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SOLAR ENERGY UTILIZATION AND EFFICIENCY OF AN OAK FOREST IN THE VAKAREL MOUNTAINS

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ABSTRACT

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Results of energy reserves in the above-ground and bellow-ground phytomass of the Quercus frainetto+Quercus cerris - Festuca heterophylla+Poa nemoralis association were analyzed. The annual accumulation and the efficiency coeficient of the association were evaluated

Key words: energy reserves, annual accumulation, efficiency coefficient.

ИЗВОД

Љубенова, М..И. (1994). Ефикасност и искористување на сончевата енергија од дабова шума во Вакарелските Планини. Екол. Зашт. Живот Сред.,, Том 2, Бр. 2, Скопје.

Во трудот се анализирани резултатите од енергетските резерви во надземната и подземната фитомаса во асоцијација Quercus frainetto+Quercus cerris - Festuca heterophylla+Poa nemoralis. Проценети се годишната акумулација и коефициентот на ефикасноста на асоцијацијата.

Клучни зборови: енергетски резерви, годишна акумулација, коефициент на ефикасност

INTRODUCTION

The functional structure of ecosystems has been continuously studied (Тооминг et al. 1973; Раунер 1978; Хилвми 1978; Бондев et al. 198.3; Нинов et al. 1982,1983; Етрополски et al. 1985; Лгобенова 1987, 1992; Флоров 1987, etc.), in order to preserve them and procure raw material for human society, i. e. to use nature resources effectively.

This paper presents the results of energy flow study in association Quercus frainetto+Quercus cerris-Festuca heterophylla+Poa nemoralis.

OBJECTS AND METHODS

The investigation has been carried out in two experimental plots of the association located in a lower and upper part of a slope, inclined at 12-14°, facing South and South West, at 950 m above sea level.

The association is situated in a climatic region, including the Western Srednogorie and pertaining to the European continental (temperate) climate zone. The soils are planosols (Пенков et al. 1992)

The reserves and production of the tree layer were evaluated (in 1986), using standard methods (Chapman 1976).

The calorific value of the phytomass

were determined with calorimeter Gallencamp CBB 01 OL,

The efficiency coefficient (EC) is calculated according to Тооминг (1977).

The quantitative data of the total radiation (TR) for the region are calculated according to Лингова (1978) and corrections were made for altitude above sea level, exposure and slope. The physiologically active radiation (PHAR) (21,486-10^9 KJ-ha"^{1} per year and 15,866-10^9 KJ-ha"^{1} per vegetation season) has been assumed to be about 50% of TR (Ефимова 1977).

RESULTS AND DISCUSSION

The total energy reserves of the association under study are about 4,644 ± 0Д5-10^9 KJ-ha"^{1}, the basic part of the energy being accumulated in the living phytomass - 80,2.3% ± 4% on the average (for the I and II plot respectively). The accumulated energy in the dry phytomass is prevalently stored in reserves on the different layers - 0,622-10^9 KJ-ha^4 ± 0,22-10^9 KJ-ha"^{1}. The energy reserves in the litter are about twice (3 to 1,3 for the I and II plot) less (table 1, fig. 1).

The energy reserves on the layers (without the litter) are 4,348 ± 0Д7-10^9 KJ-ha"^{1} the energy included in the dry phytomass being 14,3% on the average in spite of its variation in the association. The grater part of the total energy reserves is concentrated in the aboveground phytomass - 66% ± 4% on the average and predominantly in the tree layer - 65,77% on the average. The portion of shrub and herb layers is insignificant - under 1%. The energy accumulated in the bellowground phytomass is about half as much -1,470 ± 0,22-10^9 KJ-ha"^{l}, while 71,97% on the average are concentrated in the living phytomass. The tree layer is the main source of bellowground energy reserves. Together with the shrub layer it forms about 99% of the association bellowground. The portion of the herb layer is under 1%.

The association under study annually accumulates approximately 0,440 ± 0,02-10^9 KJ-ha"^{1}, which is about 10% of the tree layer reserves. 77,04 layer reserves. 77,04% of the total annual energy increase accumulate in aboveground phytomass of that is 11, 78% ± 1% (for the I and II plot respectively) of the association energy reserves in aboveground phytomass. The portion of the bellowground phytomass in the annual energy binding and accumulation is 22,95% ± 1% on the average (over 3 times less than the aboveground portion) and on the average it constitutes about 6,87% of the available energy reserves. The tree layer gives the greatest contribution to the annual energy accumulation in aboveground as well as in bellowground phytomass of the association (on the average 77,04% and 22,95% respectively). The contribution of the other two layers is weak: shrub layer - 0,23% ±0,1% and herb layer - 2,5% in the aboveground and 1,59% in the bellowground phytomass on the average (Tab. 1, Fig. 1).

The shrub and herb layers (and particularly the latter) are of great importance for the rotation of matter in the association. Annually 33% and 7.3% (for the shrub and herb layers respectively) of the aboveground and 3.5% of bellowground energy reserves of the herb layer are accumulated. Insignificant at first glance, the annual energy reserves and production of the species on these layers take part in the rotation of matter and energy flow and that constitutes their dynamic and vital importance for ecosystem functioning.,

Energy about 0Д10-10^9 KJ-ha"^{1} falls in the litter annually: on the average 89.09% ± 2% of it comes from the tree layer and it is about 30% of the annually accumulated energy and about .3,4% of the energy reserves in this layer. The herb and shrub layers give respectively 10% and 0,9% in the total energy, contained in tjhe litter. The energy accumulated in the annual litter-fall represents about 2,25% of the average energy reserves, 3.3,11% of the energy litter reserves and 22,27% of the annual energy increase in the coenoses.

