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20-22 June 2018

BOOK OF ABSTRACTS

IUFRO

University of Belgrade
Faculty of Forestry

REFORESTA

International Conference

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Vladan Ivetić and Jovana Devetaković

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KEYNOTE SPEAKERS

Changing climate, changing challenges, changing reforestation practices

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Our forests are under extreme pressures from anthropogenic activities that either remove forests entirely or chronically degrade them; both lead to ever-increasing losses of biodiversity and ecosystem services. While perhaps the most prominent effect of anthropogenic activity is climate change, other human activities, such as surging global population and inherent associated demands for food and shelter, and international trade that facilitates an escalating introduction of invasive and/or destructive pathogens and other pests, are noteworthy challenges as well. And, all of these activities interact. Thus, for land managers, their traditional reforestation practices after conventional forest harvesting and forest restoration efforts may need to embrace a suite of new approaches in order to be successful against these mounting pressures. Broadly, these new approaches (and/or more vigorous focus on current practices) fall under the umbrella of the Target Plant Concept. Project objectives may need to favor changes in planting density and/or species composition to ensure functioning forest ecosystems, especially with anticipated increases in the frequency, duration, and intensity of drought events. In addition, local assisted migration of populations within existing ranges, and expansion of ranges into proximate areas, may be necessary to maintain adaptation with shifts in climate. Rapid responses to invasive pests and pathogens may require using molecular genetics and genetically engineered seedlings to maintain species on the forest landscape. And, continued emphasis on growing seedlings with proper morpho-physiological characteristics, efficient and effective site preparation, and outplanting during the best atmospheric and edaphic conditions remain essential to success. Finally, implementing new approaches, especially those concerning assisted migration and bioengineering, may face significant social hurdles. Thus, framing the debate in specific contexts and providing land managers more definitive science-based evidence of potential risks and benefits will be essential.

Keywords: Climate change; Assisted Migration; Invasive Species; Biotechnology; Functional Restoration; Reforestation; Forest Restoration

The role of nursery production in global forest restoration efforts

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Seedlings are the foundation for many terrestrial ecosystems and are a critical consideration and investment for implementing global forest and landscape restoration programs. Global leaders have pledged to restore millions of hectares during the next decade, necessitating many millions of established plants. Although natural regeneration and direct seeding will likely meet a portion of that need, large quantities of high-quality, nursery-grown seedlings are also required. Insufficient plant quantities or poor-quality plants result in unsuccessful outplanting programs. Such failures have considerable economic and environmental consequences and will result in an inability to meet restoration goals. Nonetheless, the importance of restoration nurseries is often overlooked when making large-scale restoration commitments. Technology already exists to produce high-quality plants to meet a variety of goals. This technology cannot be applied, however, unless adequate resources and training are made available by overcoming political and socioeconomic barriers.

Keywords: Nursery; Bonn Challenge; Seedling; Reforestation; Restoration

Target Reforestation: preparation of high-quality seedlings through root manipulation and LED spectra treatments

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Demands for forests products and services are growing due to rising population. These demands are to be met without prejudice to forest survival and to biodiversity conservation. These drivers due to societal demands add up to other drivers due to climate changes such as 1) increase in mean temperature, 2) alteration of precipitation patterns, 3) increase of carbon dioxide concentrations. To make matters worse, it is necessary to add also the increasing frequency of extreme weather events such as droughts, wildfires, pests and diseases attacks. The picture emerging shows a condition where the forests at a global scale are under siege. The response to this challenge rests in the new concepts of Forest Landscape Restoration (FLR) that highlight the need to increase the biophysical adaptive capacities of trees and forests. The need for a better resilience capability at single-tree-scale as well as at stand- and landscape-scale is also supported by the New Generation Plantation (NGP) concept. The above considerations lead to the need to adapt the overall objectives and practices of a forest nursery to prepare New Generation Seedlings (NGS). The preparation of NGS with an improved adaptive strength requires the collaboration of trans-disciplinary expertise in various fields. In recent years, we have been called to use our expertise in root growth and development in order to understand how this anatomical portion of a tree responds to challenges such are drought, fire, and uprooting (due to terrain's slope). The data collected by us in regard of root response to these environmental stresses indicate that the trees are able to adapt by modifying their root architecture and achieve a higher degree of fitness to the modified rooting environment. These responses are qualitatively and quantitatively specie-specific and take place at any developmental stage, even in adult trees. A better knowledge of the events (also at a cytological and molecular level) occurring in the roots to adapt to the new rooting conditions is preliminary to its exploitation at biotechnological level. Engineered seedlings for reforestation to achieve a higher resilience at stand and landscape level is the new frontier but good results are obtainable also without resorting to genetic technique. As for example, our data show that the less expensive nursery approaches such as the use of LED lights or chemical pruning can induce variations in the development of roots that could result to be an advantage in the growth potential following transplantation in the fields.

Keywords: Seedlings; LED; Pruning; Reforestation

Plantation silviculture in eastern Canada in a changing world

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Canada's forests cover nearly 400 million hectares, and about 575,000,000 seedlings are planted every year. Plantation activities in eastern Canada account for 44% of the seedlings planted annually in the country. They are used to meet a wide variety of social, economic, and environmental objectives. Examples include complementing natural regeneration when seedling establishment success is low, the reconstruction of functional forest ecosystems on degraded lands, the restoration of original species assemblage, or the replacement of species with new plant genotypes as a response to climate change. Plantations further offer the potential to substitute part of the harvest usually performed in natural forests to obtain commodity wood for the lumber and pulp and paper industries, hence allowing setting aside areas that can be dedicated to extensive management or protection. Plantation silviculture shows, however, the greatest potential for the artificialization of natural forests, which appears antagonistic to ecosystem-based management –the overarching paradigm in most of Canada's provincial jurisdictions. Thus, plantation silviculture in eastern Canada is faced with issues related to the localization, scale, and arrangement of plantations, their productivity and profitability, the key attributes and resilience of natural forests, and the social acceptability of the treatments involved, including the use of genomics and exotic species. Moreover, global change brings new challenges that potentially require revisiting traditional approaches in plantation silviculture. For example, traditional site preparation or vegetation management approaches may not be efficient to deal with site invasion by new competing species, either native or exotic. Also, silviculture must be adapted to cope with changes in species phenology due to climate change or to create more complex plantations with an increased resilience to pests, diseases or climate extremes. Research is ongoing to face these challenges and support sustainable management of Canadian forests.

Keywords: Reforestation; Boreal Forest; Acadian Forest; Canada; Vegetation Management; Site Preparation; Issues; Ecosystem-Based Management

Seedling establishment to the forest stand
The perilous journey

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Seedling field performance is affected by both seedling quality and reforestation site conditions. If these environmental stresses are excessive or seedlings are of poor quality, then mortality can occur. Seedlings enter the establishment phase on reforestation sites when they start to develop root systems into the surrounding soil, thereby overcoming transplanting stress. This is why initial seedling growth just after planting is critical to their survival. Once seedlings are established, their inherent growth potential is related to their morphological and physiological attributes and their ecophysiological response to site environmental conditions, which ultimately determines seedling field performance. This establishment phase is a time when seedlings developed as specific stocktypes or treated with certain nursery cultural practices begin to respond to site conditions. The establishment phase is also a period when silvicultural practices have reduced the vegetation, thereby creating sites free from competition of established plants. Before the site is reoccupied with a new vegetation complex, planted seedlings typically have an opportunity to develop under open site conditions. As a result, seedlings can be exposed to a wide range of environmental conditions, some of which may be extreme enough to exceed the ability of the seedlings to physiologically tolerate environmental stress. When this occurs, growth of seedlings on the reforestation site is reduced. On the other hand, this phase can also provide the planted seedlings with ideal environmental conditions that allow for an optimum physiological response and a maximization of their growth potential. An understanding the ecophysiological capability of the planted forest species in combination with desirable seedling quality attributes can ensure the planted seedlings have the best chance at rapid plantation establishment.

Keywords: Ecophysiological Approach; Seedling Establishment; Seedling Quality

ORAL PRESENTATIONS

Tree improvement may contribute to increased carbon accumulation in forest standing biomass

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Tree improvement through selection and breeding of proper planting material has a potential not only to enhance tree growth, but also to alleviate increasing concentrations of atmospheric $CO_2$by enhancing capture of atmospheric carbon (C) and its sequestration in the biomass. We assessed the ability to accumulate carbon in standing aboveground biomass of 36 populations of Scots pine (*Pinus sylvestris* L.) growing at four sites of a provenance trial in Poland, and compared it to commercial pine stands at the same age. For this purpose we measured diameters and heights of all live trees the trial. For each site we chose reference stands where we measured trees at 4 to 5 (0.02 ha) circular plots. We used a series of allometric equations to estimate biomass of individual tree components, and converted it to C using percentage values available in the literature. Mass of carbon was summed at the plot level and expressed at per hectare basis.
We found significant differences in C productivity among sites and among studied populations. However, ranks of populations varied among sites. On average, accumulated C in standing biomass at provenance trials was from 13.2-16.7% greater to 11.2-17.3% lower than in the reference stands, depending on location and the allometric equation used. Our results indicate that, depending on location, the choice of proper planting material would lead to the increase in aboveground biomass C accumulation at age of 52 years by 60 to 100% compared to the current commercial stands of Scots pine in Poland. However, due to the existence of provenance-by-site interaction the more realistic estimate of the likely increase in C accumulation would amount to 10-30% over current commercial stands. Our data also point to a high value of Scots pine provenances from the southeastern Poland in terms of their growth and adaptability.

Keywords: Biomass; Forest Carbon; Provenances; Tree Breeding

Challenges in reforestation with native species in restored sodic soils: Application of basic and applied research results in Haryana India

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Large tracts of once productive farmlands in the Indo-Gangetic plants of India were degraded due to intensive cropping and over-irrigation leading to soil salinization and alkalization. Such soils were afforested with salt-tolerant tree species *Prosopis juliflora* in late 1980 and study results indicated that a broad range of soil and plant processes such as biomass accumulation, understorey vegetation development, and recycling of litter restore productivity of degraded sodic sites after afforestation. In this paper emphasis is on the application of these basic processes and their interactions to arrive at theoretical explanations for reclamation of sodic soils by *Prosopis juliflora* and their long term sustainable production with a management regime, which achieves production combined with conservation of resources. Evidence is given from experiments, which involved planting of native tree species after clear felling of 25 year old *Prosopis* plantations planted on sodic soils (25 years ago) and resultant survival, growth of seedlings and associated processes observed after five years of planting. It is demonstrated that results support the hypothesis that maintenance of tree cover for a longer duration than those suggested in the earlier studies may be necessary for the sustaining the improvements in soil physical, chemical and biological properties and resultant soil productivity.

Keywords: Alkaline soils; Eco-restoration; Ecological rotation; Native species; Sustainability

Morphology in seed orchard and seed stand seedlings of Brutian Pine (*Pinus brutia* Ten.)

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Turkey has 22.3 million ha forest area cover is about 28.6% of Turkey managed by General Directorate of Forestry of which about half of the area (9.6 million ha) is unproductive (Anonymous, 2016). Forest establishment, included afforestation, reforestation /artificial regeneration, rehabilitation, erosion control, avalanche control, energy forest is the most important way in conversion of unproductive forest to productive, and also to increase present productivity of product forest. According to inventory of between 1946 and 2013, about 4 million ha forest was established or improved. 14 billion seedlings and 8 thousand tones seeds were used in the establishment (Bilir and Gulcu 2015). However, it is known that there are many genetical and environmental factors in success of the conversion from seed harvest to plantation or other forestry practices. Seedling morphology produced from improved seeds is one of the most important factors in biological and economical success in forest establishment. This study was carried out on 1+0 year bare root seedlings originated from a seed stand (latitude- 39° 24' 46" 'N, longitude – 28° 21' 50" E, altitude 450 m) and a seed orchard (latitude- 40° 11' 51" 'N, longitude – 27° 32' 25" E, altitude 320 m) of Brutian Pine (*Pinus brutia* Ten.) at Dursunbey Forest Nursery (latitude-39°32'50"N, longitude 28°39'24"E, altitude 400 m) of Turkey to contribute nursery practices, plantation, and genetic-breeding of the species. Seedling height and root-collar diameter were examined on 150 seedlings chosen randomly in each seed sources at the end of growing period of 2017. Averages of seedling height and root-collar diameter were 11.5 cm and 2.61 mm in orchard seedlings, while they were 12.2 cm and 2.64 mm in stand seedlings, respectively. Significant difference ($p<0.05$) between orchard and stand seedlings for seedling height was found according to results of variance analysis, while they were similar ($p>0.05$) for root-collar diameter. 12% for root-collar diameter and 49% for seedling height of stand seedlings were cull/unsuitable for plantation, while they were 38% and 11% of orchard seedlings according to quality classes of Turkish Standard Institute. The results showed that seed stand seedlings had higher growth performance than that of orchard seedlings. Similar results were also reported in other studies of the species (Dilaver et al. 2015, Cercioglu and Bilir 2016). Positive and significant ($p<0.05$, $r=0.812\&0.774$) relations were found between seedling height and root-collar diameter in both seed source based on results of correlation analysis.

