

Respondents are aware of the threat from new imports of alien invasive species, as 48% of them agreed with the statement that it is ‘high likely’ that more tree pests and diseases could be imported into the country or region. Additionally, 31% were of the opinion that it is “likely that new imports could occur”. Research revealed that 79% of respondents are aware of the risk that new alien species of tree pests and pathogens could be introduced.

Research on the sources of information used to gain knowledge about tree pests and pathogens indicate that the majority of visitors to The 19<sup>th</sup> International Horticulture Fair usually use three sources (23.40%) or one and two sources (21.28%). The internet is the most frequently used source of information (29%). In second place are educational establishments (15%) and the third most frequent used sources are newspapers and trade journal articles (14%). Professional organisations which provide lifelong learning

are recognised as a source of information for 12% of the respondents.

Preferable types of pest and disease information are about pathways, the identification of pests, photos of pests and their symptoms. Respondents suggested field trips to the affected area or forest. They would like access to information which is simple enough to be understood by non professionals and would prefer to obtain descriptions of species and their symptoms, with illustrations and suggested control measures. Respondents would prefer to receive information through lectures, seminars, training, as well as in the form of TV programmes, printed brochures, books, newspapers, on web sites or other internet sources.

## DISCUSSION RASPRAVA

Research on public awareness of tree pests and pathogens revealed that this knowledge is currently insufficient. Research documented that 60.30% of respondents have never heard of the selected tree pests and pathogens. The results reflect the current limited availability of literature providing such knowledge and awareness (Hurley et al., 2012; Tomićević et al., 2012). The survey of public awareness of invasive species, conducted in Belgrade, revealed that 54.17% of respondents were not familiar with alien invasive plants. Additionally, the majority of them (87.50%) expect public information regarding this phenomenon to be provided (Tomićević et al., 2012). Public awareness as well as knowledgeable professionals are important for both the prevention and the reduction of the spread of biological invasions (Liebhold et al., 2012; Liebhold et al., 2013; Haack et al., 2010, Hurley et al., 2012). Research is a very important resource for shaping policy and management responses to biological invasions. Furthering knowledge does not mean that it will be applied or that it offers a practical solution (Bayliss et al., 2013).

The early detection of alien pests is of crucial importance for their successful control. In the case of the invasion of *Agrilus planipennis* in Moscow, samples were first collected in June 2003 and it was identified in 2005. Consequently, it was realised that this species was responsible for ash dieback in Moscow. In the period from 2006 to 2013 it spread from Moscow up to 230 km westwards, at an average speed of 10–12 km per year. Based on recorded data from the USA, where *A. planipennis* caused noticeable damage to ash trees 10–15 years after its first introduction, it was concluded that this pest was probably introduced into Moscow in 1990 (Baranchikov, 2014). The American experience with alien species is well documented using historical data; range areas are strongly correlated with time since establishment. The average radial rate of range expansion is 5.2 km per year, and this rate does not differ among foliage

feeders, sap-feeders, wood borers or plant pathogens (Liebhold et al., 2013). Residents, teachers, tree professionals and other stakeholders require an awareness and knowledge of alien invasive species in order to identify them or their symptoms and apply early warning measures to mitigate their influence on cultivated trees and forests. More than a half of respondents attended seminars about pests and diseases held by the Faculty of Forestry at the University of Belgrade in the period from 2004-2014 and obtained information about alien species by way of lectures. It is likely, however, that they are not able to apply their knowledge and identify pests and diseases. This suggests that there is need to develop the appropriate educational technology in order for them to gain more practical knowledge and use it as a practical solution.

Although the level of knowledge of respondents about pathways is insufficient; they are of the opinion that imported plants are the main pathway for forest insect and pathogen invasion, which corresponds to research in the USA (Liebhold et al., 2012). Phytosanitary legislation and regulations governing the import of plants for planting are based on the International Plant Protection Convention and the World Trade Organisation's Agreement on Sanitary and Phytosanitary Measures. The integrated measures for plants for planting described in ISPM 36 (FAO, 2012) are likely to reduce the level of contamination of exported plants (Eshen et al., 2015). Educational technology enables the easy sharing of information on legislation, tree pests and pathogens and, thus, supports lifelong learning and public awareness.

Governmental measures for the prevention of biological invasions are considered to be of low effectiveness, with respondents primarily trusting local authorities, educational establishments, then government and the environmental protection agency. If they found a pest or a diseased tree, they would first inform these institutions. It appears very positive and optimistic that respondents are ready to change their behaviour and perform actions which could represent preventive measures resembling the best practices of Europe and the USA. The most powerful motivation for adults to learn is pleasure, self-respect and respect for others (Tough, 1979, Savićević, 2007). Respondents are eager to gain knowledge about pests and pathogens and they use multiple sources in order to achieve this. The most preferred sources of information are the internet, (e.g. web portals), brochures and articles in newspapers or trade journals. Respondents would prefer to receive information through lectures, seminars and training, with detailed descriptions of pests and pathogens and their biology, well illustrated and with suggested control measures. Motivation among respondents to improve their knowledge and awareness about alien invasive species could be a very important and helpful resource for early detection, especially in private gar-

dens, where monitoring and surveying are not done on a regular basis.

