Short communication

CULTIVATION OF ALTERNATIVE CROPS AS ENERGY CROPS

ANAMARIJA KOREN[1], VLADIMIR SIKORA[1], ŽELJKO MILOVAC[1], PETAR MITROVIĆ[1], DRAGANA MILADINOVIĆ[1], SLAVEN PRODANOVIĆ[2], ANA MARJANOVIĆ JEROMELA[1]

CORRESPONDING AUTHOR: anamarija.koren@ifvcns.ns.ac.rs

Alternative Crops and Cultivation Practices

VOL. 4, 2022, 17-20

ACKNOWLEDGEMENTS: The research is the result of activities within the Center of Excellence for Innovations in the Cultivation of Crops Resistant to Climate Change, IFVCNS and was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (grant number: 451-03-68/2022-14/200032) and Provincial Secretariat for Higher Education and Scientific Research, Autonomous Province of Vojvodina, Republic of Serbia (grant No 142-451-2160/2022-01, and grant No 142-451-2609/2022-01/01).

SUMMARY

Several winter and spring alternative crops are grown in our country. Similar to the yield of staple field crops, the yield of minor cultivated crops is affected by complex climate-soil interactions, abiotic and biotic stress and cultivation technology. If grown solely for the production of plant raw materials (aboveground biomass, grain and/or root) for conversion into biofuels and bioenergy, the alternative crops are energy crops. Although they have different taxonomic affiliations, morphologies and origins, energy crops can be: oilseeds (oil rapeseed, camelina, white mustard, and castor), starch-sugar (sorghum, Sudanese grass, corn) and lignocellulosic (miscanthus, hemp). From the point of view of agronomy, the prerequisite for increasing the area under energy plant species for the production of biofuels in Serbia is the improvement of assortment, cultivation technology and mechanization. The paper provides an overview of agronomic forms and cultivation technology of several specific alternative plant species in the context of using crop biomass for energy purposes.

KEYWORDS: agriculture, cultivation technology, plant biomass

KOREN, A., SIKORA, V., MILOVAC, Ž., MITROVIĆ, P., MILADINOVIĆ, D., PRODANOVIĆ, S., & MARJANOVIĆ JEROMELA A. (2022). CULTIVATION OF ALTERNATIVE CROPS AS ENERGY CROPS. ALTERNATIVE CROPS AND CULTIVATION PRACTICES, 4, 17 -20.

INTRODUCTION

Energy crops are crops unsuitable for human or animal consumption and grown exclusively for the production of: (i) products considered biofuels listed according to Article 2, point 2 of Directive 2003/30/EC of the European Parliament and of the Council of 8 May 2003 on the promotion of the use of biofuels or other renewable fuels for transport (bioethanol, biodiesel, biogas, biomethanol, biodimethylether, bio-ETBE (ethyl-tertio-butyl-ether), bio-MTBE (methyl-tertio-butyl-ether), synthetic biofuels, biohydrogen, pure vegetable oil), and/or (ii) electric and thermal energy produced from biomass (EU, 2003).

Energy crops produce more biomass throughout the annual production cycle compared to other plant crops. Energy crops are affiliated to *Poaceae* (miscanthus, reed, prairie millet, tall sedge, elephant grass, Sudan grass, and sorghum), *Fabaceae* (lupins, soybeans) and *Asteraceae* family (Jerusalem artichoke, safflower). *Brassicaceae* (oil rapeseed, white mustard), *Euphorbiaceae* (castor and jatropha) and *Cannabaceae* (industrial hemp) species have high grain oil content, important for obtaining biodiesel. Also some species from the *Malvaceae* family have excellent bioenergetic value (kenaf, abutilon and Virginian mallow).

[1]Institute of Field and Vegetable Crops, National Institute of the Republic of Serbia, Maksima Gorkog 30, 21 000 Novi Sad, Serbia
[2]Faculty of Agriculture, University of Belgrade, Nemanjina 6, 11080 Belgrade, Serbia

ENERGY CROPS CULTIVATION TECHNOLOGY

The agropedological conditions of Serbia favor the production of energy crops. In order to mitigate the effect of the limiting factors of cultivation, the correct choice of the species, agricultural form and assortment of energy crop is of extreme importance. Each of these alternative plant species has specific advantages that can make it suitable for a specific growing region. The system of good agricultural practices is the basis for achieving high and stable yields of energy crops. Proper crop rotation in compliance with integral crop management can ensure proper development of the crop even in unfavorable environmental conditions.