Keywords: Afforestation; Forest establishment; Plantation; Seedling Quality

Serbian spruce conservation - current status and prospects for the future

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Available predictions on the effects of the global climate change on forest tree species demonstrate severe rearrangements of their range distribution in the future. Forest tree species with a limited natural range are the most threatened ones because their genetic variation may be lost rapidly, their migration to more suitable habitats may be impossible, and their adaptability may simply be insufficient to keep up with the accelerating rate of climate changes. Serbian spruce [*Picea omorika* (Panč.) Purk.] is a rare conifer endemic to the Balkans with c. 30 remnant populations scattered within an area of c. 100 km^2 and comprised of several hundreds to several thousands of trees. This species was legally protected by the law since 1950, and it has been IUCN red-listed in 1998 (category endangered). We present available data on Serbian spruce neutral genetic diversity and genetic structure, adaptive variation inferred from past translocations, and discuss current and future conservation measures required for the species long-term survival.

Keywords: *Picea omorika*; Conservation; Genetic Diversity; Adaptability

This work is funded by the Ministry of Education, Science and Technological Development of the Republic of Serbia, project number 173030.

Variation of morphology and quality in 1+0 year containerized and bare-root seedlings of Taurus cedar (*Cedrus libani* A. Rich)

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Turkey has 22.3 million ha forest area cover is about 28.6% of Turkey managed by General Directorate of Forestry of which about half of the area (9.6 million ha) is unproductive (Anonymous 2017). Taurus cedar or also called Lebanon cedar (*Cedrus libani* A. Rich) has the largest natural distribution in Turkey by 482391 ha of which 49 % to be unproductive in whole the world (Anonymous, 2017). Forest establishment, included afforestation, reforestation/artificial regeneration, rehabilitation, erosion control, avalanche control, energy forest is the most important way in conversion of unproductive forest to productive, and also to increase present productivity of product forest. However, it is known that there are many genetical and environmental factors in success of the conversion from seed harvest to plantation or other forestry practices. Seedling morphology produced from improved seeds is one of the most important factors in biological and economical success in forest establishment. However, seedling morphology and quality originated from seed orchard which is an important improved seed sources have not been studied in the species, yet. It could be said that this is first study in seed orchard seedlings of the species. This study was carried out on 1+0 year containerized and bare-root seedlings, originated from a seed orchard (latitude- 37° 47’ 00” ’N, longitude – 35° 44’ 30” E, altitude 1325 m, Adana-Feke) of Taurus cedar, produced at Adana-Kicak Forest Nursery (latitude 37°34'40”N, longitude – 35°12'45”E, altitude 980 m) of Turkey to contribute nursery and afforestation practices, and genetic-breeding of the species based on height and root-collar diameter of 100 seedlings chosen randomly in each seedling type at the end of growing period of 2017. Containerized seedlings showed higher growth performance than bare-root seedlings for both height (10.3 cm & 7.3 cm) and diameter (3.1 mm & 2.1 mm). Besides, there was significant difference ($p<0.05$) between seedling types for the characteristics according to results of variance analysis. 12% for seedling height (height<6 cm) and 41% for root-collar diameter (diameter<2mm) of bare-root seedlings were cull/unsuitable for plantation, while they were 7% and 9% of containerized seedlings according to quality classes of Turkish Standard Institute. Results of correlation analysis showed positive and significant ($p<0.05$) relations between height and diameter in both seedling type.

Keywords: Afforestation; Forest Establishment; Plantation; Seedling Quality

The use of molecular diagnostics to improve the quality of forestry seedlings

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The quality of nursery seedlings play an important role in determining the success of reforestation. During the cultivation of seedlings, nurseries must make irreversible decisions which can have a major effect on the seedling vitality. Therefore, it is important that nurseries have access to reliable methods that can help them through those decision-making moments.
In Sweden, about 200 million Norway spruce (*Picea abies*) seedlings are annually planted. A great portion of these seedlings are transferred into frozen storage in late autumn to prevent seedlings from outdoor winter damage. For seedlings to be able to survive in storage it is crucial that they are storable and can cope with the cold and dark storage environment. Already for a decade, NSure has a freezing tolerance assay on the market for Norway spruce. This test, the ColdNSure test, is based on measuring the activity level of a set of genes that are involved in freezing tolerance development.
Another key attribute in the cultivation of Norway spruce is the dormancy status. The dormancy cycle of Norway spruce is strongly affected by seasonal changes in day length and temperature. To prepare seedlings for autumn planting or frozen storage, nurseries perform a short-day treatment during summer. A short-day treatment does not only inhibit plant growth and promote bud set, but also induce dormancy and eventually freezing tolerance. It is relatively easy to determine plant growth and bud set, but measuring the level of dormancy and its relationship to subsequent freezing tolerance is complex. Within this study, we demonstrate that the expression of dormancy related genes can be used to monitor the dormancy level. Furthermore, by using the existing ColdNSure test, we were able to demonstrate that a short-day treatment stimulates the freezing tolerance, thereby speeding up the moment of storability.

Keywords: Gene Activity; Short Day Treatment; Freezing Tolerance; *Picea Abies*; Seedlings; Molecular Tools

The effectiveness of coconut substrate and fertilization regimes during nursery culture and post-transplant response in three *Quercus* species

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In Mediterranean countries, the intensity and length of spring and summer dry periods are becoming harsher. The frequency of such phenomena is likely to increase in the future in Mediterranean areas of Italy, and also in the northern regions, following climate change scenarios. These conditions will reduce post-transplant survival and growth and influence forest restoration planting success. To improve nursery stock quality for overcoming 'transplant shock' and to promote environmentally sustainable nursery production, we tested a conventional peat-based substrate *versus* coconut fiber substrate, in combination with three different fertilizations (nursery standard; phosphorous-enriched; and potassium-enriched) on *Quercus ilex*, *Quercus pubescens*, and *Quercus robur*, which differ in drought resistance adaptability. In 2017, seedlings were grown in a nursery in Central Italy under well-watered conditions. Growth (48 seedlings per treatment, 2592 in total) and physiology was followed during the growing season by chlorophyll fluorescence, leaf spectroscopy and gas-exchanges techniques. At the end of the season, above- and below-ground biomass and morphological traits were measured on a sub-sample (15 seedlings per treatment). In May 2018, a "speed water-stress test" was performed under controlled greenhouse conditions by exposing seedlings to 3 water stress levels: control (field-capacity irrigation), medium (50% of control irrigation) and strong (water-suspension). Concurrently, post-transplant establishment, growth and physiological responses are being tested in open-field under natural environmental conditions. We present the mid-term results of the project.

Keywords: Seedling Quality; Forest Nursery; Enriched Fertilization; Renewable Nursery Substrate; Water Stress; *Quercus*

Substrate influence on the quality of seedlings of ornamental trees produced in pots

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The production of quality planting material of the most commonly used woody species for the needs of „greening "of urban areas is a complex problem caused by several factors. One of the most important factors in the production of seedlings in pots is the choice of the appropriate substrate.
In the nursery of Tamaris Company (near Banja Luka, Bosnia and Herzegovina), 4 most frequently used taxa for planting in urban areas of Bosnia and Herzegovina were tested: two varieties of northern white-cedar (*Thuja occidentalis* L.): 'Emerald Green' and 'Columna'; then Europen box (*Buxus sempervirens* L.) and Forsythia *(Forsythia × intermedia*). Rooted one-year old cuttings were transplanted into pots of two liters volume in 5 different substrates: soil, compost, lumbric humus, peat and a combination of all of these substrates. At the end of the growing period, morphometric parameters of the seedlings were measured, and on the basis of these parameters, the quality indexes were determined.
The results indicate that each of the tested species and varaities did not react equally in different substrates. In general, the best results were obtained by using lumbric humus and compost of local producers, although some seedlings, for example, *Thuja occidentalis* 'Emerald Green' had almost the same values regardless of the used substrate. Recognizing the fact that the prices of the used substrates are not the same, the production of these taxa seedlings with significantly better quality can be planned with less production costs.

Key words: Substrate; Planting Material; Ornamental Trees

Changes in forest nursery seedling production in the XXI century in Mexico

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During the first two decades of this century, forest nurseries in Mexico have made major advances toward improving the quality of the stock they produce. Currently, about 300 forest nurseries produce about 210 million plants annually, although the number of nurseries in the past has varied from 150 to more than 600. Most of the changes involved the production system, nursery facilities, containers and substrates used, and cultural practices applied. The use of polybags dropped from 90% of production 30 years ago, to 50% in 2000, to just 5% today. Now, the container production system (e.g., multiple Styrofoam or hard-sided cells aggregated into trays) accounts for 93% of production, with bareroot comprising the remaining 2%. Container volumes vary between 150 and 310 mL for the container system and between 0.7 and 3.8 L for polybags. In 2000, substrates used for container production were mainly composed of peat moss, perlite, vermiculite (60:20:20 v/v), but the composition of substrates has progressively substituted local materials such as composted pine bark and sawdust. In 2017, the five species produced in the largest quantities were *Pinus cembroides*, *P. pseudostrobus*, *P. devoniana*, *P. oocarpa*, and *P. montezumae*, with a combined production of 77.5 million seedlings (36% of national production). The most representative families were *Pinaceae, Fabaceae, Bignoniaceae, Meliaceae, Mimosaceae,* and *Cupressaceae*, which together represent more than 90% of the national production. Species corresponding to temperate climate are the most produced (67%), followed by tropical and subtropical (30%), and semi-arid (3%). Groups of produced species are mainly conifers (64%), followed by broadleaves (33%), and agaves, palms and other species representative of the semi-desert (3%). In summary, all changes have made a difference in improving seedling quality, reducing production costs and better survival after outplanting in reforestation programs.

Keywords: Nursery; Seedling Production; Containers; Substrates; Fertilization

Visualization and quantification of peat substrate moisture by fully automated moisture controlling system (SMCS) in forest container nursery

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Innovative controlling systems of peat substrate water balance for forestry nurseries have primarily focused on the problems related to water retention, which is important in irrigation management strategies especially for seedling cultivation. Water balance within the production fields in container system determines plants' growth and development, physiological activity, as well as effectiveness of fertigation.
This study explores the use of fully automatic monitoring system of peat moss substrate moisture under pine seedlings at Rudy Raciborskie forest nursery in the Silesian Country. A brand new multipoint system for this study was created. The multichannel electronic recorder MPI-DN Metronic was the main part of the project. Twelve HD3910.2 probes (three electrodes) for volumetric water content measurement were used in a distributed configu-ration. Modbus RTU protocols were used for data transmission and the results were archived into an internal 2GB memory. One probe delivers 1440 measurements a day. Based on the average substrate moisture data from the field, the recorder controls the watering system according to the precisely defined parameters. Proper placement of sensors in the field allows for accurate analysis of the temporal and spatial variability of peat moss substrate moisture. Results of the statistical analysis have confirmed that the peat moss moisture is significantly differentiated within the homogeneous production field of the forest tree seedlings. The study findings suggest that irrigation systems should be adapted to specific situation of substrate moisture at the nursery surfaces aimed at optimized water management.

Key words: Peat Moss Substrate; Irrigation; Forest Nursery; Pine; Water Content

New ranges of optimal concentrations of selected macro-elements for Scots pine, Norway spruce, European beech and English oak seedlings produced at the container nurseries

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Good growth and viability of trees can be achieved with a sufficient amount and the right proportion of nutrients in a specific pattern of their variability. The basis is rational nutrition related mainly to fertilization, an important issue during fertilization is to respond to the current demand of seedlings for nutrients possible by determining the concentration of a given element in the assimilation apparatus and comparing with the optimal value. The research was carried out with the use of cuttings produced using the container method at the Nursery Farm in Nędza, Rudy Raciborskie Forestry Inspectorate. As part of the conducted experiment, in 2014 the method of seedling production was tested, in 2015 the compaction was modified to form a thickened (ZG) and uncompressed (NZG) option, and in 2016 - fertilization, which was cut at the moment the seedling obtained the appropriate standard parameters (W1) and achieving the appropriate index of surface coverage by the assimilation apparatus - LAI (W2). Plant material was collected in 2 weeks growth period and chemical analysis of the concentration of elements in individual parts of needles or leaves in dry matter. The paper analyzes the occurrence of differences between accepted variants of the conducted experiment and their influence on obtaining optimal values of basic concentrations of macroelements: N, P, K, Ca, Mg in the assimilation apparatus. New optimal concentration ranges based on detailed three-year laboratory tests and current production methods have been created based on the conducted analyzes, which allow optimizing fertilization, obtaining "standard seedlings" at the right time, that is seedlings with appropriate growth parameters due to the optimal content of elements in the assimilation apparatus. The results of the experiment carried out take into account the moment when seedlings of individual species obtain the parameters of the "standard seedlings" and on their basis new ranges of optimal concentrations were created.

