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THE POSSIBILITY OF GROWING ALTERNATIVE CEREALS ON DEGRADED LAND

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Abstract: Sustainable Development Strategy harmonized with the environment, strengthened legislation and the protection of living and working environment and its management, according to a series of international standards, is of paramount importance that needs special attention. As demand for alternative grains is on the rise in the global market, with qualitative changes in the diet of mankind alternative, grains returns the old value. And this is contributed mostly by their nutritional properties (use value). A two-year research of alternative possibilities for growing cereals (buckwheat and spelt) were conducted during 2011 and 2012 at three sites, two types of soil (degraded and chernozem), two of those sites are degraded land, while the third site is among the best land in our region (chernozem). These are two absolutely different types of soil and therefore this was an attempt to determine the suitability of degraded land for growing alternative cereals (chernozem was the control one).

Results of this research showed that the highest grain yield per unit area was obtained in the chernozem test field in Srem. However, the results achieved on degraded soils shows that these plants can be successfully grown in less favorable conditions for plant production.

Key words:*alternative cereals, degraded land, environment, spelt wheat yield, buckwheat.*

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INTRODUCTION

At the European Council session in Brussels in mid-2000, it was concluded that the most important goal of the European Union is sustainable development, and environmental protection as a major determinant in future production and further development at all levels of entrepreneurship. Consumer's right to safe food and protection from products harmful to health and life of consumers should be provided in the modern market economy. Therefore, the ecological quality of products is required on the market at the global level[4].

Alternative grains represent a special group of cultivated plants, named pseudo-grains, as well as forgotten old-new, neglected, ignored and special grains, which have significant importance as good preceding crop in the plant production, since they are leaving the land in good condition for the crops that follow them up in the rotation (rotational crops). Crop residues of these cereals are a good bioenergetic material, which helps to alleviate the current energy crisis. These grains have a long tradition in our nourishment as well as in the world's population. Throughout the history of civilization they were indispensable in human nutrition. By changing dietary habits and switching to fast food, the use of these grains of wheat was ignored and they are used in the diet of the rural population.

With qualitative changes in the nutrition of mankind, alternative grains regain the old value. This is due to their nutritional properties (use value). By cultivating these crops in less favorable agro-ecological and soil conditions, during the long history, these grains have developed a natural sustainability system and tolerance to abiotic stress, which is growing nowadays as a result of global climate change. From the agronomic point of view, these species are important because they can be grown successfully on a wide geographical area and in different climate conditions. In our country, they are mainly grown in poor soils and in mountainous regions, which are less suitable for the cultivation of conventional grain crops. Also, crop residues are used in various industries for the purpose of making many products (insulation materials, construction goods, etc.)[5].

This grain thrives on different soil types, as well on soils with decreased production traits, which can be classified as various degraded land. As a result, the expansion of production of alternative grains does not deprive the area of conventional grains, which contributes to the total production of grain[6].

[4] Jela Ikanović, Vera Popović, Snežana Janković, Ljubiš Živanović, Sveto Rakić, Dalibor Dončić (2014): Khorasan wheat population researching (triticum turgidum, ssp. turanicum (McKEY) in the minimum tillage conditions, Genetika“ Vol. 46, broj 1 pp 105-115

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The flawed tendency is that the area occupied with degraded land is increasing[7]. This is the result of degradation multiplying factors, which come from nature itself, as well as people.

Plant production cannot be realized on some soils (very salty soil, waterlogged, land damaged by erosion, chemical agents, and the like) as pointed out[8]. It should be noted, that alternative cereals and other cultivated plants, achieve higher yields and provide a good quality when grown on better soils.

