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GREYISH OAK (*QUERCUS PEDUNCULIFLORA* K. KOCH) SMART FORESTS FROM DOBROGEA'S PLATEAU

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Abstract

Dobrogea Plateau is situated in southeast Romania, being bordered by Danube's Meadow and Delta at West and North. The climate is temperate-continental, with reduced precipitations (around 400 mm/year) and a silvosteppe and steppe vegetation. Climate-Smart Forestry (CSC) is a branch of the forest's smart management that focuses on the response of forests towards climatic changes. In the present article, this is adapted to Greyish oak. Greyish oak smart forests are characterised by advanced ages (61-70 years) and even-aged stand structures. These forests are situated at altitudes between 51-100 m and 250-300 m, and on west and east expositions. The purpose study showed that Greyish oak can be included in the category of smart forests, by taking into account 13 elements (flora, soil and forest type) and stand conditions (pruning, vitality, diameter and average height, functional group, litter). As Greyish oak resists well to drought and grows relatively well, the species is important for improving the climate and conserving forests from the silvosteppe.

Key words: *age, altitude, greyish oak, smart forests, structure.*

INTRODUCTION

Dobrogea Plateau is situated in southeast Romania, being bordered by the Danube's Meadow and Delta.

It is a hill region where fragmentation has sometimes led to the development of pinnacles, large valleys and basins. The region amounts to approximately 10 400 km^2, meaning 4.3% of Romania's territory.

The relief is mainly plain (over 50%) or slightly reclined. Exceptions are represented by cliffs marked by a surface slope of up to 90%, petrographic or structural steeps, susceptible to active modelling. The exposition of slopes with an important role in activating phenomena and processes is more diverse in the north area of Dobrogea.

The climate is temperate-continental, with reduced precipitations (around 400 mm/year). All these data suggest that Dobrogea has a semiarid temperate climate, situated at the limit of the transition temperate climate (both as geographic location, precipitation and other meteorologic elements) (Ielenicz M., 2003).

Drought is the most extended and pregnant meteorological phenomena (both in time and in space) in Dobrogea's climate. This is the main argument for its semi aridity and also the most visible component of the image inhabitants form about this area. Even though Dobrogea is the warmest territory from Romania, this does not exclude frost phenomena.

In Dobrogea, silvosteppe is situated as a layer over the zonal steppe. Two other levels are developed over the silvosteppe: sub Mediterranean soft oak forests (present in Dobrogea and in south Banat); nemoral forest level with a holm and mixed holm inferior sublevel that is strongly influenced by the sub mediterranean one. Two areas distinguish themselves in the steppe area: graminee steppe (very narrow) and graminee and dicotyledonous steppe. Two subareas can also be found: north silvosteppe with mesophile oaks (*Quercus robur*); and south silvosteppe (sub mediterranean) with xerophile oaks (*Quercus pubescens*, *Q. pedunculiflora*) (Doniță et al., 2005). Eutric cambisol, luvisol and preluvisol are the specific soils from this area (Spârchez et al., 2017; Oneț et al., 2019; Crișan et Dinca., 2020).

Quercus Genus (oaks) is one of the most important trees from an economic and ecologic perspective. Widespread in the north hemisphere, it includes approximately 350-500 species. In Romania, it is represented by 7 species, occupying approximately 16% of the country's forest surface in the year 2012 (Beldeanu, 2004; Apostol et al., 2017; Dincă L., Breabăn I.G. 2020).

The first mention from Romania regarding the presence of Greyish oak was made by the renowned botanist Al. Borza, in 1936. The species appears in the silvosteppe from Oltenia, Muntenia, Dobrogea and South Moldavia, in both fields and low hills of 50-300 m (Curtu et al., 2009; Doniță et al., 2004).

Pedunculate oak is considered to be the most important species from Romania's forest steppe (Enescu, 1993).

Greyish oak (*Quercus pedunculiflora*) has more accentuated xerophyte characteristics than pedunculate oak and Hungarian oak, allowing it to vegetate better on dry steppe soils (Stănescu et al., 1997).