Keywords: Fertilization; Reference Seedlings; Optimal Concentration Ranges; Macroelements

Screening mycorrhizal fungi indigenous in mine tailings for the rehabilitation of mined-out areas in the Philippines

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Mine tailing areas are normally devoid of plants except ferns in the gullies and few grasses on the plateau areas. It is thought that, to bring back green cover and dead soil to life of a three decade abandoned barren mine tailing area in Barangay Capayang, Mogpog, Marinduque, rhizosphere soil of five different ferns, two species of grasses and two species of shrubs thriving in the area were collected. Mycorrhizal spores were separated from the rhizosphere soil, mass produced and inoculated into narra (*Pterocarpus indicus*) seedlings during pricking and grown in oven sterilized garden soil sand mixture. The potential of these new isolates were compared with proven plant growth promoters containing mycorrhizal fungi (MYKOVAM® and MYKORICH®) developed in the Philippines. After six months in the screenhouse, the control plants had the lowest height and stem diameter. Plants with the mine tailings mycorrhizal isolates except those from batino, promoted height and stem diameter comparable with the commercial inoculants. Plants inoculated with spores from Fern5 and MYKORICH® gave the heaviest (15.24 and 15.20 g plant^{-1}, respectively) while the control gave the lowest (3.49 g plant^{-1}). MYKORICH® promoted the heaviest (0.59 g plant-1) and the lowest (0.19 g plant^{-1}) were the control plants. MYKORICH® and MYKOVAM® promoted total dry weight by 4.35 and 3.54x, respectively, that obtained from the control counterpart. The mine tailing isolates gave 2.54 to 3.53x greater than the control (3.49 g plant^{-1}) plants. Root colonization by mycorrhizal fungi ranged from 61 to 86% as compared with 43% in the control. By contrast, spore production by mycorrhizal plants ranged from 12 to 17 spores g soil^{-1} as compared with 1.8 spores g soil^{-1} in the control counterpart. The most promising isolates under field conditions will be mass produced for the immediate rehabilitation of mine tailings in the Philippines.

Keywords: Narra; Pterocarpus Indicus; Arbuscular Mycorrhizal Fungi; MYKOVAM

Characteristics of artificial regeneration with seed sowing in sessile oak forests

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This paper presents the results of research of the successibility of artificial regeneration with seed sowing in forest of sessile oak with linden (*Quercetum petraeae tilietosum tomentosae)* on the mountain Cer in western Serbia. The surface for regeneration was prepared with removal of undergrowth floor of accompanying tree species (linden), floor of shrubs and weeds, and after that the nest sowing was conducted (three acorns in the nest) in the rows with a triangular layout, and a distance of 30 cm. The analysis of the influence of site conditions on survival, state and development of one-year old seedlings was conducted, whereby it were defined the number and dimensions of seedlings at the end of the first vegetation period of 2016. It was found that there were significant differences in survival, the achieved height and height increment of one-year old seedlings. Only every fifth plant was germinate and survived the first vegetation period, or 19.3%. In 66% of cases it was appeared one plant per nest, in 27% of cases two plants per nest, while in only 7% of cases it was tree plants per nest. It was expressed the variability of achieved heights of one-year old plants - the maximum is 26.5 cm, the minimum is 4.0 cm and the average is 12.3±4.1 cm. The phenomenon of multiphase growth was noted: one phase of growth have 11% of plants, two phases of growth have 77% and three phases of growth have 12%, which is, among other, consequence of significantly higher temperature of the air and amount of precipitation (higher for 17%) in vegetation period compared to the reference period, so the deficit of the water was only in September, and it was only 1%.

Keywords: Artificial Regeneration; Seed Sowing; Sessile Oak; Western Serbia

Nurse plants and the regeneration niche of tree seedlings in wood-pastures from North-Western Transylvania

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Facilitation is a positive interaction demonstrated to be one of the important factors shaping the regeneration niche of trees, mostly under stressful conditions which is currently studied in the frame of complex ecological networks. The protection provided by benefactor plants for tree seedlings playing the role of beneficiaries is documented mainly in arid and semi-arid habitats or in situations where herbivores' pressure constitutes the main stressful factor for tree regeneration. One of the iconic Transylvanian landscapes is the wood-pasture, also one of the oldest agro-forestry systems to which recent forest expansion in abandoned agricultural fields or pastures is added. The proposed work represents a preliminary investigation on the association between benefactor plants, mostly spiny shrubs (*Rosa canina, Crataegus monogyna, Prunus spinosa* as the most frequently encountered benefactors) and tree seedlings (*Quercus* spp., *Tilia* spp., *Carpinus betulus*, *Fagus sylvatica, Pyrus pyraster* as most frequently encountered beneficiaries), in four different locations from North-Western Transylvania, wood pasture, abandoned pasture and abandoned agricultural field under the consideration that the main stressful factor is represented by livestock grazing. Bipartite, qualitative networks were generated as well as a summary bipartite network depicting the interaction between beneficiaries and benefactors. Commonly used metrics were calculated: connectivity, nestedness, betweeness centrality and modularity and comparisons with similar facilitation networks presented in the literature were performed. Further investigations will clarify if the resulting not significant modularity is a sampling artifact due to the small number of species involved or it is a structural characteristic of the analyzed bipartite networks. The study of facilitation offers also a good perspective for reforestation and afforestation plans as an ecologically sound alternative.

Keywords: Facilitation Interaction; Nurse Shrubs; Regeneration Niche; Bipartite Network; Transylvanian Wood Pastures

Establishment success of *Betula pendula, Alnus glutinosa, Populus spp.* and *Pinus sylvestris* tree species in different micro-locations of a drained peatland after afforestation and the effects of wood ash use as fertilizer

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For centuries peatlands have been drained for forestry, agricultural and peat harvest purposes. Establishment of water drainage systems results in complex changes like increased aeration thus faster decomposition, altered soil pH, nutrient availability, microbial communities, etc. These changes induce successional shift in vegetation composition and typical peatland species are replaced. Forest planting could be an efficient utilization option for such degraded soils, increase primary production and subsequently perhaps reduce overflowing by evapotranspiration. In our study we looked at the first two-year success of afforestation and whether adding different concentrations of wood ash (0, 5, 10, 15 Mg ha^{-1}), which lacks nitrogen, but adds other nutrients to the stand, is beneficial for tree growth. We also took a closer look at tree growth in locations with different hydrological conditions at the site. The trial was established in northern Europe, in the central part of Latvia on an over 9 ha large area with artificial drains between differently fertilized plots. Interestingly results differed both between species and concentration of wood ash, as well as hydrological conditions in the study site. Highly significant differences in the last year's increment were found between different tree species and micro-location ($P<0.0001$), while the fertilizer ($P=0.055$) only tends to significantly impact the last growing season's increment.

Keywords: Drained Peatland; Wood Ash Fertilizer; Afforestation

A contribution to the site defining of deforested surfaces and selection of the appropriate tree species for biomeliorations

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In this paper are presented the research results of the presence of artificially established stands of Austrian pine in southeastern Serbia, which were established with afforestation in the biomelioration of deforested surfaces on the habitat of oaks. Altogether 26 stands were monitored, on the altitudinal belt between 401 and 700 m a.s.l. The applied method of defining the local heat potential represents potentially possibility of soil heating without vegetation. The largest number of the analyzed stands of Austrian pine (57.7%) were established at altitudes from 410 to 500 m, and 34.6% of stands were at altitudes from 501 to 600 m. Also the largest number of stands (30.8%) are present on terrains with thermal coordinate of aspect and slope E=7, i.e. on the terrains with southern aspect and slope up to 7º, southeastern and southwestern aspect and slope from 53 to 60º, or transitional - eastern and western aspect with slope up to 25º. On the terrains with coordinate E=8 are present 26.9% of stands - on southeastern, south and southwestern aspects with slope from 16 to 35º. A slightly smaller number of stands are present on terrains with coordinates E=4 and E=6, which are terrains with eastern and western aspects and with same slope. In relation to the stated altitudes, the analyzed stands are present on terrains with thermal coordinates V=12 and V=14. Hungarian and Turkey oak stands on this area occur at the sites with combinations of thermal coordinates from E.V=4.13 to 8.14, and sessile oak stands occur at the sites with combinations of thermal coordinates from E.V =3.11 to 9.11. The Austrian pine stands were established on the sites with combination of coordinates from E.V=4.12 to E.V=8.14. This indicates that a good selection of tree species for afforestation has been carried out in the biomelioration of degraded oak forests in this area. By using the local heat potential of a region, it can be identified which sites, i.e. which combinations of aspect, slope and altitude belong to the particular tree species.

Keywords: Topographic Factors; Local Heat Potential; Southeastern Serbia; Distribution Of Austrian Pine; Oak Forests

Reoccurring deer browsing damage patterns in young *Pinus sylvestris* stands

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Browsing is one of the main factors influencing tree survival and stand quality after planting. Population of deer family animals has been increasing in Europe for the past decades, therefor it is important to study deer inflicted damage patterns and find optimal forest management methods. In this study we looked at deer damage spatial and temporal patterns in 7 year old *Pinus sylvestris* stand in central Latvia. Aim was to determine if deer browse previously browsed trees and to examine spatial distribution of damaged trees in relation to deer paths. Damaged trees are often cut in thinning due to low productive value, but instead could be left as food source for mammals to alleviate browsing pressure on healthy trees.

To evaluate browsing patterns, 1568 trees were surveyed. No significant correlation between tree breast height diameter and deer inflicted damage was found, however tree height was influenced by browsing. Signs of previous lateral shoot browsing were present on 37% of newly browsed trees, 29% of trees with new bark wounds had signs of earlier bark damage and 15% of trees with freshly damaged top shoots showed signs of previous top damage. Most cases of fresh browsing occurred on trees that had not been damaged by deer before. However, both recently and previously damaged trees were located close to current animal paths, suggesting that animals choose nearby plants for food. This factor could be taken into consideration when planning forest thinning.

Keywords: Ungulates; Scots Pine; Repeated Shoot Browsing; Forest Management

Afforestation trend in Republic of Serbia

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Afforestation problematic is of great importance, because it directly impacts on forest cover changes, that is about 29.1 % in Republic of Serbia, which is close to forest cover percent in the world (30 %) and much lower compared to European forest cover (46 %). The size of afforestation conducted in the past has changed due to social, political and economic situation in Republic of Serbia. According to previous research, there has been analzyed data related to trend and size of afforestation in period 2003-2016. Negative trend, which means decreasing of afforested areas, is remarkable not only in central Serbia, but also in Vojvodina, with even more expressed negative tendency. As for conifers, the most used species for afforestation are spruce (over 60 %) and black pine (about 25 %). On the other hand, the most used deciduous species are oaks in central Serbia and black locust and poplars in Vojvodina. In the last five years of the whole analyzed period, an average yearly afforestation and filling of empty space was conducted at just about 2.000 ha a year (about 1.300 ha with deciduous species and about 700 ha with conifers), with an expressed tendency of permanent decreasing. Bearing on mind achieved dynamics of afforestation, predicted optimal forest cover of about 41 % cannot be reached before 2050. Obtained data and predictions related to afforestation trend behaviour in the following period are very significant during managing and performing measures based on new forests establishing. It is also very important in order to increase forest cover in the future.

Keywords: Serbia; Forest Area; Forest Cover; Afforestation; Trend

Evaluation of hexagonal tree planting in poplar plantations

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This study shows the effect of spatial arrangement of trees on the growth of 2 poplar clones: *Populus x euramericana* I-214 and *Populus deltoides* PE 19/66. The research was done in 4 permanent plots in the period from 2007 to 2017. DBH yield for both clones were analyzed after using two different distances between trees in hexagonal tree planting: 6x6 m and 6.5 x 6.5 m.
Sample plots were established in the same conditions (type of soil, site preparation, underground water and weather conditions). Identical forest tending measures were performed in all sample plots in the first 7 years.
Average DBH for both clones at the age of 11 were bigger with wider spacing. DBH yield is higher at the age of 8 to 11 in sample plots with wider spacing. Higher DBH yield is observed in the sample plot with clone PE 19/66 at the age 2-6. At the age 7-11 higher DBH yield was observed in the sample plot with clone I-214.
It can be concluded that with wider tree spacing there's an increase in DBH, as well as potential value of the wood assortments.

Keywords: Poplar; Tree Spacing; DBH Yield; DBH

Alley cropping with strawberries: two case-studies in Romania

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The paper presents the use of alley cropping, an arable agroforestry system comprising rows of trees planted with a companion crop grown in the alleyways between the rows, in two sub-compartments (81B%, 0.75 ha, alt. 715 m asl; 81E, 3.4 ha, alt. 735 m asl) artificially regenerated at 1.80 m x 1.60 m spacing in the south-east of Transylvania, Romania in 1997 (81B%) and 2003 (81E). The climate (D.f.k - specific to low and middle mountains) and soil (luvisol, of moderate fertility for pure or mixed *Quercus petraea* stands) are only moderately favourable to strawberry culture. The rows of tree species consists of *Quercus rubra*, *Acer pseudoplatanus*, *Prunus avium* (81B%), and *Quercus petraea*, *Fagus sylvatica*, *Acer pseudoplatanus*, and *Larix decidua* (81E). Strawberries (variety Elsanta, one of the most used worldwide) were planted at 60 x 60 cm spacing in two pure rows in-between the tree rows as well as within the rows of planted trees. Both plantations were fenced, with manual topsoil hoeing 3-4 times a year, lighly fertilized (N, P, K) and chemically protected against pests and browsing. Strawberry rotation: six years, of which five years (2 to 6) with fruit production, longer than the one (maximum three years) recommended in pure crops. Strawberry production reached the maximum level (13.7 t/ha, close to 12-20 t/ha in the pure strawberry cultures in Romania) in years 3 or 4.
In the local conditions, with cheap and available labour, quite fast growing tree species and a good market for the crop, the alley cropping with strawberries had demonstrated to be a viable alternative to the 'classical' monocropping system in terms of:
- economics: early and relevant revenue from the crop;
- survival rate of plants: over 95 per cent (i.e., almost no losses of plants, tended cautiously and simultaneously with the crop);
- initial height growth of plants: very quick, resulting from reduced competition with grasses and naturally regenerated forest trees such as pioneer species (e.g., goat willow, silver birch and trembling aspen in the local conditions), and consequently
- quick establishment of a new forest culture, the forest environment (full forest cover) being achieved immediately after the end of strawberry production.