In the literature we can find numerous scientific papers that deal with this issue. There is much evidence that alternative grain thrives on different soil types, and therefore on soils with poor production traits[9]. Particularly noteworthy is the fact that this applies to degraded land. It is estimated that there are about 1.5 billion hectares of such lands in the world. In the last forty years, about 30% of agricultural land suffered from degrading processes, especially in developed countries. There are about 30 000 hectares of disturbed (degraded) area in Serbia. It is slightly exploited, which seriously affects domestic agriculture. Degradation dynamics of our land is such, that every year, about 4 000 hectares of agricultural area is being destroyed[10]. The same authors indicated that the greatest damage of soil is done through mining works, surface mines, industries, and roads, construction of reservoirs as well as dumps and tailing ponds.

There are certain attempts to improve degraded land, or to re-cultivate, but the results in the world are mainly symbolic, as well as in our country. Many researchers point out to the possibility of their repair[11].

There is an increasing awareness of the importance of land for food production, including degraded land. In recent years, the research is

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[10] Ana Đorđević, Tanja Cupać, Tijana Čoporda-Mastilović (2010): Identifikacija degradiranih površina na području opštine Soko banja. Međunarodna konferencija Degradirani prostori i ekoremedijacija (Zbornik radova), Beograd, str. 349-358

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undertaken in order to improve and exploit these lands. Presently, crop production cannot be realized in certain soils at all (very salty soil, waterlogged, land damaged by erosion, chemical agents, etc.). Finding the possibility of using these areas for agricultural purposes, is gaining importance, and one of the solutions can be alternative grains, and the main objective of this research was to obtain new knowledge about cultivating conditions and opportunities for the production of alternative grains in the soil in varying degrees of degradation.

MATERIAL AND METHODS

The research was performed during 2011 and 2012, and the subject of this study was to find opportunities for the production of alternative cereals on degraded soils as well. This research was comprehensive, and it covers two types of buckwheat crop varieties *Novosadska* and spelt wheat, a wheat not cultivated in our country for a long time, but due to the increasing demands for this grain flour, it was included in the program of these studies, the variety of*Nirvana*, selected at the Institute of Field and Vegetable Crops, Novi Sad, which were grown in the two-year period in the following areas:

A. Stanari (Bosnia and Herzegovina), degraded soil

B. TENT Obrenovac (Serbia), degraded soil,

C. Chernozem Test trial on Stara Pazova, (Serbia).

Degraded land, resulted from carrying out extensive construction work on the building of thermal power plants and it is considerably uneven, and due to that in some places encounters a significant share of sand, gravel and other solid material that was used to build the plant.

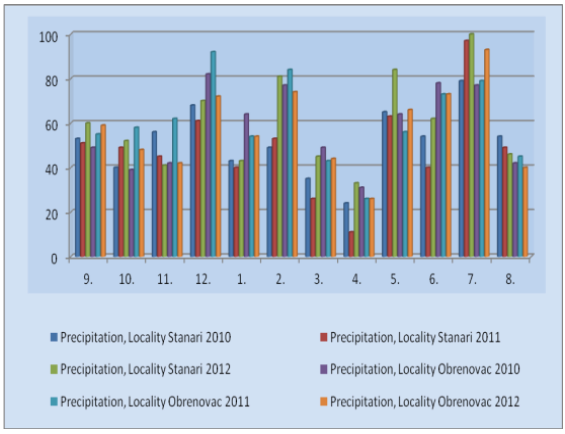
Chernozem is very favorable type of land for growing almost all cultivated plants, hence the alternative crops. It is also characteristic for chernozem where to set up alternative grains. It is located on a small hill, protected from groundwater.

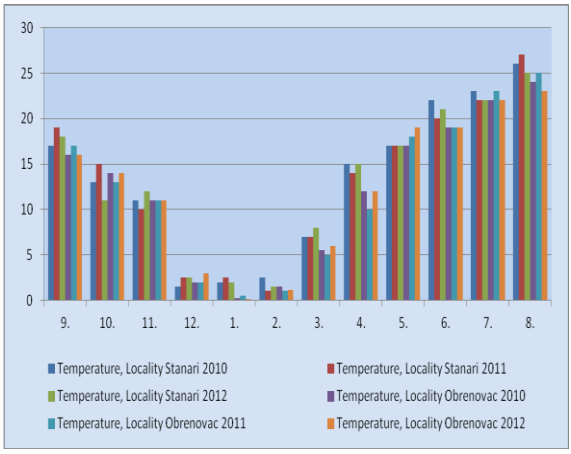
Cultural methods are adapted to each type individually as well as adapted to the specific weather and soil conditions of the investigated area. During the research, agro-meteorological and soil conditions were analyzed in these locations. Studies included phenology observations and analysis of the dynamics of growth and development of plants during the growing season. After the harvest of crops, grain yields per unit area were calculated.