Greyish oak (*Quercus peduculiflora* K. Koch), together with other oak species such as Pubescent oak (*Q. pubescens* Willd.), Pedunculate oak (*Q. robur* L.) and Sessile oak (*Q. petraea* (Mattuschka) Liebl.) are of interest for the afforestation of degraded fields (Enescu, 2015; Constandache et al., 2016; Dincă et al., 2018; Silvestru-Grigore et al., 2018; Vlad et al., 2019).

Studies realized in Romania have shown that oak has declined in the extra-carpathian Romanian area from 1900 up to present days. This also includes Greyish oak (Nechita, 2019; Clinovschi, F. 2004).

The Climate-Smart Forestry Concept (CSC) appears as an important step in promoting the objectives of long lasting forests, as well as a response towards climatic changes (Bowditch et al., 2020). A smart silviculture is needed from a climatic perspective in order to increase the total surface of forests and to avoid land clearings.

Forests ensure numerous ecosystem services that are essential for both environment and climate. In addition, they conserve and protect biodiversity, protect against climatic changes, produce wood and non-wood products, offer water and recreational functions (Nabuurs et al. 2015; Tognetti, 2017; Vasile et al., 2018; Nabuurs et al. 2018; Dincă et al., 2018; Cântar et al., 2019; Pleșca et al., 2019; Tiwary et al., 2020; Verkerka et al., 2020; Leskinen et al., 2020; Tudor et al., 2020; Toressan et al., 2021). Furthermore, Greyish oak acorn is considered as one of the most important forest products, followed by linden and locust (Cioacă et Enescu, 2018; Dincă L. and Dincă M., 2020).

Greyish oak is a slivosteppe species that prefers a warm climate and has a slow growth especially during its youth as well as a reduced productivity.

The species has a very high ecoprotective value for conserving forests from the silvosteppe. Numerous old oak forests exist in Dobrogea's Plateau (Vechiu et al., 2021). However, they can be affected by intensive grazing (Hinkov et al., 2019).

The purpose of this article is to identify and describe Greyish smart oak forests from Dobrogea's Plateau in order to protect them.

MATERIALS AND METHODS

The material used in this paper is represented by Greyish oak elements extracted from forest management plans realized during 1993-2007 for 10 forest districts (Amenajamente silvice). The extremely large number of values (2751 stand elements) ensures a good statistical representation.

In total, 13 parameters specific to the stands or site were taken into consideration (Table 1). Each analysed parameter has obtained a grade from 1 to 5, namely: 1 = very low; 2 = low; 3 = medium; 4 = high; 5 = very high. The degrees took into account the Greyish oak's ecological requests. A hierarchy of Greyish oak stands was obtained by adding all these values. The largest values were framed in the smart forest category.

Table 1. Grade obtained based on the site and stand characteristic

Nr crt	Characteristic	Grade 1	2	3	4	5
1	Soil type	1215; 1703; 9102; 9604	1210; 2205	1204; 1701; 2401	1301; 1302; 2201; 3101	1201; 1401
2	Station type	6112; 9110	6151; 7120	9210; 9220	7430; 9530	9320
3	Litter	1	2	3	4	5
4	SUP	Q	V	A	K	E, M
5	Functional group + Functional category	1,3G ; 2,1C	1,3A; 2,1B	1,2B	1,2A; 1,2E; 1,5L	1,5C; 1,5D; 1,5H
6	Average diameter (cm)*	2-8	10-14	16-18	20-22	24-70
7	Average H (m)*	1-6	7-9	10-11	12-13	14-23
8	Production class	5	4	3	2	1
9	Pruning	0.2-0.3	0.4	0.5	0.7	0.6
10	Vitality	5	4	3	2	1
11	Structure	1	2	3	4	
12	Crown density	0.2-0.3	0.4-0.5	0.6; 0.9	0.8	0.7
13	Distance to road	1-3	4-6	7-11	12-22	23-90

*For these characteristics, the entire value range was divided in 5 categories, 1 = the smallest 5 = the highest. The category division was realized so that the analyzed biometric characteristics are respected. In addition, a balanced division was intended as number of values for each category.