Keywords: agroforestry; alley cropping; tree species; strawberry; production; economics

Weed control by glycophosphate in poplar plantations

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This study shows the impact of weed control by glycophosphate on the growth of the hybrid poplar clone, *Populus x euramericana* I-214. The research was done in 3 permament plots in the period from 2011 to 2016. Permament plots were arranged in rows: one treated row and one controlled row. Herbicide weed control as forest tending measure was done by using 2% concentrate of glycophosphate in a circle area of 1 m around the trees. Using herbicide for weed control impacted only 9% of the total area compared to other type of weed control which impacted a much larger area. The environmental benefits are obvious due to the smaller impacted area. Herbicide weed control was done in the first 3 years of the trees life.

Impact on growth by using herbicide for weed control was observed during the period from the first to the sixth year of the trees age. In sample plots, there is a significant increase in DBH yield as well as DBH growth in treated areas compared to controlled areas. Research shows that in the sixth year DBH in the treated area are larger and range between 3.6 to 4.7 cm compared to the controlled area.

Keywords: Hybrid Poplar; Herbicide; Forest Tending Measures; DBH Yield; DBH

Seedling establishment pests of *Acacia mearnsii* De Wild. (Mimosaceae) in South Africa

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There are about 106,690 ha of *Acacia mearnsii* (wattle) plantations in South Africa. Wattle was previously grown mainly for the commercial potential of its bark (a source of tannin extract) but is now also managed on a short rotation for pulpwood. Clear-felled sites are continually being regenerated. Although considerable research has been done on the post-establishment insect pests of wattle, little is known about the incidence and status of seedling establishment pests. Fourteen trials were planted, on previous wattle sites, over six growing seasons from 1990/91 to 1999/00. Seedlings were evaluated monthly after planting for one year. Stressed, damaged and dead seedlings were uprooted and inspected to determine the cause of death. About 9% to 51% of seedlings failed to establish during wattle regeneration, and the incidence of damage by seedling pests ranged from about 2% to 30%. At sites where the plantation residue was windrowed and burnt, the average incidence of seedling establishment pests was about 20%, and the average total failure of wattle seedlings to establish was about 34%. Whitegrubs (larvae of Coleoptera: Scarabaeidae: Melolonthinae, Rutelinae) were the dominant and economically most important seedling establishment pests (average incidence of about 13%), followed by cutworms (larvae of Lepidoptera: Noctuidae) whose average incidence of about 4% was similar to that of grasshoppers (Orthoptera: Acrididae, Pyrgomorphidae) (about 2%) and millipedes (Diplopoda: Juliformia) (about 1%). Other seedling establishment pests included termites (Blattodea: Termitidae, Hodotermitidae), tipulid larvae (Diptera: Tipulidae), wireworms (Coleoptera: Elateridae), false wireworms (Coleoptera: Tenebrionidae), crickets (Orthoptera: Gryllidae), ants (Hymenoptera: Formicidae) and nematodes (Nematoda: Heteroderidae, Trichodoridae). Nematodes were sporadically important (about 12%) in an old arable wattle site. Although the prophylactic and corrective application of insecticides was widely used to control these pests at planting, their routine use in certified plantations now contravenes the Forest Stewardship Council guidelines.

Keywords: Black Wattle; Post-Establishment Pests; Pest Status; Pest Control; Forestry; Insecticides; Reforestation; Regeneration

Occurrence of ash dieback fungus in different common ash plantings in Montenegro

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Common ash (*Fraxinus excelsior*) is noble broadleaf and one of the most value tree species. Dieback of common ash in Europe caused by fungal agents caused many losses and many researches that investigate further development of this tree species under biotic threats are done. Identification of fungus *Hymenoscyphus fraxineus* (Kowalski) Baral, Queloz and Hosoya in Montenegro allows different researches linked with dieback phenomenon. Background researches that explain role of this pathogen are important for complete understanding of ash decline, especially in different environments and young plants. This paper treats impact of ash dieback fungus on dieback in different types of common ash plantings in Montenegro including its impact and distribution patterns on different common ash habitats.

In order to determine impact of fungal pathogen on different common ash plantings, monitoring across Montenegro was performed. Monitoring covered different common ash plantings including young decorative plantings and single planted young trees. Plant samples were collected for laboratory analysis where identification of this fungal species was confirmed. Statistical analysis using chi square test for significance of location characteristics for fungal occurrence were performed.

Results showed that fungal species *Hymenoscyphus fraxineus* was present and its spread is growing and leading to damage of plantings. Results also show potential of some other species for damage of this plantings but at this point their occurrence is very rare. Statistical analysis has confirmed irregularity of ash dieback occurrence between common ash plantings, young trees and other types of stands ($p < 0.05$). In the age of ash decline this results open large number of possibilities of common ash young trees survival in this part of its areal.

Keywords: Ash Dieback; Occurrence in Plantings; Plants Survival

Growth response of *Eucalyptus grandis* and *Acacia mearnsii* plantation trees in South Africa to prophylactic insecticide application against whitegrub (Coleoptera: Scarabaeidae) pests

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Eucalyptus grandis and *Acacia mearnsii* are amongst the most planted species by the South African forestry industry. Whitegrubs are very important pests affecting plantation forestry establishment. They are root feeding insects that cause poor growth and seedling mortality. The aim of this study was to elucidate the impact of whitegrub damage on the growth of *E. grandis* and *A. mearnsii* trees during the first year of establishment in sites previously planted with *A. mearnsii* located in the KwaZulu-Natal Midlands of South Africa. The hypothesis was that the prophylactic application of insecticides against whitegrubs will increase tree height at six or 12 months after planting. Seven insecticides were assessed in 12 treatments over three trials in Bloemendal, KwaZulu-Natal. Statistical analyses were performed using PRIMER and SAS. Whitegrubs were confirmed as the predominant factor (17.1%) followed by pathogens (3.3%) and 12 more factors that cumulatively caused the remaining 7.0% mortality. *Pegylis sommeri*, *Schizonycha affinis* and two unknown *Maladera* species were the most important, typical and prevalent whitegrub species found in this study. However, their ranking differed between these two crops suggesting a tree host preference. The prophylactic application of insecticides against whitegrubs significantly increased tree height on eucalypt trees. Black wattle tree height, however, did not consistently show a significant effect to insecticide control because of the additional mortality by pathogens. A potential crop rotation scenario was observed that may have benefitted eucalypts instead of black wattle and now warrants further investigation. Generally though, whitegrubs can kill seedlings and reduce tree height when left uncontrolled.

Keywords: Tree Height; Monocrop; Crop Rotation; Insecticides; Tree Establishment; Forestry; Scarab Larvae

Seedlings Forensics and Planting Site Investigations: How to determine the reasons for reforestation failure?

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There are different measures of success of reforestation, afforestation, and forest restoration programs. The success of operational programs on different scales vary from reported total failure to reported total success, with most of the programs reporting a success of approximately 80%. However, the focus of this paper is on failure. In addition to obvious loss of money, time, and resources, the failure of reforestation as a consequence have a loss of support for the future programs and creates a negative image in general population. So, the questions like: "What caused the failure?" and "Who is to blame?" need to be answered. Often, the answers for these questions are given without any evidences to support the claim.
I am offering a set of procedures for investigation of reasons for reforestation failure. These procedures are: 1) data gathering, 2) evidence gathering, and 3) laboratory testing. For purpose of this paper, I consider a death of seedlings as an ultimate failure. The data on seedlings quality, site conditions, planting technique applied, silviculture after the planting, weather conditions during and after the planting, and data on other important events can indicate a causes of seedlings mortality. The planting site should be considered as a crime scene or an accident scene, and evidences indicating the causes for seedling mortality should be collected and documented. The samples collected at the planting site should be further investigated in the laboratory, and in some cases the hypothesis should be tested by reconstructing the conditions and events preceding the seedling death.
The results and evidences gathered by following the procedures of "Seedlings Forensics" and "Planting Site Investigations" will provide a solid foundation not only for conclusion of what caused the failure and who is responsible, but also to improve important aspects of reforestation program, with a final goal of reducing a reforestation failures to minimum.

Keywords: Seedlings Forensics; Planting Site Investigations; Seedling Mortality; Reforestation Success

POSTER PRESENTATIONS

The fine root dynamics of *Pinus massoniana* plantations as affected by understory vegetation removal and thinning

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Pinus massoniana is the main tree species used for afforestation in South China. It plays a major role in providing forest resources and ecological services, and it covers the largest area in the Three Gorges Reservoir area. However, in this region, the soil C content is relatively low. Thus, in recent years, recreating forest structures and optimizing the use of soil by forest management activities were a major focus of the sustainable management of *Pinus massoniana* aimed at maintaining ecosystem sustainability and soil productivity. An intact control forest (CK), understory vegetation removal (shrub clear-cutting, SR) low-intensity thinning (15% stem thinning, LIT), and high-intensity thinning (70% stem thinning, HIT), were compared for fine roots characteristics. This study investigated the seasonal dynamics of fine roots (<2 mm) in *Pinus massoniana* plantations for one year by using a sequential soil coring method. The fine roots showed pronounced seasonal dynamics, with a peak of fine root biomass (FRB) occurring in September. Significant differences were noted in the seasonal dynamics of FRB for the different diameter size sub-classes (0.5 mm, 0.5-1 mm and 1-2 mm); also FRB was inversely related to soil depth in all treatments. In addition, only the HIT reduced the SOC content remarkably accompanied by a decrease in fine root biomass. Our results showed an influence of low-intensity thinning on the fine root dynamics with a different magnitude according to fine root diameter sub-classes. These results provide a theoretical basis to promote the benefits of C cycling in the management of *Pinus massoniana* forests.

Keywords: Fine Root; Diameter Sub-Classes; *Pinus massonia*; The Three Gorges Reservoir Area

Experience from riparian forests restoration projects in Bulgaria

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The aim of the poster is to present the experience and lessons learned from practical activities for reforestation of riparian forests in Bulgaria.
The huge ecological importance of these forests, the damage they have already suffered, and the threats they face today call for immediate efforts for their restoration. Some of these are aimed at the creation of new riparian forests by means of reforestation activities using typical local species; others – to the improvement of the structure and functions of existing forests through the removal of invasive species.
The poster will present the experience and lessons learned from six concrete reforestation sites along Danube River. Aspects related to the reforestation methods used, the results, the current status of reforested areas, as well as reforestation costs will be discussed.

Keywords: Riparian Forests Restoration; Mimic Natural Processes; Invasive Tree Species; Danube; Lessons Learned

Examination of Taurus cedar (*Cedrus libani*) afforestation in Isparta province of Turkey

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Taurus cedar or also called Lebanon cedar (*Cedrus libani* A. Rich) has the largest natural distribution mainly on the Taurus Mountains in southern Turkey, and small populations are remained in Syria and Lebanon in whole the world (Boydak, 1996). It is also classified as one of the economically important species for Turkish forestry and the "National Tree Breeding and Seed Production Programme" (Koski and Antola, 1993) because of its valuable wood product. However, 49 % (235.229 ha) of forest of the species is unproductive (Anonymous, 2017). Similar ratio can be also said for general Turkish forestry. The species is getting importance because of the higher ratio and also its using largely in forest establishment of Turkey. However, limited studies (e.g., Boydak and Ayhan, 1990; Boydak *et al.*, 1990; Kocas, 2011; Yazici and Turan, 2016; Ayan *et al.*, 2017) was carried out on examination of present and early forest establishment of the species.
Height (H), diameter at base (D_o) and survival (S) data was collected in three afforestation area which were 12 (A1), 12 (A2), and 10 (A3) years from southern part of Turkey at end of growing period of 2017.
Averages of height were 498 cm (A1), 724 cm (A2) and 313 cm (A3). They were 15.2 cm, 19.3 cm and 7.1 cm for diameter in the afforestations, respectively. There was significant difference ($p<0.05$) among the sampled areas for height and diameter. Survivals were 83% (A1), 92% (A2), and 83% (A3) in the sampled areas.
Positive and significant ($p<0.05$, $r>0.87$) relations were between height and diameter.

Keywords: Afforestation; Cedar; Forest Establishment; Survival

Results of application of Superabsorbent Zeba™ on field survival of containerized Austrian Pine (*Pinus nigra* Arn.) seedlings in Macedonia

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In 2012, an experiment with application of cornstarch-based superabsorbent Zeba™ in afforestation with Austrian Pine (*Pinus nigra* Arn.) containerized seedlings of various age was conducted. The aim wasto determine whether the application of superabsorbent will affect the survival of seedlings of three different ages. The experimental plot was established near the village of Mrshevci (Skopje region), on sandy clay loam soil, in region with mixed continental and sub-Mediterranean climate.