Compared to the staple field crops, most of these winter (oil rapeseed, camelina) and spring (oil rapeseed, camelina, sorghum, hemp) alternative crops do not require optimal agro-ecological conditions (camelina, sorghum, hemp), tolerate greater climatic fluctuations and can be grown on marginal and saline soils (sorghum), soils of reduced fertility (sorghum, hemp) or in semi-arid areas (sorghum, camelina). From the biomass production perspective, the tolerance of these species to abiotic stress factors (lack of soil and atmospheric moisture and high temperatures) is important. Some of the energy crops (sorghum) have developed a number of morphological and physiological characteristics that enable them to achieve stable yields even in extreme environmental conditions (Sikora et al., 2013).

Table 1. Key agrotechnical points for the energy crops cultivation in agropedological conditions of Serbia (recommendations)

Crop	Crop rotation	Soil tillage	Soil fertilization	Seed sowing	Crop maintenance	Harvest
Industrial hemp *Cannabis sativa* L.	Annual legumes/ small grains → hemp → spring crops	Primary and secondary tillage	60 kg ha^{-1} N, 32 kg ha^{-1} P_2O_5, 72 kg ha^{-1} K_2O (Koren & Sikora, 2021)	*Time*: mid-March to mid-April *Depth*: 3-5 cm *Seeding rate*: 20 kg ha^{-1}, 50 cm x 3-5 cm (grain hemp), 50 kg ha^{-1}; 12.5 cm x 2-3 cm (biomass)	Topping (grain hemp)	End of September-beginning of October (grain hemp) Mid-August (biomass)
Oil rapeseed *Brassica napus* L.	Grow in a crop rotation with at least a four-year crop cycle (Marjanović Jeromela & Prodanović, 2021)	Primary and secondary tillage	According to recommendations after soil analysis	*Time*: August 25-September 20 *Depth*: 1.5-2 cm *Seeding rate*: 500,000-550,000 seeds ha^{-1} (hybrids)	Weed management	At technological maturity when the seeds are brown and hard to the touch
White mustard [*Brassica alba* L. or *B. hirta* L.]	Maize/ potato/ legumes → w. mustard	Primary and secondary tillage	According to recommendations after soil analysis	*Time*: beginning of March *Depth*: 2-3 cm *Seeding rate*: 5-7 kg ha^{-1}, 25 cm inter-row spacing	-	Mid-July to beginning of August
Camelina [*Camelina sativa* (L.) Crantz]	Not after *Brassicaceae* family plants	Reduced primary tillage	According to recommendations after soil analysis	*Time*: September-October (winter crop) or March (spring crop) *Depth*: 2 cm *Seeding rate*: 10 kg ha^{-1}, 12.5 cm inter-row spacing	-	One- or two-stage harvesting
Sorghum [*Sorghum bicolor* (L.) Moench]	No special needs	Primary and secondary tillage	100 kg N, 60 kg P_2O_5 (Sikora et al., 2013)	*Time*: mid-April *Seeding rate*: 10 kg ha^{-1} ≈ 250,000 plants ha^{-1}	Weed management	Mid-September to mid-October Two-stage harvesting

Main agricultural practices and the key points major for successful cultivation of the energy crops are listed in Table 1.

Some of the alternative plant crops have a long production tradition (hemp, sorghum, broomcorn), while others are not well known to Serbian farmers. For some there are certified varieties, while for others the breeding process has just started using different methods of hybridization and selection. In September 2021, The National Council for Scientific and Technological Development of the Republic of Serbia granted the status of the Center of excellence (CoE) – 'Centre of Excellence for Innovations in Breeding of Climate-Resilient Crops' of Institute of Fields and Vegetable Crops in Novi Sad. The CoE is directed towards breeding superior genotypes of several alternative crops exploiting existing and creating new genetic variability (Table 2).

Table 2. State-registered IFVCNS varieties of alternative crops that can be grown for energy purposes

Crop	Cultivar / hybrid	Description
Hemp	Helena	Monoecious, grain-hemp
	Marina	Dioecious, fiber-hemp
Sudan grass	Srem	Drought tolerance Excellent resistance to low temperatures
Oil rapeseed	NS Ras, NS Pek	'00' group, Disease resistant
	NS Zlatna, NS Zorica	Winter crop, For biodiesel
Grain sorghum	Alba F1, Gold F1	Grain starch content 72%

These energy crops have different taxonomic affiliations, therefore disease and insect pest management must be approached separately for each plant species or at least energy crop type (Table 3). Most management practices are simple or even unnecessary, and by applying integral protection measures, damages can be reduced to a minimum.