Educational technology could fulfil many requirements of the process of developing public awareness of tree pests and pathogens. The transfer of knowledge is an important issue, especially where public knowledge and awareness is concerned. Problem-based learning as a learner-centred approach is suitable for education and lifelong learning. It is essential that individuals themselves take responsibility for this learning. Learning should be integrated from a wide range of disciplines or subjects, as this meets the needs of a multidisciplinary approach to integrated forest protection. During the process of learning, collaboration is also an essential element. One of the main characteristics of problem-based learning is that it must be valued in the real world. This is exactly what is needed in order to raise public awareness about pests and pathogens and improve professional practices.

## CONCLUSIONS ZAKLJUČCI

The survey about tree pests and pathogens was conducted among 63 respondents from Serbia with an almost equal gender balance and an age range from 18 to 49 years. We could conclude that the current level of public awareness regarding tree pests and diseases, their pathways of introduction and the effectiveness of the dissemination of knowledge are currently low or very low. Continued and increased efforts are needed to achieve the level of public knowledge and awareness which could support governmental measures and responsible behaviour related to plant health issues. They should be aimed at citizens, hobby horticulturists, vocational secondary schools and university level education. A system of approach is required to enable the valuable scientific resources already available to meet the needs of public users. It would also be beneficial to provide an opportunity for experienced tree professionals, social scientists and educational and IT experts to contribute to the better communication and transfer of knowledge. This would better meet the requirements of effective biosecurity practices among diverse stakeholders and improve their knowledge and awareness about tree pests and pathogens.

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## Sažetak

Proučavanje razina znanja i svijesti javnosti među posjetiteljima 19. Međunarodnog sajma hortikulture, održanog u Beogradu od 03. do 04. 2014. godine, sprovedeno je putem samostalnog popunjavanja upitnika. Svijest javnosti (stanovnika, učitelja, profesora srednjih stručnih škola, stručnjaka za njegovanje drveća i drugih korisnika) i znanja o invazivnim vrstama su neophodna za njihovo rano otkrivanje, primjenu strategije "uspore širenje" i upravljanje populacijama invazivnih stranih vrsta. Proučavanje svijesti javnosti i znanja o pet odabranih štetočina i bolesti drvača pokazala su da 83.3% ispitanika nemaju znanja o njima. Ispitanici su upitani kaka bi pokazalu praktično znanje i povezalu štetočinu ili patogena sa simptomima na drveću i samo 4-11% su bili u stanju da daju točan odgovor. Odnos javnosti prema pitanjima zdravlja bilja je pozitivno. Skoro svi ispitanici kupuju biljke samo od registrovanih proizvođača, odnosno od dobavljača i registriranih rasadnika i više od pola njih ne kupuje uvezene biljke i svjesni su rizika da još stranih invazivnih vrsta može biti uvezeno u zemlju ili regiju preko uvoza biljaka, kao najvjerojatnijeg puta unošenja istih.

Ispitanici se koriste višestrukim izvorima kaka bi dobili znanje o štetočinama i patogenima. Najčešći izvor kojim se koriste je internet, neposredno učenje u obrazovnim ustanovama (predavanja, seminari i sl.), novine i časopisi o trgovini. Ispitanici su motivirani ne bi li dobili više znanja o štetočinama i patogenima, putevima njihovog unošenja i to ponajprije kao informacija a interneta, televizijskog programa, tiskane brošure i iz knjiga. Tehnologije podučavanja omogućavaju lako širenje informacija o zakonskim propisima, štetočinama patogenima i dobra su pomoć u realizaciji cjeloživotnog učenja i poboljšanja svijesti javnosti. Problemsko

učenje, kao pristup usmjeren prema onome tko uči, pogodana je metoda za obrazovanje odraslih. Najvažnije je što se odgovornost za učenje prebacuje na osobu koja uči. Učenje treba biti integrisano iz više izvora ili subjekata, i to odgovara primjeni multidisciplinarnog pristupa u učenju o integralnoj zaštiti šuma, zelene infrastrukture i okoliša. Suradnja je neophodna u procesu učenja. Jedna od osnovnih osobina problemskog učenja je da ono mora biti vrednovano u praksi. To je neophodno da bi se podiglo razino znanja i svijest javnosti o štetnicima i bolestima i poboljšala praktična primjena znanja.

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**KLJUČNE RIJEČI:** svijest javnosti, štetnici i bolesti drveća, putevi unošenja, tehnologija podučavanja, cjeloživotno obrazovanje