The experiment was designed as randomized block system and seedlings of three variants were represented: age of1+0,2+0and 3+0, all grown in Yucosad containers (hard plastic bullet-shape, H = 10 cm, upper diameter 4 cm, volume 75 mL). Part of seedlings of each age were shortly soaked in gel of *Zeba* superabsorbent (concentration 100 g/10 L water), and non-treated seedlings were used as a control. Planting was conducted in April 2012. The soil was prepared by furrow plowing and manual planting followed. During the vegetation season, once a month, number of survived seedlings per variant was recorded.

Dying of the seedlings started very early and continued during all the vegetation season. In October 2012survival of seedlings of all variants was very low, ranged from 0.4% (1+0 Control) up to 9.4% (Zeba application, 3+0).Differences between variants within one age were small.

Keywords: Pinus nigra Arn., Container Seedlings, Superabsorbent Zeba™, Afforestation, Survival

Backyard plantation - a major contributor towards social forestry in north-east India

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In the absence of industrial development in Himalayan ranges of the North – East part of India, the Government of India, under poverty alleviation scheme introduced the Social forestry program for the management and protection of forests and afforestation on barren lands with the purpose of helping in the environmental, social and rural development and also aims at raising plantations by the common man so as to meet their growing demand for timber, fuel wood, fodder, etc., thereby paving way to earning the livelihood and reducing the pressure on the traditional forest area. The present study through interviews with representatives from the civil society organizations of the North- East India indicate that the temperate zone of The Himalayas ranging in altitude from 1600 to 3500m representing one of the phytogeographical regions where northeastern sector is situated, considered best suited for backyard planting of different varieties of willow (large to small trees) grown by branch cutting, namely, *Salix alba* (bis) – large tree used for making cricket bats, matchwood, tool-handles, fuel and fodder, *Salix babylonica* (majnu) - large tree used for fodder, fuel and ornaments and *Salix daphnoides* (bhashi, bashroi) – small tree suitable for basket making, fuel, fodder. Backyard plantation is an age-old practice in India. Habitants of north-east India have been raising, willow (*salix*) and bamboos in their backyard. It is one of the easiest to implement and also it is the most rewarding component of social forestry to reduce poverty and improve food security.

Keywords: Phytogeographical Regions; Backyard Plantation; Social Forestry; Poverty; *Salix*

Microbial inoculated plants to bring back green cover and live soil environment in barren mine tailings?

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To bring back green cover and dead soil to life, a three decade abandoned barren mine tailing area in Barangay Capayang, Mogpog, Marinduque were planted with tree legumes. Aseptically pre-germinated two week old narra (*Pterocarpus indicus*) and *Acacia mangium* were inoculated with biofertilizers (mycorrhizal fungi and nitrogen fixing bacteria) during transfer into individual polybags. Plant growth response to biofertilizers was positive three months after inoculation. In the field, lime, compost and NPK fertilizer were applied to all seedlings. After 15 months, mycorrhizal narra seedlings gave height increases ranging from 98-139% and stem diameter increases from 67-87% relative to the control (78cm). Narra planted without any amendments gave 50% seedling survival and height of 36cm against 78cm with lime and vermicompost but no biofertilizers. MYKORICH® inoculated seedlings were more than two meters tall.On the other hand, the biggest stem diameter was obtained from BioN™, MYKOVAM® and Mykorich+BioN inoculated plants with increases ranging from 17-19% relative to the control (5.79cm).On *A. mangium*, BioN™ and Surigao isolate increased height by 28%. Seedling survival was 98% on narra and 95% on *A. mangium* one year after planting. Fungal population was highest (9.9±5.5 CFUx10^4g $soil^{-1}$) in MYKORICH inoculated narra as compared with 0.82±0.17 CFUx10^4 g $soil^{-1}$ in the control plants. BioN+Surigao isolate inoculated *A. mangium* gave the highest (65.5±5.5 CFUx10^4 g $soil^{-1}$) fungal population over 1.12±0.26 CFUx10^4 g $soil^{-1}$ in the control. Bacterial population was highest (28.26±0.93 CFUx10^4 g $soil^{-1}$) in Bio-N inoculated *A. mangium* while the lowest (0.5±CFUx10^4 g $soil^{-1}$) was in the control. In conclusion, biofertilizers promoted plant growth, survival and soil microbial build up in mine tailing area in Barangay Capayang, Mogpog, Marinduque, thus, brought back green cover and a living soil environment.

Keywords: *Acacia mangiu*; *Pterocarpus indicus*; Microbial Population

Morphological characteristics as quality indicators of one-year-old seedlings of Hungarian oak (Q*uercus frainetto* Ten)

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The paper presents and analyses the morphological characteristics as quality indicators of one-year-old seedlings of Hungarian oak (*Quercus frainetto* Ten) with a particular retrospective view to their correlations. The conducted analyses showed which one of the measured morphological characteristics gives the best seedling quality assessment with minimum spending of time and resources.

The seedlings used for the conducted studies were produced in the seedling nursery of the Institute of Forestry in Belgrade (Serbia); the seedlings were produced in the equal environmental conditions from the seed collected in the seed stand RS-2-2-qfr-00-811. The measurements were performed on a random sample of 30 seedlings in three repetitions. The following morphological characteristics were measured: root collar diameter, seedling height, weight of the underground and aboveground part in the dry condition, and root volume. Based on the measured values, the following ratios were calculated – height : root collar diameter, weight of the aboveground part : weight of the underground part, and quality index.

The quality index has proven to be the most comprehensive morphological indicator of quality. The height of the seedlings and the root collar diameter are also good indicators of quality - especially the diameter due to stronger correlations with other measured morphological characteristics, so it can be recommended as a good indicator of the quality of Hungarian oak one-year-old seedlings.

Keywords: Hungarian Oak; Seedling; Quality; Morphological Characteristics

The world needs more planted forest!!!

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FAO issued "Global Forest Resources Assessment 2015", at http://www.fao.org/forest-resources-assessment/en/. Currently 93% of forests are natural and 7% planted (or seeded). Year 1990 96% were natural and 4% planted. The rate of increasing planted forests was 5.3 million ha per year for the period 2000–2010 but slowed to 3.2 million ha between 2010 and 2015.
The third international conference on planted forests 2013 emphasized that planted forests in principle should not replace natural http://www.fao.org/forestry/37902-083cc16479b4b28d8d4873338b79bef41.pdf.
It is surprising few regard lack of more planted forests as a major global problem!
UN Strategic Plan for Forests 2017-adopted in 2017 by the UN General Assembly calls for reversing the loss of forest cover and increasing forest area by 3 percent worldwide by 2030. But the world loses 3.3 million hectares of forest net every year. The loss is much bigger than the gain. One-third of agricultural landscapes were degraded in 2010. There is a large need for more afforestation. Planted forest is a vital component in the tool box for afforestation!
Planted trees and forests open for more desirable characteristics than natural by choosing seed source and applying tree breeding. Domestication/breeding success for agricultural crops and husbandry was the cradle for civilisation and still a fundamental pillar. It is a good road for forestry also!
But there does not exist a reasonable considered estimate of the overall use and variability of bred materials. No other than FAO can ask the right question to get a reasonable estimate, but FAO does not intend to.
For specific circumstances where are a multitude of good reasons against planted forests. But added together they can hardly rationally explain the global reduction. It seems caused by over exaggerating a multitude of concerns about social, ecological, economic, silvicultural, diversity and similar problems.

Key words: Reforestation; Afforestation; Planted Forest; Seeding

Reforesting the depleted forest estates of Akwa Ibom State, Nigeria (current review 2017)

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Akwa Ibom State occupies a total land area of 8,412km2 of the tropical rainforest in south-eastern Nigeria. In recent years, the state forest estate had suffered great perturbations due to rapid urbanization, increased infrastructural development, high population density and traditional farming practices resulting in unprecedented deforestation and environmental degradation. The problem was further compounded by the destruction of the mangrove ecosystem by gas flaring and oil spillages from facilities of multinational oil companies operating in the area. Each year, an estimated 1000 ha of forest land were being degraded in the state between 1970 and 2002, while an average of 90 ha only were being reforested yearly in the corresponding period by the state government using indigenous and exotic species. Ironically, the state government within the same period deserved 460 ha of the Stubbs Creek Forest Reserve and gave same to various interest groups for economic ventures. Deforestation thus became an instrument of state for achievement of economic goals. In order to achieve sustainable management of the forest estate in the State, government should maintain a competent workforce and increase funding to the forestry sector. Management plan which recognizes proper timing of forest operations must be put in place, while artificial regeneration programme must be supplemented with natural regeneration using artificial gaps of appropriate sizes. Legislation would also be needed to check incessant oil spillages and gas flare in the Niger Delta, and the State Forestry Law should be strictly enforced to check the activities of illegal timber exploiters ravaging the forest estates in the State.

Keywords: Tropical Rainforest; Deforestation; Degradation; Reforestation; Planning

Public private partnership, a requirement for operationalization of the conditional participation driven agro-forestry reforestation model (CPAF-Model) on small holder farms

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Deforestation, one of the most precarious forms of environmental degradation occurring in the developing countries, is putting billions of lives at risk. Across almost all developing countries in African, Asia and South America, forests area is declining at a fast rate. In Uganda alone, forest cover reduced from 4.934 million hectares in 1998 to 3.604 million hectares by 2005 representing a 27% reduction (NPA, 2010). By 2016 Uganda was remaining with 1.727 million hectares of natural forests (CIF, 2016) a 65% reduction within 2 decades. Similar situation cuts across other developing countries. Deforestation is undertaken by the rapidly increasing population in these countries compelled by the need to satisfy the corresponding increase in food and fuel wood. Indeed most deforestation takes place more on private land owned by small holder farmers (CIF, 2016). Not that they do not know its negative effects. Communities are aware that it is mainly deforestation responsible for the numerous catastrophes that they face today such as the unpredictable weather, excessive soil erosion among others. However, due to their livelihood requirements, communities view deforestation as a necessary evil. It has, therefore, necessitated the intervention of numerous players working towards the restoration of the deforested areas. Unfortunately, most times the individual players undertake the individualistic approach. Because they are using different tools, resources and methods, organizations have often passed out un-coordinated and sometimes conflicting messages to the communities resulting into their (communities) limited adoption of environmental restoration technologies. To resolve this bottle neck in Uganda, Trees for Life in collaboration with World Vision Uganda and National Agricultural Research Organization is piloting the CPAF-model which requires all stakeholders in environment are being brought under one platform. The model requires a multi-sectoral public private partnership approach to guide reforestation interventions in smallholder farming communities in developing countries.

Keywords: Reforestation; Deforestation; Degradation; Public Private Partnership; Smallholder

Bamboo in rebuilding rural livelihood - a new approach in Vindhyan region of India

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In India, Bamboos improve thousands of livelihoods devastated by land degradation. The state of Uttar Pradesh in India is fourth largest and the most populated state. The district Allahabad is located in the southern part of the state, at 25°28'N 81°50'E, and stands at the confluence of the holy Ganges and Yamuna rivers. The land productivity of villages located in western part of the district was poor and it was a challenging task for farmers to sustain their livelihood. Since 1960's, farmers of the region were selling their top soil to brick-making companies. The soil from barren lands of Allahabad was mined to 3- 4 m depth destroying fertility and severely affecting productivity. Approximately, 5000 hectares of land owned by poor people were lying unproductive. The Utthan – Centre for Sustainable Development & Poverty Alleviation", started a large-scale 're-greening' with bamboo for bio-remediation of degraded soils. After 10 years of time, the area has become productive improving landscape, lives and livelihoods. In this model, Bamboo is in the centre of an integrated cropping system with MPTs (*Moringa oleifera, Acacia nilotica* and *Azadirachta indica*) and fruit trees (*Zizyphus zuzuba* and *Artocarpus heterophyllus*) in combination with vegetables, rice, wheat, fish, fibres and medicinal plants. The cultivation of Jatropha and Medicinal Plants with Bamboo is in the centre of an integrated cropping system of Jatropha and *Aloe vera*. After 10 years of study, Bamboos also helped in raising water table from 30 m below surface in 1996, to 25 meters above surface in 2017. The soil carbon content increased from 0.1 to 0.9 %. The Bamboo leaves enhanced micro-nutrients of the soil too. The soil pH was also reduced from 10 - 11 to 6 - 7. The Bamboo based agroforestry promoted agriculture, over 200 bird & 6 mammal species. The farmers of the area are earning from Rs. 1-2 Lakh per annum by sale of tree products, Bamboos, NTFPs and fishery. The Bamboo has immense potential to improve livelihoods and landscapes and can tackle global sustainability challenges of the 21st century.