The meaning of some terms used in Table 1 is rendered below:

Soil type: 1201 = chernozem; 1204 = rendzic chernozem; 1210 = vertic-stagnic chernozem; 1215 = lithyc-rendzic chernozem; 1301 = cambic chernozem; 1302 = cambic-vermic chernozem; 1401 = phaeozem; 1701 = rendzina; 1703 = lithyc rendzina; 2201 = preluvisol; 2205 = stagnic preluvisol; 2401 = luvisol; 3101 = eutric cambisol; 9102 = calcic lithosol; 9604 = lithyc erodisol.

Station type (TS): 6112 = Hill oak, rockland and excessive erosion; 6151 = Hill Quercus (cer, gârniță) small edaphic Bi eutricambosol; 7120 = Hill Quercus on strongly eroded slope in B non-chalk sedimentary small edaphic eutricambosol; 7430 = Hill Quercus with oak, high edaphic Bm-s eutricambosol; 9110 = strongly eroded silvosteppe in limestone sedimentary; 9210 = External silvosteppe with soft oak, Bm chernozem on loess; 9220 = External and extrazonal silvosteppe in xerophyte oak steppe, Bm-i, weak chernozem on loess; 9320 = Average silvosteppe of xerophyte oak stands, Bs, clay chernozem on loess; 9530 = Internal silvosteppe of mezo xerophyte-xerophyte Quercus, Bs, degraded chernozem on fine clay.

Litter: 1 = missing litter; 2 = thin interrupted litter; 3 = thin continuous litter; 4 = normal continuous litter; 5 = thick continuous litter.

Production/protection subunits (SUP): A = Regular forest, normal assortments; K = Seed reservations; E = Reservations for integrally protecting nature; J = quasi-selection system forest; M= Forests under the extreme conservation regime; Q = simple locust thicket; V = Forests with recreation functions through hunting.

Functional group (GF) and functional category (FCT): 1,2A = Forests located on cliffs, debris, on fields with depth erosion, on fields with a slope higher than 35 degrees and on flysch, sand or gravel with a slope higher than 30 degrees; 1,2B = Forests composed of entire parcels, bordering public roads of high interest or normal railroads from areas with rugged relief (fields with slopes higher than 25 degrees and in danger of landslides); 1,2E = Forest plantations realized on degraded fields; 1,3A = Steppe forests, from the limit between steppe and silvosteppe; 1,3G = Bodies of dispersed forests, with surfaces under 100 ha, situated in plain areas; 1,5C = Natural reservetions; 1,5D = Scientific reservations; 1,5H = Forests established as reservations for the production of forest seeds and the conservation of the forest genofond; 1,5L = Forests located in reservation protection areas (buffer areas); 2,1B = Forests destined to produce thick trees with superior timber quality; 2,1C = Forests destined to produce mainly average and slim trees for cellulose, rural constructions and other usages.

Vitality: 1 = very vigorous; 2 = vigorous; 3 = normal; 4 = weak; 5 = very weak.
Structure: 1 = even aged stand; 2 = relatively even aged stand; 3 = relatively uneven aged stand; 4 = uneven aged stand.

RESULTS AND DISCUSSIONS

The final grades for the analysed stands vary from 22 to 54. Smart forests are the ones that have grades higher than 50, namely 29 stands (6% of all stands).
The percentage is similar with the one obtained by other species situated in the smart forest category (Dincă et al., 2019; Dincă & Dincă, 2019; Blaga et al., 2019; Dincă & Breabăn, 2019).
The main characteristics of Greyish oak smart forests from Dobrogea's Plateau are rendered in Table 2.