METEOROLOGICAL CONDITIONS

During thistrial, the most important meteorological parameters - distribution and the amount of precipitations and temperature conditions during the growing season of plants were followed. Data on monthly rainfall and average air temperatures for 2010/2012 were obtained from the Hydro meteorological Service of the Republic of Serbia and the Hydro meteorological Department of Bosnia and Herzegovina.

According to the precipitation amount and distribution by months and years, trials of the vegetation period studied, the alternative grain water regime tested, these sites was relatively favorable. (Fig. 1a).





(a) (b)

Figure 1. Total precipitation amount (a) mm, and the mean monthly temperature (b), °C, Stanari in Bosnia and Herzegovina and Obrenovac - TENT 2 in Serbia, 2010-2012.

In the trial years, the distribution of heat by months was favorable for the growth and development of cereals (Fig. 1b), primarily in the spring with a gradual increase of temperature until the beginning of the summer which provided the transitions of the plants from vegetative to reproductive growth stages with optimum thermal regime. Variations of average monthly air temperatures at the trial sites were not high, although in the vicinity of Obrenovac the temperatures were lower by 1-2 °C compared to other locations.

RESULTS AND DISCUSSION

Grain Yield. Results of two-year trial of the impact of agro-meteorological conditions to the yield of buckwheat and spelt wheat showed that they significantly influence the success of the production of these alternative grains (Table 1).

Table 1. Average grain yield of alternative cereals t/ ha^{-1}

Alternative cereals	Buckw heat	Buckwhe at	Buckw heat	Spelt wheat	Spelt wheat	Spelt wheat
Location	2011	2012	X	2011	2012	X
Stanari (BiH)	0,91	0,72	0,81	-	2,92	2,92
TNT Obre-novac	1,33	1,31	1,32	2,96	2,71	2,83
Stara Pazova	1,54	1,79	1,66	3,78	3,98	3,88
X	1,26	1,27	1,26	3,37	3,20	3,21
$LSD_{5\%}$	0,23	0,24	0,35	0,76	,54	0,73
$LSD_{1\%}$	0,55	0,57	0,93	1,89	1,20	1,64

The obtained results showed us that the lowest average grain yield of buckwheat was on degraded land in Stanari mines 0.8t ha-^{1}, and the highest on the most fertile chernozem soil, 1.66t ha-^{1}. Weather conditions did not significantly affect the difference in yield because the weather conditions in both years had similar values. Spelt wheat was sown at two sites is in the first year, and all three sites the second year. Consistent average yield on the first two sites with degraded land and significantly higher yield on chernozem showed that this grain gives the best results in fertile soils, where the highest yield was achieved.

Productive characteristics of cultivated cereals depended on their ability to adopt plant assimilation, together with soil conditions and the amount of nutrients on degraded land, as well as the distribution of precipitation in the early stages of plant growth. On with less favorable chemical and physical properties, water was rapidly lost from the surface layer of soil, resulting in reduced yield.

However, the results achieved on degraded, less fertile land and with altered agroecological conditions show that these plants can be successfully grown in less favorable conditions for crop production. The results showed adaptability of these plant species to soil conditions, and comparing our results from barren soil with the results obtained on chernozem[12], it is obvious that these results are effects of supplemental nutrition of plants and showed that the soil fertility has a great influence on buckwheat yield, but also the system of production technology (time and method of planting). Increasing food demands and pharmaceutical industries for buckwheat, shows that the production of these plants should be organized over large areas, mainly to meet own needs, but also for export. Lately, buckwheat is getting new economic importance, as well as new agro-technological and agro-commercial value[13].