Keywords: Bamboos; Plantation Model; Rehabilitation; Rural Livelihood; Sustainability

Bamboos as better alternative reforestation species in the Philippines

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Bamboos is now considered as one of the better alternative reforestation species because it exhibits exceptional growth rate and takes only an average of 4 to 5 years for bamboo to reach maturity. Also, bamboos are ideal substitute for wood in nearly all its uses and as a result new products are now being developed. On a hectare basis, it is cheaper to establish a bamboo plantation than a tree plantation. The difference is due to the fact that only about two hundred propagules of bamboo are required for each hectare in contrast to tree plantation requirements of about a thousand seedlings. Because of the lower number of propagules required, cost of site preparation, planting and maintenance is significantly lower. In addition, bamboo needs no replanting once established. Even when subjected to periodic harvesting, bamboo will continue to survive and produce new shoots that will later become poles. For trees, replanting is obligatory after harvesting. It is also adaptable to a wide range of site conditions and therefore can be planted in different parts of the Philippines without much difficulty. Once established bamboo is extremely hardy and can survive strong typhoons and fire and has no known serious pests and diseases. The Philippine government through the Department of Environment and Natural Resources plans to establish one million hectares of bamboo plantations for the next 6 years (2017-2022) under the Enhanced National Greening Program. However, there is still need to address the low yields and quality of bamboo poles from existing natural stands and slow pace of bamboo plantation development; Moreover, the Science and Technology intervention needed to solve these issues are effective and efficient management of existing bamboo stands and development of more bamboo plantations in bamboo rich and market driven areas.

Keywords: Plantation Development; Management of Existing Bamboo Stands; Enhanced National Greening Program

Approaches for planning and management of national afforestation programmess in Uttar Pradesh, India

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Uttar Pradesh is the most populous state of the Indian union and the forest cover is merely 6.09 % and 9.18 % including tree cover of total geographical area of the state. A large portion of the forests is either degraded or has become barren and devoid of any growth due to industrial/household demand, biotic factors, illegal felling, encroachments, mining, developmental projects etc. The existing forests are increasingly losing the economically important species and their production capacity is reducing. In order to ensure people's participation in afforestation activity, National Afforestation Programme (NAP) is being implemented through forest development agencies. The programme is being implemented through Joint Forest Management Committees (JFMCs) set up under joint forest management rules. In monitoring and evaluation programme of NAP in the state of UP, it was found that for improvement in vetgetative impact, more emphasis must be paid on introduction of improved technology, provision of irrigation and soil improvement in drier parts of the state as Vindhyan plateau and ravines. The introduction of naturally occurring species and fruit species for plantations and streamlining of schedule of rates for different agro climatic zones will be also a good step. There is urgent need to give training to the villagers to increase their capacity for self-employment, skill development, value addition, cottage industries and creation of village development fund and maintenance of common assets and benefit sharing mechanism. The strong extension network may also be established from district to village level and the appropriate technology of forestry/agro forestry/ forest based industries may be transferred to the villagers. The Forest Development Agencies and JFMCs should be managed like a commercial entity on a professional basis and they may generate their own resources on sustainable basis so as to remain viable for a long time. The entry point activity (EPA) may be focused on development of skills and techniques so as to empower the villagers to go for self-employment. The active participation of women may play a vital role for improving the plantation/ forest of the area. The institution of awards for forest development agencies and JFMCs may further take a lead role for superior results of survival of plantations. It is also suggested that EPA and approved micro plan may also be interlinked well. The National Afforestation Programme has involved the villagers in the protection and development of the forests and also improved condition of villages. It is a very good example of public – private partnership and has given boost to villagers and joint forest management committees.

Keywords: National afforestation programme; improved plantations; peoples' participation

Enrichment planting in monoculture rubber plantations: an approach to gradually restore tropical forests

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Monoculture rubber plantations have replaced a large area of tropical forests in southern Yunnan, China during the past half century. With more recognition on the value of tropical forests and awareness on the negative impacts by monoculture rubber plantations in recent years, the management objective of rubber plantation has changed from exclusive rubber production to production plus conservation and campaigns to restore tropical forests have already started in the region. To meet this demand, enrichment planting in monoculture rubber plantations was tried to make the rubber plantation more conservative, and to restore tropical forests gradually in Xishuangbanna, Yunnan, China since 2010.

We have tested 2 major types of enrichment planting in monoculture rubber plantations as followed:

(1)Seedlings of the desired species (mainly high value timber species and medicinal plants) were underplanted in a strip between 2 adjacent rows of rubber trees. No rubber tree was felled, therefore continued harvesting of rubber was expected for a certain period of time while the monoculture plantation was environmentally improved.

(2) Canopy gaps were opened up by removing 1-2 rows of rubber trees from every 5 rows, then seedlings of indigenous tree species (mainly constructive species and few associated species of zonal tropical forests) were planted in the gap and those naturally regenerated seedlings were protected. The extent to which further canopy openings are created will depend on ecological and economic circumstances.

An analysis on growing performance of the planted species, affected rubber production, and effectiveness of restoration of each type of enrichment planting was made based on surveyed field data. The potentials and limitations for enrichment planting in monoculture rubber plantation as an approach to gradually restore tropical forests were discussed from both ecological and economic perspectives.

Keywords: Enrichment Planting; Monoculture Rubber Plantation; Tropical Forest Rehabilitation

Coniferous plantations in the Osogovo, south west Bulgaria

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Coniferous plantations in Bulgaria have been the subject of forestry research since the late 19th century. Studies on Scots pine, Austrian pine, Douglas-fir, European and Japanese larch and other species are focused on growth dynamics, habitat conditions, planting technology. The studies of coniferous stands in the Osogovo region are scarce and are mainly related to development of the first afforestation in this area. The total area of the coniferous stands is 34,115.1 ha, which is almost half (46.2%) of the total forested area of the Osogovo forest vegetation subregion. The stands of Scots pine are 15311.6 ha (44.9%), Austrian pine - 12090.1 ha (35.4%) and Douglas-fir - 3195.2 ha (9.4%). The remaining 3518.2 ha (10.3%) are from other coniferous species - spruce, silver fir, larch and Eastern white pine. A survey of the growth, productivity and condition of coniferous plantations in the Osogovo subregion was carried out in 23 representative sites. The work was focused on situated in the Lower and Middle forest belt Scots pine, Austrian pine and Douglas-fir stands, aged from 40 to 60 years. Stem analysis was used to assess the growth of the studied species. Douglas-fir has the highest productivity, follow Austrian pine and Scots pine. Austrian pine plantations were characterized by the best collective and individual mechanical stability, the most unstable were Scots pine plantations, followed by the Douglas-fir plantations. The regeneration in most of the plantations was poor due to the high densities and insufficient light under the slopes, which lead to poor fructification. In the case of necessity of afforestation in the future Austrian pine could be used in the lower forest belt. As non-native species in Bulgaria, Douglas-fir plantations require silvicultural measures that is not in contradiction with the Natura 2000. The established Scots pine plantations have bad results and worsened health condition, so it is recommended to restrict the afforestation of this species to atypical habitats outside its natural range.

Keywords: Coniferous Plantations; Scots Pine; Austrian Pine; Douglas-Fir; Mechanical Stability; Regeneration; Productivity

Change in forest cover, Stubb's Creek Forest Reserve Akwa Ibom State, Nigeria

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Stubb's Creek Forest Reserve (SCFR) is the largest remaining forest in Akwa Ibom State. The reserve possesses fragile ecosystems with valuable fauna and flora species. Human activities have resulted to continued biodiversity degradation necessitating monitoring, protection and conservation. Forest cover change in SCFR was examined. Three sets of time- series satellite imageries were used to assess the trend in forest cover change in the study area. Integrated Land and Water Information System, and ARCGIS were used to analyze the imageries of 1993, 2003, 2013 and maps of the land cover were produced. Results indicated that between the period of 1993 and 2013, the overall forest cover change was 35.28 km^2 (55.56%) with annual rate of 1.76 km^2 (2.78%). Between 1993 and 2003, 21.07 km^2 (35.50%) of forest was lost at an annual rate of 2.107 km^2 (3.31%) and between 2003 and 2013 it declined to 14.21 km^2 (33.50%) with an annual rate of 1.42 km^2 (3.35%). This decline could be attributed to increased awareness on the importance of the forest reserve, shift in preferred source of energy, and concentration of infrastructural development. It was predicted that by 2033 the whole SCFR will be lost. This could bring about diverse disasters. Therefore, ecological restoration should be conducted. Human activities within the SCFR should be sustainable and environmentally friendly.

Keywords: Forest reserve; Integrated Landsat; Land cover; Change rate

Germination and growth response of *Moringa oleifera* Lam*, Acacia mellifera* and *Zizyphus mauritiana* seedling to different substrates

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Despite the importance of forests and trees, Senegal is facing to the loss of forests and the decline of tree diversity and density. This study focuses on Moringa *oleifera* Lam*, Acacia mellifera* and *Zizyphus mauritiana* Lam which constitute a significant source of food and economic value for the populations of Casamance. In addition to a germination test, a follow-up of seedlings on different substrates was carried out in the nursery, in order to determine the effect substrates on growth parameters (number of leaves, height, diameter and biomass). The substrates used were three potting mixtures of forest soil of *Faidherbia albida* (FSFA), *Elaeis guineensis* (FSEG) and *Anacardium occidentale* (FSAO) with sand with the following proportion : 1/3 sand + 2/3 forest soil). Based on species, the germination rate was higher for *Acacia mellifera* (88.89%) *followed by Moringa oleifera* (55.28%) and Zizyphus mauritiana (50.55%). The germination rate was more important in FSFA and FSEG than in FSAO. For growth parameters, there was a significant effect ($P<0.05$) of substrate type on height, diameter, number of leaves and root biomass. In term of growth parameters, the seedling performed better in FSFA and FSEG than in FSAO. The species effect was also significant ($P<0.05$) with higher root biomass and diameter found in *Moringa oleifera* and height and number of leaves in *Acacia mellifera*. The most important total biomass was found in FSFA followed by FSEG. Comparing the fraction of biomass according the part of the seedling, the stem and branch had the higher fraction of biomass for *Acacia mellifera* (43%) and *Moringa oleifera* (38%) and the leaves for *Zizyphus mauritiana* (46%).However, the study found that type of substrates can affect seedling development and growth parameters and better results were recorded in FSFA and FSEG substrates.

Keywords**:** *Moringa oleifera; Acacia mellifera; Zizyphus mauritiana*; Substrates; Germination; Growth; Biomass; Nursery

Climate change impacts, adaptive capacity of African forest ecosystems and livelihoods

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Climate change is posing threats today with widespread implications on the earth's ecosystems and livelihoods. However, the research motivation was based on only few available studies which have assessed the extent climate change and Green House Gases (GHGs) affect the ecosystem structure, and responses. The study examined vegetation changes and characteristics as a result of extreme climate events and anthropogenic activities on the environment. Primary data was obtained from randomly selected respondents within the forest communities while the sixty years (1973-2017) climatic data were obtained from the Nigerian Meteorological Agency (NIMET) analyzed using statistical techniques. The vegetation indexes were used and analyzed from the Lands at satellite images to quantify the changes in forest vegetation. A measure of climate changes, statistical correlations were established between the peak values of average seasonal and annual temperatures across the region. Results showed that the average temperature had increased significantly over the 45-year period. Normalized Difference Vegetation Index (NDVI), Integrated Forest Index (IFI), and Enhanced Vegetation Index (EVI), were calculated from Lands at at-sensor-reflectance data. It was observed that vegetation covers had shown a considerably low radiant temperature in all the years considered, areas of dense vegetation recorded less temperature amount of heat and surface structures through transpiration. The built-up areas, cultivated lands with its sparse vegetation (croplands) and exposed bared surfaces showed a significant increase in temperature over vegetation. The study concluded that climate change is reducing the natural ability of the forests to provide ecosystem services in the study area. Recommendations however were made for increased research effort, including increased resolution of climate models, better predictive capacity at a regional level for within and between-yearly climatic patterns, seasonality and extreme events. Collaborative monitoring programs for scientific researchers and policy-makers should be established for effective improvement on ecosystem services.

Keywords: Ecosystem; Livelihoods; Vegetation

Updated fertilization programs and shading to accelerate *Pinus nigra* seedlings' nursery growth

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Pinus nigra J.F. Arnold, is a conifer with a wide but fragmented distribution across Europe and Asia Minor, predominantly in mountain areas. Because of its ecological flexibility, it is one of the most widely used tree species for reforestation along its geographical distribution. Also it is considered a potential substitute for other indigenous coniferous species in Central Europe under future climate scenarios. However, *P. nigra* seedlings are transplanted in the field as two-year or three-year old seedlings because of their relatively low growth rate during the first few years. With this study, we aim to investigate the effect of updated fertilization programs and shading on *P. nigra* seedlings' nursery growth in order to accelerate early seedling growth, and thus, to reduce the time needed in the nursery.
The experiment was laid out in a completely randomized block design and was conducted in an open-air nursery. *P. nigra* seeds originating from Grevena, Northern Greece, were sown in March in plastic containers, Quick pots (cavity volume 330 cm^3, and depth 16 cm) filled with peat:perlite 2:1. Seedlings were subjected to the following treatments (216 seedlings per treatment): two levels of fertilization; 5 g and 10 g NPK fertilizer formulations 30-10-10 per lit substrate, and two levels of shading; 50% and 70%. At the end of the first nursery growing season, we recorded seedlings' above- and below-ground morphology and biomass.
Preliminary results, from the first year in the nursery, showed that the selected fertilization programs as well as the shading levels had no significant effect on above-ground seedlings' morphological characteristics. On the contrary, they had significant effect on seedlings' root characteristics; seedlings raised under 50% shade had significantly greater number of first-order lateral roots and number of root tips. Also, the lower level of shading (50%) contributed to seedlings with significantly greater number of above- and below-ground biomass ($P<0.05$). The combination of high fertilization rate and high shading level resulted in seedlings with significantly lower number of first-order lateral roots and number of root tips. Further findings are expected during the second year study.