It is well known that the energy reserves in ecosystems are of a great importance for their stability. The average time for energy transfer in the association under study is 10,6 years (9,4 years only for the aboveground phytomass) and is about half as much as the value given by Ricklefs (1979) for deciduous forests in the temperate zone, We may assume that there are possibilities for biomass and energy reserves increase in the association.

Tab. 1 Average energetic reserves and annual accumulation of energy (KJ $ha^{-1}10^9$; %)
Таб. 1 Просечни енергетски резерви и годишна акумулација на енергија (KJ- $ha^{-1}10^9$; %)

KIND OF PHYTOMASS (типови на фитомаса)	RESERVES (РЕЗЕРВИ) total (вкупно) KJ	%	living (жива биом.) KJ	dry (сува) KJ	ACCUMULATION (АКУМУЛАЦИЈА) KJ	%
ABOVEGROUND (надземна)	2, 878	66, 18	2, 668	0, 210	0, 339	77, 04
Tree layer (кат на дрвја)	2, 860	65, 77	2, 654	0, 206	0, 327	74, 31
Quercus frainetto Ten.	1, 600	36, 80	1, 453	0, 147	0, 178	40, 45
Quercus cerris L.	1, 134	26, 08	1, 080	0, 054	0, 107	24, 32
Quercus dalechampii Ten.	0, 126	2, 89	0, 121	0, 005	0, 042	9, 54
Shrub layer (кат на грмушки)	0, 003	0, 07	0, 003	0, 000	0, 001	0, 23
Herb layer (приземен кат)	0, 015	0, 34	0, 011	0, 004	0, 011	2, 50
BELLOWGROUND (подземна)	1, 470	33, 81	1, 058	0, 412	0, 101	22, 95
Tree and shrub layer (кат на дрвја и грмушки)	1, 450	33, 35	1, 038	0, 412	0, 094	21, 36
Herb layer (приземен кат)	0, 020	0, 46	0, 020	-	0, 007	1, 59
TOTAL (вкупно)	4, 348	99, 99	3, 726	0, 622	0, 440	99, 99
FOREST FLOOR/LITTER (шумска простирка / опад)	0, 296	-	-	0, 296	0, 110	100, 00
Tree layer (кат на дрвја)	-	-	-	-	0, 098	89, 09
Shrub layer (кат на грмушки)	-	-	-	-	0, 001	0, 91
Herb layer (приземен)	-	-	-	-	0, 110	10, 00

The EC (as compared to PHAR) of the association under study is 0,42% (for the tree layer - 0,27%) on the average for the whole period of its existence (1,60% per year and 2,78% per vegetation season). Taking into consideration Тооминг (1977) and Риклефс (1979) data on EC of the vegetation cover, the calculated EC of the coenoses under study is lower. However according to the classifications developed for objective evaluation of effective solar energy utilization by vegetation plant communities (Тооминг 1977; Ничипорович 1971), the EC obtained for association Quercus frainetto+Quercus cerris-Festuca heterophilla-Poa nempralis is good.

The PHAR of the region are under 167,44-10^9 KJ-ha"[1], in which case according to Дроздов (1969) the increase of radiation and the annual rainfall would raise the EC.

CONCLUSIONS

The total energy reserves of the association under study are 4,644-10^9 KJ-ha^{-1} and the greater part of that is accumulated in aboveground phytomass (68,4%). The tree layer is of the greatest importance for building up of the available energy reserves. Only about 6,4% of the reserves are concentrated in the litter.

The average annual solar energy accumulation is about 10% of the energy reserves in the association (0,440-10^9 KJ-ha"[1]), 77% of it being stored in the aboveground phytomass of the coenoses. The tree layer gives 97,7% of the total annual accumulation energy.

About 22,3% of the energy litter reserves renew every year.

According to Tooming's (1977) classification, the calculated EC of the association compared to PHAR for a vegetation season is good

The average time of energy transfer is about 2 times less than that given by Риклефс (1979) for deciduous forests in the temperate latitudes. The improvement of radiation conditions (thinning out of the forest) and increasing soil humidity would help raising the EC of the forest association under study.

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ЕФИКАСНОСТ И ИСКОРИСТУВАЊЕ НА СОНЧЕВАТА ЕНЕРГИЈА ОД ДАБОВА ШУМА ВО ВАКАРЕЛСКИТЕ ПЛАНИНИ

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РЕЗИМЕ

Вкупните енергетски резерви н а асоцијацијата Quercus frainetto+Quercus cerris - Festuca heterophyla + Poa nemoialis се 4644-10^{9} KJ ha''^{1} и поголем дел од нив е акумулиран во надземната фитомаса (68,4%). Катот на дрвјата е од најголема важност во изградбата на достапните резерви енергаја. Само околу 6,4% на резервите се концентрирани во акумулираната мртва органска материја на површината на почвата.

Просечната годишна акумулација на сончева енергија е околу 10% од енергетските резерви на асоцијацијата (0,44О10^{9} KJ ha''^{1}), при што 77% од нив се складирани во надземната фитомаса на ценозата. Катот на дрвјата содржи 97,7% од вкупната годишна акумулација на енергија,

Околу 22,3% од годишното зголемување на енергија, паѓа со опадот на површината на почвата, односно 33,1 % од екергетските резервк ка шумската простирка се обковуваат секоја година.

Според Тооминг (1977), енергетскиот коефициент на асоцијацијата спореден со ФАР (фотосинтетски активна радијација) во периодот на вегетацијата е добар.