Table 2. The characteristics of the smart greyish oak forests from Dobrogea's plateau

Nr crt	OS	Age (years)	Participation percentage (%)	Current growth (m^3/year/ha)	Relief	Configuration	Exposition	Field slope (g)	Altitude (m)
1	Casimcea	70	7	0.9	31	P		10	265
2	Casimcea	110	2	0.1	31	P		10	265
3	Casimcea	85	3	0.2	31	O	NE	36	260
4	Baneasa	120	6	0.3	33	P	NE	10	155
5	Constanta	70	3	0.4	12	P	V	6	60
6	Babadag	80	3	0.2	32	O	NE	6	160
7	Ciucurova	70	1	0.1	30	P	E	15	212
8	Constanta	90	1	0.1	12	P		0	70
9	Constanta	80	1	0.1	12	P	SV	6	70
10	Constanta	65	1	0.1	53	P		0	35
11	Babadag	105	4	0.1	32	P	E	8	155
12	Babadag	100	2	0.1	52	P	E	13	230
13	Babadag	70	5	0.3	43	P		0	145
14	Casimcea	70	5	0.6	31	O	V	15	275
15	Casimcea	160	2	0.1	31	O	V	15	275
16	Casimcea	85	8	0.5	30	O	S	15	270
17	Casimcea	120	2	0.1	30	O	S	15	270
18	Ciucurova	80	3	0.2	32	O	V	20	210
19	Baneasa	55	4	0.7	31	P	N	20	65
20	Baneasa	60	2	0.2	30	F	N	30	55
21	Baneasa	50	7	1.1	33	O	V	15	75
22	Baneasa	55	5	0.8	31	P	V	10	25
23	Constanta	60	2	0.3	31	P	E	15	80
24	Constanta	75	9	0.5	43	P		0	150
25	Babadag	60	1	0.1	32	O	V	16	170
26	Babadag	70	4	0.2	32	P	E	8	155
27	Casimcea	100	1	0.1	11	P		0	235
28	Ciucurova	50	3	0.8	32	P	V	12	190
29	Ciucurova	80	4	0.3	30	P	S	15	240

Location
From a geographic perspective, Greyish oak smart forests are present in the following forest districts: Casimcea, Băneasa, Babadag, Ciucurova, Constanța, Cerna, Măcin, Niculițel, Cernavodă (Figure 1).
The age of these smart forests is diverse, varying between 50 and 100 years. The majority of stands are situated in the 50-60 year category and between 61-70 years (Figure 2).
The altitude where Greyish oak appears in Dobrogea's Plateau ranges between 38 m in Constanța and 275 m in Casimcea. Our analysis shows that 24% of the surface occupied by these stands is situated at altitudes between 51-100 m and 250-300 m (24%) Figure 3).
Participation percentage in the stand's composition. It has been observed that this species is included in the stand's composition in different percentages. The composition is mixed (intimate + groups = 42%) and in groups (14%) (Figure 4).
The structure of Greyish oak stands is especially even-aged (52%), relatively even-aged (34%) and relatively uneved-aged (14 %) (Figure 5).

Figure 1. Distribution of smart Greyish oak stands from Dobrogea's Plateau

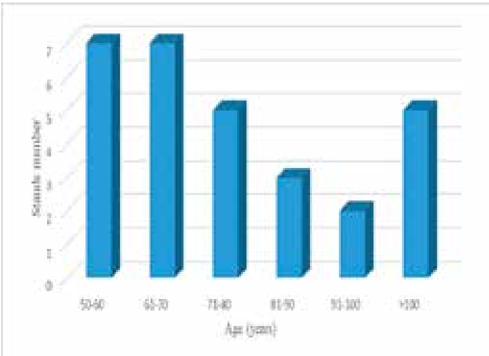

Figure 2. Distribution of smart Greyish oak forests in Dobroudja Plateau on ages

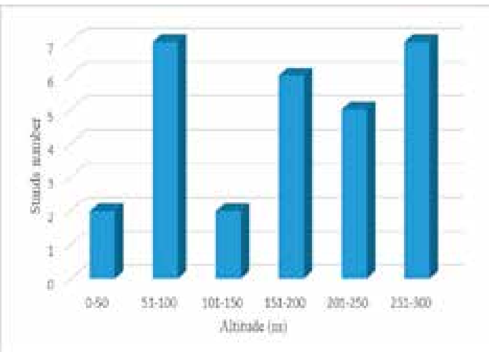

Figure 3. Distribution of smart *Quercus pedunculiflora* in Dobrogea Plateau on altitudes