Keywords: Mediterranean Pines; Black Pine; Seedling Growth; Fertilizer; Shade

Growth and yield results in a 60-year-old red pine plantation established in widely different initial spacings and managed by commercial thinning

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Competitive interactions among individual trees, which are intimately related to stand density, affect individual-tree growth, wood quality (wood density and branch dimensions), and survival. Management of stand density in plantations aims at improving both stem and stand quality, shortening rotation cycles and increasing product values. Silviculturists manage stand density by establishing plantations with specific initial spacings and performing partial cuts when trees reach commercial dimensions. Long-term studies examining the main and interacting effects of initial stand density and thinning are important: they provide empirical data to strengthen the decision-making process and are useful for growth and yield modelling. In this study, we report growth and yield results for a 60-year-old red pine (*Pinus resinosa*) spacing trial experiment located in the Great Lakes–St. Lawrence forest region of Canada. Red pine is a fast-growing species that has potential for high value products. The experiment includes combinations between six initial spacings (from 1.2-3.0 m), and the presence/absence of a commercial thinning (CT) regime. The CT regime was initiated 30 years after planting; about 30% of the mean pre-treatment basal area (BA) was removed to obtain a residual BA of 37.9 m^2ha^{-1}. Four CT treatments had been performed to the same residual BA by 2013. Preliminary results indicate that mean tree size increased with the increase in initial spacing. However, stand BA and gross merchantable volume for residual trees reached a plateau in the 2.1–3.0 m spacings. Individual tree sizes were larger in thinned stands than in unthinned stands, but the spacing effect was similar. Cumulative yield (live+harvested+mortality) was close among spacings for both unthinned and thinned stands, except for the 2.1 m treatment, in which the unthinned stand had a greater cumulative yield. This suggests that growing space was under utilized in this scenario.

Keywords: Planting density; Thinning; *Pinus resinosa*; Growth; Silviculture; Long-Term Experiment

Genetic aspects of reforestation practices for the maximization of forest ecosystem resilience

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The consequences of reforestation practices on the genetic variation and structure of forest tree populations are reviewed assessed and discussed, with a focus on the selection and handling of forest reproductive material. It emerges that averaging genetic diversity parameters, such as those typically reported in the assessment of forest population genetics, generally present some reduction when comparing populations established through reforestation and natural geographically proximal "control" populations. Even when differences are not substantial, subtler changes that regard the structure of genetic variation and the lasting adaptive potential of natural forest tree populations, are detected. Therefore, reforestation practices may have a longer-term impact on the genetic diversity and structure of forest tree populations, and their assessment should be based on parameters that are sensitive to population perturbations and bottlenecks. In this respect, reforestation exerts a significant influence on the resilience of forest ecosystems, defined as their capacity to absorb disturbance and reorganize while undergoing change in order to retain essentially the same function (processes and properties), and ecosystem services. Neutral and adaptive genetic diversity provides a mechanism reinforcing both population perseverance and persistence of ecosystem functions and loss of genetic diversity may reduce resilience**.** To the level that genetic diversity affects species resilience, thegenetic changes found as a result of reforestation practices may eventually decrease fitness and exert some unfavorable influence on the resilience of forest ecosystems. The nature and extent of genetic effects and impact of reforestation, call for a concerted effort regarding their thorough study using genetic, genomic, as well as monitoring approaches, in order to provide insight and improve future practices.

Keywords: Forest Management; Genetic Diversity; Genetic Structure; Reforestation; Resilience

Seasonal change in the physical and mechanical parameters of the nursery substrate in the Hiko V-120 containers

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Breeding plants in containers require the use of especially composed substrates, which have a significant influence on the growth characteristics and parameters of cultured potted plants. Taking into account the technological requirements, it was found that the major conditions for successful breeding are the desired physical and chemical properties of the substrate. The air capacity and water retention characteristics of the substrate determine the watering requirements i.e. an amount of water and frequency of watering. The air and water conditions of the substrate may change in time which is the effect of progressive compaction due to the spontaneous settling, gradual fouling, irrigation and the growth of plant roots.
The paper presents the results of measurements of seasonal changes in the physical and mechanical parameters of a peat-based potting substrate that was taken twelve times (every two weeks) during one production season (from the beginning of August, to the end of October). In the experiment, the Hiko V-120ss containers were used, in which pine and spruce seedlings were grown. The investigation covered a determination of bulk density, total porosity, and air and water capacity, as well as the penetration resistance of the substrate, using a cone penetrometer, *Eijkelkamp* 06.06. The results indicated that as the time passed, the bulk density, air volume and total porosity of the substrate in particular cells of packs decreased, while its penetration resistance increased.

Keywords: Nursery Production; Container; Peat; Seedlings

The size and structure of the root system of Norway spruce, Scots pine, European beech and pedunculate oak seedlings growing in Hiko containers

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The research determined the size of the root system of the spruce, pine seedlings grown in nursery containers Hiko V-120ss and common beech and English oak in containers Hiko V-265. At the end of the growing season (24 October), one container with seedlings was taken at random for each analyzed species. After cleaning, the root system analysis was performed using the WinRhizo (Regent Inc.®) program. The root system of a single seedling was leached out under running water and after drying it was separated into samples for scanning (from 2 to 7 for 1 seedling). A scanner STD 4800 (Epson V800 photo) was used, and the resulting root images were 600 dpi. Five thickness intervals were used for root analysis, i.e.: >5 mm; 2-5 mm; 1-2 mm; 0.5-1 mm; 0.2-0.5 mm; 0.1-0.2 mm and <0.1 mm. For each seedling the total root length was determined in each of these thickness ranges, and the average total length of the root system was calculated.The average density of roots per 1 cm^3 of the substrate in the cell of the nursery container was also assessed. The highest average total length of roots (about 21.9 m) was noted in beech seedlings, a similar value in spruce (about 9.8 m) and oak (about 9.5 m), and the lowest in pine (about 7.3 m). It was found that the seedlings of all analyzed species were dominated by small roots, whereas in coniferous species (pine, spruce) from the range of 0.5 to 1 mm thick, while deciduous (beech, oak) from the compartment below 0.5 mm thick. The largest density of roots expressed in their length per 1 cm^3 of the substrate occurred in seedlings of Norway spruce and beech (over 8 $cm \cdot cm^{-3}$).In turn, pedunculate oak seedlings have developed a root system with the lowest density, ie approx. 3.5 cm per 1 cm^3 nursery substrate.

Keywords: Nursery Container; Roots Length; Roots Density; *Picea abies*; *Pinus* sylvestris; *Fagus sylvatica*; *Quercus robur*

Biometric features of Scots pine in the Voronezh nursery by size grading seeds

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Qualitative and quantitative features are used as markers in the analysis of phenotypic structure of populations. From the point of view of identification of interrelations between signs of division of forest seeds and morphometric indicators of growth of cultures, the processes occurring at the juvenile stage of ontogenesis are of the greatest interest. An alternative hypothesis was confirmed that the classification of seeds on quantitative grounds could lead to excessive genetic differentiation and loss of genetic diversity within each of the fractions. The Voronezh forest nursery carried out a standard rotary cycle of seedlings with closed root system from the seed material of an Scots pine. Seeds were graded on a dimensional basis into four fractions (2.25 mm; 2.75 mm; 3.25 mm; more than 3.25 mm) using a sieve processing line for presowing treatment. Sown in 40-cell containers filled with peat substrate, 120 seeds of each fraction and 160 unsorted (control) seeds. Containers set in a greenhouse with automatic control of temperature and humidity. After moving the containers to the quenching sites, equipped with automatic irrigation systems, measurements of the length of seedlings from the soil to the end of the needles were carried out with a specified periodicity. The results of biometric studies are interpreted in different variations depending on the size of the seeds, soil germination and the location of the seedling in the container. There are certain correlation differences between the heights of seedlings in fractions. The study, however, did not reveal whether the genetic diversity of the seed batch had been disturbed. The low quality pretreatment seeds are determined by the observation technology level. In the future, to identify genetic features planned biometric studies of seedlings, graded and color, and size.

Keywords: Artificial Reforestation; Seed Size; Seed Grading; Forest Nursery

Influence of acorn size on development of one-year-old English oak (*Quercus robur* L.) seedlings

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The aim of this research was to examine the influence of acorn size on morphological characteristics of one-year-old English oak (*Quercus robur* L.) seedlings in different half-sib lines. The collection of seed material was carried out in autumn 2014 and only the visually healthy and undamaged oak nuts were selected for the study. Ten test trees were selected based on phenotypic characteristics. One hundred oak nuts were collected from each tree. Among the first five trees, oak nuts were of visually larger dimensions, while oak nuts were of visually smaller dimensions in the other five trees. The measurement of oak nut's length, width and mass was performed and based on these parameters the volume and shape of oak nuts were calculated. Consecutively, in one-year-old seedlings the analysis included: root collar diameter, root mass and structure, mass and length of above-ground part and number of leaves. All parameters were described with descriptive statistics and analysis of variance (ANOVA) was carried out. The correlation analysis between height of one-year-old seedlings and morphological traits of oak nuts did not show statistically significant dependence. The seed germination was 13.9%.

Keywords: English oak; Acorn Size; Seedlings; Germination; Half-Sib Lines

Is it possible monitoring plant physiological condition with a Near Infrared Consumer digital camera in forest nursery stock?

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Monitoring plant physiological status is a fundamental tool to understand the relationships among environmental conditions and vegetation productivity and health, especially in Mediterranean areas where the intensity of dry periods is increasing. Therefore, the development of new methods to monitor plant physiology is a key point to strengthen new strategies for forest restoration projects in a context of climate change. The recent availability of Near Infrared (NIR) Consumer Digital cameras has opened the possibility to improve in a cost-efficient manner the development of new methods to assess plant physiology without sophisticate instruments such as spectrometer and fluorimeter. NIR cameras are recognized by remote sensing communities as a cost-effective method to monitor vegetation health over large area. Several authors have demonstrated that these cameras provide highly detailed data of single plant in forest monitoring conditions thanks to the times series acquisitions. Therefore, what happen if the NIR Cameras are used to assess the physiological condition of forest seedlings in nursery and in the planting season?
The present study aims to test the possibility of monitoring seedlings physiology by NIR camera images (i.e. CANOM S110 NIR) comparing the results with the ones obtained by spectrometer and fluorimeter (i.e. USB-2000 Ocean Optics and PAM-2000 Walz). The final objective is to evaluate if in future NIR camera can be a reliable tool to assess seedling physiological status both in nursery and after planting.
We carried out two experiments, in greenhouse and in field, on seedlings coming from the same nursery stock grown in 2017. We present the preliminary results of the "speed water-stress test" under controlled greenhouse conditions by exposing *Quercus* seedlings (*Q. ilex*, *Q. pubescens*, and *Q. robur*) grown in two substrates (peat and coconut fiber) with three fertilizations (nursery standard; phosphorous-enriched; and potassium-enriched) to three water stress levels: control (field-capacity irrigation), medium (50% of control irrigation) and strong (water-suspension).

Keywords: Leaf spectroscopy; NDVI; Proximal sensing; Images; Hydric stress; Quercus

Forest restoration at Natural protected area "Veliko ratno ostrvo"

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Veliko ratno ostrvo Island is on the confluence Sava and Danube River and represent very important ecological point on the Belgrade area. It is protected natural area and natural habitat for some rare and endangered plant and animal species. Soil moisture and periodic flooding caused specific riparian forest with very rich and diverse floor of shrubs and grass. Some introduced and invasive species (*Fraxinus americana, Amorpha fruticosa, Rubus caesius, Vitis sylvestris,* etc.) form very dense and impenetrable areas with lacking natural regeneration of trees. Forest existence is very important from several aspects and the main goal of this research is provide young trees and new forest on this area.

In last five years reforestation is conducted on 2 ha with the aim to collect information about species selection and potential success. Natural populations of European white elm and black poplar from the Island was basis for producing different type of seedlings. European white elm seedlings were planted on total area of 1 ha, on spring (containerized, 2+0) and autumn 2013th (bareroot, 1+2,) and autumn 2015th (bareroot, 1+0). One-year old black poplar clones was planted on autumn 2014th, on total area 1ha. The planting site was prepared by mechanical removing obstacles, shrubs and weed. Seedlings were planted in mechanical prepared holes on distance 2 X 3 m with after planting weed control.

Higher and older seedlings of European white elm (1+2 (130.4 cm, 13.30 mm) and 2+0 (86.1 cm, 8.06 mm)) were survived in higher percentage (more than 80%) then younger and inferior seedlings (1+0 (37 cm, 3.71 mm), survival percentage 68 %). Black poplar clones (1/1 (262.4 cm, 21.06 mm)) was survived in the highest rate, near 90% after first growing season in the field. Trend of survival is high in next growing season with minimal damage from wild animals. Survival in the lowest rate of one year old European white elm seedlings can be affected by their height and flooding time on this area (sometimes it can be period long than three weeks). This is main reason to recommend higher seedlings for reforestation flooding areas as Veliko ratno ostrvo Island.