Table 3. The most important pathogens of the energy crops

Energy crop	Pathogen
Industrial hemp	*Sclerotinia sclerotiorum* *Botrytis cinerea*
Oil rapeseed	*Plasmodiophora brassicae* *Hyaloperonospora parasitica* *Alternaria brassicae* *Leptosphaeria maculans* *Leptosphaeria biglobosa* *Sclerotinia sclerotiorum* *Botrytis cinerea* *Albugo candida* *Erysiphe cruciferarum* *Xanthomonas campestris* pv. *campestris*
White mustard	*Alternaria brassicae* *Albugo candida*
Camelina	*Hyaloperonospora parasitica*
Sorghum	*Exserohilum turcicum* *Ramulispora sorgi* *Ramulispora andropogonis* *Gloeocercospora sorghi* *Sporisorium reilianum* *Peronosclerospora sorgi* *Fusarium moniliforme* *Colletotrichum graminicola* *Puccinia purpurea*

The modern assortment of all agronomic forms of the abovementioned energy crops tends to shorten the vegetation period in order to avoid drought. From the aspect of agricultual production for energy purposes, varieties and hybrids of plant species with juicy stems and high biomass yield are preferred.

Exceptional plasticity and adaptability, well-developed cultivation technology and multipurpose use of this energy crops will give them a place in the global system of plant production in conditions of evident climate change.

CONCLUSIONS

Climatic conditions in Serbia favor the production of energy crops. Proper selection of the type and assortment is of importance to mitigate the effect of limiting factors of cultivation of the energy crop. A particular type of energy crop has its own specific advantages that can make it suitable for certain growing conditions. Good agricultural practice (proper crop rotation, quality soil tillage, certified seeds sowing in the optimal sowing time, nutrition, integral plant protection measures and timely harvest) is a guarantee of high and stable energy crops yield.

REFERENCES

EU, 2003, Council Regulation (EC) No 1782/2003 of 29 September 2003 establishing common rules for direct support schemes under the common agricultural policy and establishing certain support schemes for farmers and amending Regulations (EEC) No 2019/93, (EC) No 1452/2001, (EC) No 1453/2001, (EC) No 1454/2001, (EC) 1868/94, (EC) No 1251/1999, (EC) No 1254/1999, (EC) No 1673/2000, (EEC) No 2358/71 and (EC) No 2529/2001. OJ L270, 21.10.2003, pp. 1-69.

Koren, A., & Sikora, V. (2021). Industrial hemp certified seed production in Vojvodina region. *Alternative Crops and Cultivation Practices, 3*, 17-22.

Marjanovic Jeromela, A., & Prodanovic, S. (2021). *Dobre poljoprivredne prakse i tehnologije za ublažavanje dejstva prirodnih nepogoda u proizvodnji uljane repice u Srbiji*. Rim: FAO.

Sikora, V., Berenji, J., Maksimović, L., & Popović, V. (2013). Sirak u uslovima abiotičkog stresa i stres izazvan sušom. *Bilten za alternativne biljne vrste, 45*, 1-11.

SAŽETAK

UZGOJ ALTERNATIVNIH USEVA KAO ENERGETSKIH USEVA

ANAMARIJA KOREN, VLADIMIR SIKORA, ŽELJKO MILOVAC, PETAR MITROVIĆ, DRAGANA MILADINOVIĆ, SLAVEN PRODANOVIĆ, ANA MARJANOVIĆ JEROMELA

U našoj zemlji se gaji nekoliko ozimih i prolećnih alternativnih useva. Slično prinosu osnovnih ratarskih useva, na prinos ređe gajenih useva utiču složene interakcije između klimatskih i zemljišnih uslova, abiotskog i biotičkog stresa i tehnologije proizvodnje. Ako se uzgajaju isključivo radi proizvodnje biljnih sirovina (nadzemna biomasa, seme i/ili koren) za pretvaranje u biogorivo i bioenergiju, ovi alternativni usevi su energetski usevi. Iako različite taksonomske pripadnosti, morfologije i porekla, energetski usevi mogu biti: uljani (uljana repica, lanik, slačica, ricinus), skrobno-šećerni (sirak, sudanska trava, kukuruz) i lignocelulozni (miskantus, konoplja). Iz ugla agronomije, preduslov povećanja površina pod energetskim biljnim vrstama za proizvodnju biogoriva u Srbiji je unapređenje sortimenta, tehnologije gajenja i mehanizacije. U radu je dat pregled agronomskih formi i tehnologije gajenja nekoliko specifičnih alternativnih biljnih vrsta u kontekstu korišćenja biomase useva u energetske svrhe.
Ključne reči: agrotehnologija, biljna biomasa, poljoprivreda

Received: 06 February 2023
Received in revised form and accepted for publication: 13 February 2023