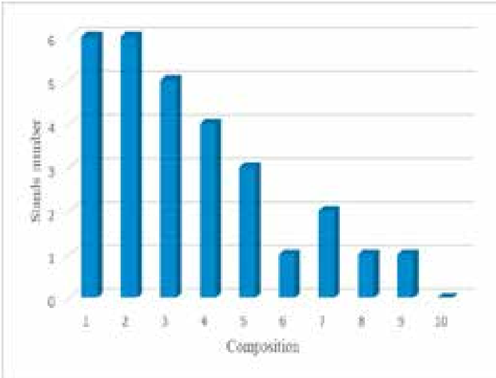

Figure 4. Participation percentage in stands compositions of smart *Quercus pedunculiflora* from Dobrogea Plateau

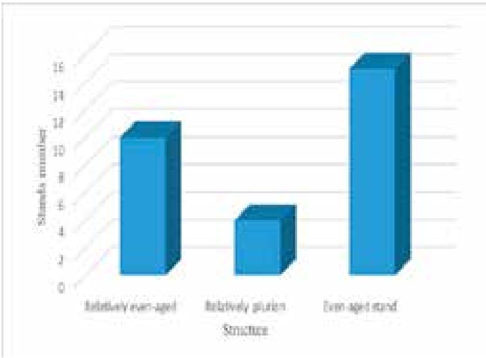

Figure 5. Distribution of smart *Quercus pedunculiflora* in Dobrogea Plateau on structure categories

The inferior slope is **the relief** form characteristic for these stands, occupying only 28% of the total surface of studied stands (Figure 6).

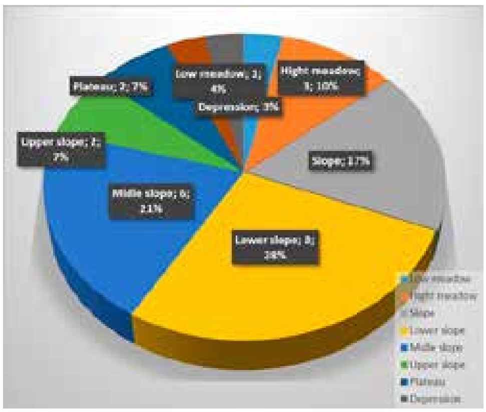

Figure 6. Relief forms characteristic for smart *Quercus pedunculiflora* stands from Dobrogea's Plateau

East and west expositions are characteristics for smart Greyish oak forests from Dobrogea's Plateau (Figure.7)

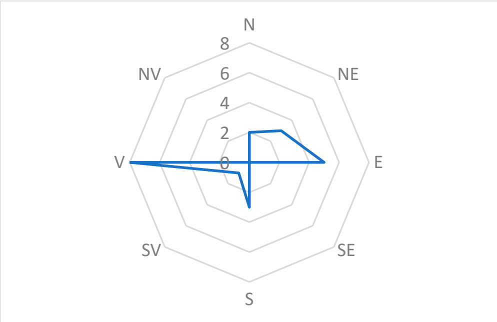

Figure 7. Distribution of smart *Quercus pedunculiflora* forests in Dobrogea Plateau on expositions

The field slope ranges between 6g and 36g, with most fields characterised by small slopes of 6g-15g. The slope acts in a close connection with exposition and altitude, influencing environment conditions.

CONCLUSIONS

The age of smart Greyish oak stands ranges between 50 and 100 years, being situated at altitudes between 51-100m and 250-300m, on West and South expositions. The stands' structure is especially even-aged, being located at relatively small distances from forest roads (between 1-10 km). In Romania, Greyish oak occupies small surfaces from the forest fund, being however widespread in the South silvosteppe. Identifying these Greyish oak stands is extremely important both for their protection, as well as for applying proper silvicultural measures.

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