Keywords: Forest restoration; European White Elm; Black Poplar

Influence of soil conditions on germination of seed of *Pinus sylvestris*

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This paper presents the study results of the influence of the unfavorable substrate characteristics on the success of *Pinus sylvestris* seed germination. The seed was sown in containers with deposol of the Majdanpek mine and a substrate from a Scots pine culture (on the mountain Jastrebac, FE Kruševac, State Enterprise "Srbijašume") from where the seed was collected for the analysis. The aim of the paper was to determine the degree of influence of different negative characteristics of the substrate (acidity, nutrient content and microbiological activity). Laboratory analysis of the deposol of the Majdanpek mine showed the initial value of pH 2,9 and by adding peat and $CaCO_3$ in different percent, five different substrates were obtained for which different pH values were measured (from 3,6 to 6,5). Very poor microbiological activity of the deposol was observed, since a very small representation of all investigated groups of microorganisms was observed, and the presence of *Azotobacter* was not confirmed at all. In the control substrate, sampled in the Scots pine culture, a high number of bacteria and fungi was found, which was conditioned by the high humus content and acidity of the tested soil (pH 4.8). In laboratory conditions, germination of white pine seed was examined on WA medium (15 gr of agar and 1000 ml of sterile water). For the study of soil condition influence on seed germination seeds were sterilized in 30% H_2O_2, for 20 minutes, rinsed with sterile water and placed in containers. Germination analysis was carried out once a week for a month.
The results of germination in the deposol indicate that the very acidic medium (pH value 2.9) had a negative influence on germination of the *Pinus sylvestris* seed, since not one sprouted individual was noticed in these containers. The seeding was fairly balanced at the measured acidity of 3.6 to 4.4 and there were no significant differences between the individual substrates. The most pronounced is in the substrate with a slightly acidic, almost neutral reaction (pH from 5.1 to 6.5). The highest percentage of germinating (77%) was recorded in the substrate from Jastrebac, and in the same period 70% of the seedlings were recorded on the WA medium.

Keywords: Seed; *Pinus sylvestris*; Acidity; Microbiological Activity

Variability of beech cupules in Serbia

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Beech is the most important tree species in forests of Serbia. However, despite its significance, the taxonomic status of beech in Serbia is unclear. Morphology of the cupules can be successfully used to distinguish species and within species taxa. In this paper we report results on cupules morphology, measuring the same attributes reported by Mišić (1955): 1) Length of the longest valve of cupule, 2) Width of that valve (at widest point), 3) Distance between base of the longest valve and peduncle, 4) Length of cupule without peduncle, and 5) Length of peduncle. The length of cupule and peduncle length from 12 populations in Serbia are in the range reported for Fagus sylvatica in western Eurasia. Results of cluster analysis shows a grouping of populations in two groups: 1) the southeast group, and 2) group consist of populations from northwest, east and southeast of Serbia. Populations from this southeast group also consist the group of populations on altitude over 850 m, indicating presence of ecotypes. The exception is population from Stara Planina (1,520 m a.s.l.) which is grouped with populations from altitudes under 850 m.

Keywords: European Beech; cupules; variability

THE EFFECT OF HALF-SIB LINES ON MORPHOLOGICAL ATTRIBUTES OF ONE-YEAR OLD *Fraxinus angustifolia* SEEDLINGS

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Aiming to produce forest reproductive material at the family level, we tested quality of twenty *Fraxinus angustifolia* Vahl half-sib lines in nursery experiment. We measured height (HT) and root collar diameter (DIA) of one-year old seedlings, and we monitored germination rate and mortality during the first growing season. Seeds of 20 half-sib lines originating from Sombor area (north Serbia) are sown in seedbed on autumn 2016. The seed dormancy was not broken in all seeds equally, resulting with un-uniform germination over a two months period. All measured attributes shows a statistically significant differences, indicating a strong effect of genetic control. The highest average HT and DIA were measured in half-sib line 7 (22.62 cm; 5.79 mm, respectively). The lowest average DIA was measured in half-sib lines 18 (2.85 mm) and 19 (2.94 mm), which can be result of growing density effect (104 seedlings m^{-2} for line 18 and 126 seedlings m^{-2} for line 19, compared to 40 seedlings m^{-2} for line 7). The correlation between DIA and HT is strong and positive (R=0.90). Due to its morphological superiority, half-sib line 7 could be recommended for mass production of *Fraxinus angustifolia* seedlings at the family level.

Keywords: Height; Root Collar Diameter; Seedlings Quality; Narrow leaved ash

European white elm biomass production (*Ulmus laevis* Pall.) in high-density plantation

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This paper provides first report for European white elm potential for biomass production. High density plantation (71,428 seedlings ha^{-1}) was established on spring 2012 near Belgrade from one-year-old seedlings, produced from seed. Weed control and irrigation was practiced only in the first growing season, without fertilization. In a three year rotation, European white elm plants in a high density plantation reach average height of 341.11 cm and average root collar diameter of 31.9 mm, with height increase of about 1 m, diameter increase of about 1 cm per year. At the end of three-year rotation total produced biomass was 90 odt ha^{-1}, or 30 odt ha^{-1} $year^{-1}$. Biomass production of European white elm is in range or higher compared to traditionally used species, indicating the need for further research on planting material, plant density and cultural practices.

Key words: European White Elm; Biomass Production; High-Density Plantation; Short Rotation Plantations; Energy Plantations

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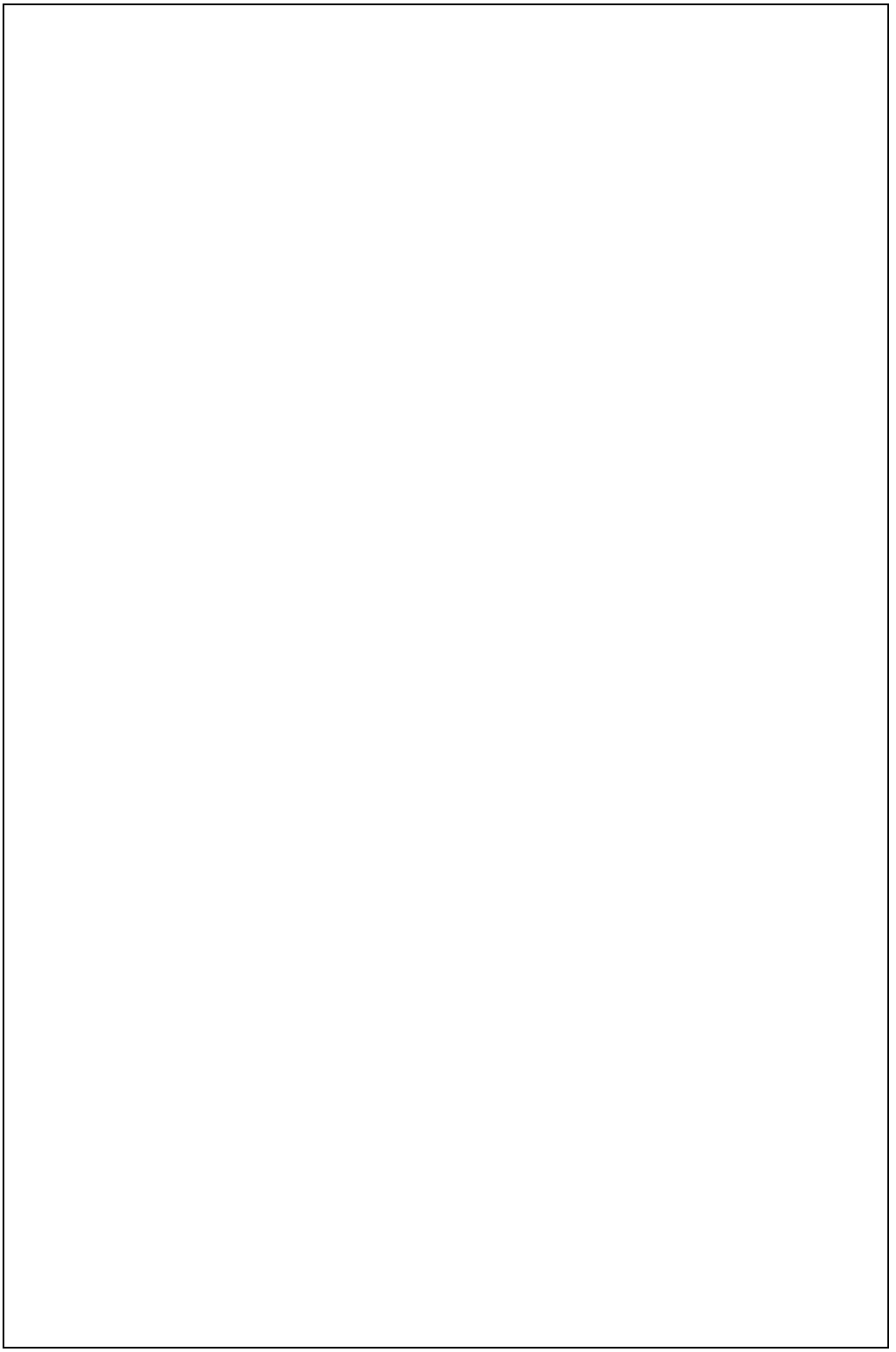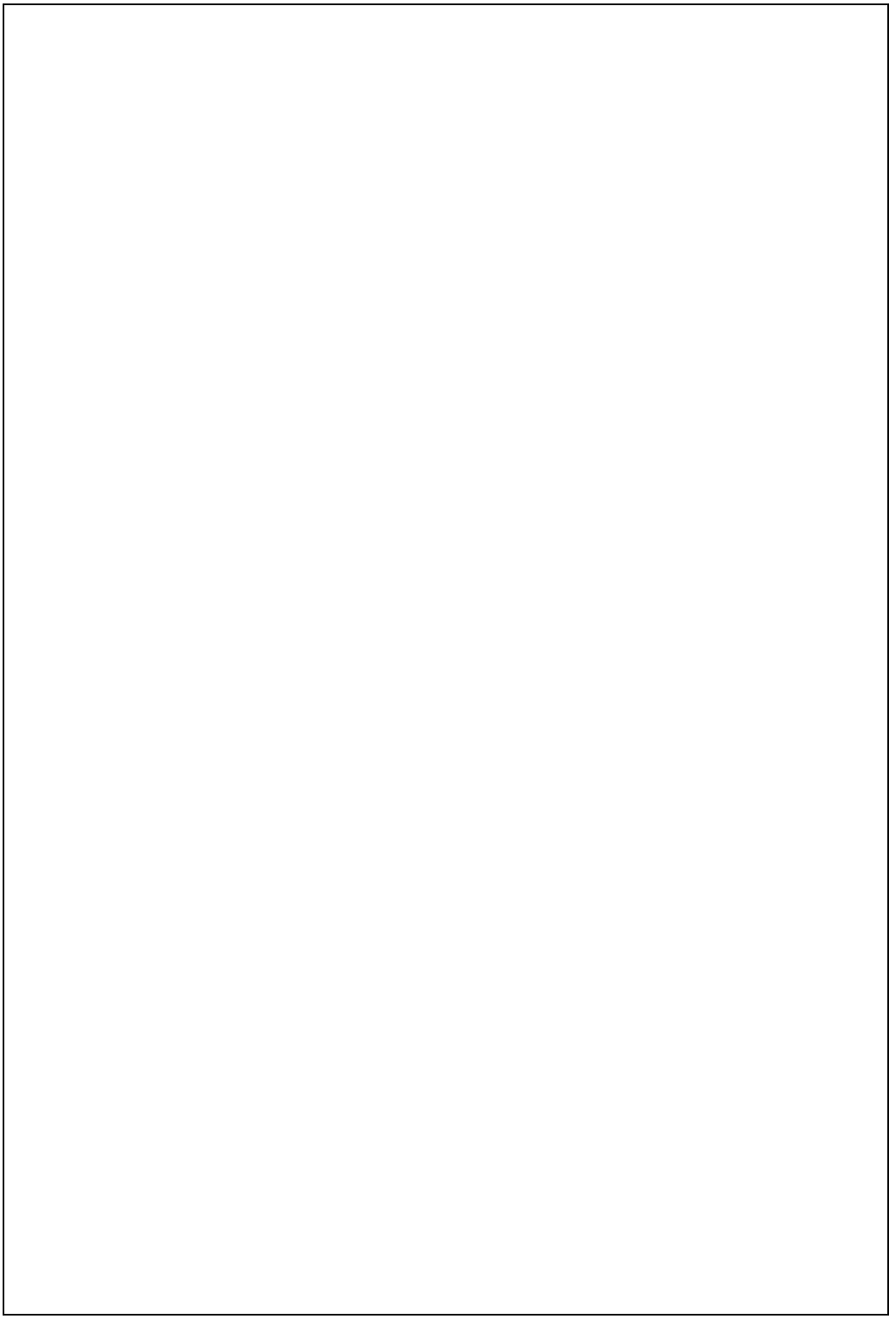
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