[12] V. Filipovic, Dj. Glamoclija and R. Jevdjovic (2005): The Application of Eco-fertilizers in the buckwheat crop (F.esculentum Moench.). XL Croatian Symposium on Agriculture with International Participation, Opatija, Thematic proceedings, pp. 145-146, Opatija.

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By selecting the most suitable plants for growing on barren soil the process of re-cultivation of the land will be accelerated. Tangible results, in this regard, arealready visible by some species of alternative cereals such as spelt, buckwheat, miscanthus, or some other[14]. The same author, points out that finding new possibilities of use of degraded land for agricultural purposes is gaining importance as well as the choice of plant species that are most tolerant to these conditions.

CONCLUSION

The results showed that degraded land has the potential and ability to produce alternative grain crops, since these grains are usually grown on soils worldwide that are not suitable for intensive crop production. Before introduction on such land, a specific production technology should be implemented, starting with the removal of natural vegetation, then to the processing of land that would reduce weed infestation of the area.

In finding the most suitable crops for reclamation of barren soil, the preferred plants are those with a strong root system and better assimilation in deeper soil layers. The results show that the highest grain yield per unit area was obtained on chernozem trial field in Srem, but the results achieved in the degraded lands on the other two sites show that these plants can be successfully grown in less favorable conditions for plant production. During a long history of cultivation in less favorable agro-ecological and soil conditions these crops have developed a natural sustainability system and tolerance to abiotic stresses, which is nowadays more pronounced as a result of global climate changes.

MOGUĆNOST GAJENJA ALTERNATIVNIH ŽITA NA DEGRADIRANOM ZEMLJIŠTU

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Apstrakt Strategija održivog razvoja usklađenog sa životnom sredinom, zaoštravanje propisa o zaštiti životne i radne sredine i njenim upravljanjem prema seriji međunarodnih standarda, pitanje je od izuzetne važnosti kome treba posvetiti posebnu pažnju. Kako je potražnja za alternativnim žitima u stalnom porastu na svetskom tržištu, sa kvalitativnim promenama u ishrani čovečanstva alternativnim žitima se vraća stari značaj. Tome najviše doprinose njihove nutritivne specifičnosti (upotrebne vrednosti). Dvogodišnja istraživanja mogućnosti gajenja alternativnih žita (heljde i krupnika) izvedena su tokom 2011 i 2012. godine, na tri lokaliteta, na dva tipa zemljišta (degradirano i černozem), od kojih dva lokaliteta spadaju među degradirana zemljišta, dok treći lokalitet spada među najbolja zemljišta na našim prostorima (černozem). To su dva apsolutno različita zemljišta, pa je ovo bio pokušaj da se odredi pogodnost degradiranog zemljišta za gajenje alternativnih žita (kontrola je černozem).

uslova na hemijski sastav kvinoje (Chenopodium quinoa Will.). Međunarodna konferencija Degradirani prostori i ekoremedijacija (Zbornik radova) Beograd, str. 295-302

[14] Đ. Glamočlija, Mirjana Staletić, Jela Ikanović, Marija Spasić, Vera Đekić, Marija Davidović (2010): Possibilities alternative grain production in the highlands area of central Serbia. International Scientific Meeting: Multifunctional Agriculture and Rural Development (V) II Book, pp. 71-77.

Rezultati istraživanja da je najveći prinos zrna po jedinici površine dobijen na test ogledu černozemu u Sremu. Međutim, rezultati ostvareni na degradiranim zemljištima pokazuju da se ove biljke mogu uspešno gajiti i u manje povoljnim uslovima za biljnu proizvodnju.

Ključne reči:*alternativna žita, degradirano zemljište, životna sredina, krupnik prinos, heljda..*

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