Kulik Maksym, candidate of agricultural sciences

Poltava State Agrarian Academy

GROWING CONDITIONS INFLUENCE ON PHYTOMASS PRODUCTIVITY OF SWITCH-GRASS (PANICUM VIRGATUM L.)OF THE SECOND VEGETATION YEAR

Reviewer – Candidate of Agricultural Sciences M. M. Marenich

Peculiarities of forming switch-grass phytomass productivityduring growing on the degraded soils for obtaining raw material for biofuel production are given. Phenologicalobservations such asinterphase periodduringthe second year crop vegetation are made. The quantitative indexes of plantvegetative part,correlation of these indexes and influence on crop productivity are established. Switch-grass phytomass productivity of the experimentedvarietieswith different space width between rows is defined.

Keywords: *varieties, spaces between rows, quantitative indexes, switch-grass, phytomass, productivity*

Problem statement.A widespread using unconventional and renewable source in energy balance of agrarian industry isa perspective approach that securesenergy deficit reduction and environment protection. Reduction of natural gas consumption and energy conservation development are the most important problemsin Ukraine nowadays (1). Asswitch-grass, Panicum of virgatum of L. is one of phytoenergycrops, vegetative mass of which is used for solidfuel production, plants can grow on different soil types and there are a few million hectares of such land on the territory of Ukraine that is whystudy of possibilities of growing thiscrop on this land is important(8).Erosion decreases and environment ecology improves due to switch-grassgrowing on this land.

Analysis of researches and scientific publications. Amongalien "energycrops" switch-grass (Panicum of virgatum of L.) is well acclimatized to growing conditions. It forms high yield with corresponding phytomassquality that is used as raw material for fuel pelletproduction. (2, 4, 9).

Electric power production through gasification, combined incineration on coal plants, ethanol production for fuel and fuel pellets production arethe main ways ofswitch-grassusing. [14, 15].

Width between rows is an important factor that determinescropproductivity inagrotechnology of switch-grassgrowing. Narrow row-spacingacceleratesoil closure in spring and increase capacity of light that is taken up by plant during vegetation period, and this definitely influences on cropproductivity and reducesweeding controlnecessity, in fact plantswill grow in space between rowsquickeron the less nutritionarea. However at the same time there is a problem of

self-thinning outthat reduces general biomass total amount from an area; in addition thick grass stand can be more easily affected by diseases and lodged. A few studies concerning space width between rows on switch-grasssown area were done.

So W. R. Ocumpaugh and other scientists (16)after comparison of researchresults ofswitch-grass growing with width of spaces between rows of 15, 30 and 50 cmproved that at droughty conditions sown area with wide space between rows had higher productivity.

D. I. Bransby with co-authors [11]established that experimented switch-grass varieties with wide space between rows havegreater productivity comparatively with narrowspace between rows. Harvest increase especially was noticeable in a few years.

According to researches conducted in Ukraine, it is established[5] that variety characteristics have greater influence on height of switch-grass plantsof the first year vegetation when width between rows is 30 cm, and at 45 cm this difference disappears.This can testify that when nutrition area increases mineral nutrient competition decreases and heightlevellingofthe experimented switch-grass varieties is observed. This tendency was the same in relation to plantdensity on the unit of area but for morevariety numbers(Phoresburg, Kanlou and Keiv-in-rok). It specifies that this index(plant density) can be more reliable characteristicthan height in the estimation of switch-grassvariety productivity for biomass production.

Other scientists(8) defined thatKeiv-in-rokand Sunburstvarieties form productivity, accordingly, 11,5 and 8,7 t/haof dry biomass during spring sowing in the second vegetation year and summer sowing significantly decreasescrop productivity. Scientists established that optimal conditions for switch-grass can be created by certain agrotechnical measures and facilities. It is necessary to selectvarieties taking into account regionalagrobiologicalpeculiarities and weather conditions of a year.

Thus, insufficient studied elements of switch-grass growing technology in the conditions of Ukraine cause necessity to research this problem and determinepeculiarities of forming switch-grassphytomass productivity **during** growing on low-yield soils.

Research objective and tasks. **Objective is** to establish influence of harvest structure elements on productivity ofswitch-grassvarietiesphytomassduringgrowing on degraded soils with different space width between rows.

Tasks are:

1. To make phenological observations and define interphase period duration of switch-grass plant growth and development of different varieties;

2. To define harvest structure elements ofswitch-grassvarieties depending onspace width between rows;

3. To determinevarieties phytomass productivity (in terms ofdry matter) during plantgrowing with space between rows of 30 and 45 centimetres;

4. To establishcorrelationbetweenharvest structure elements and their influence onswitch-grass dry phytomassproductivity.

Research methods. Within the framework of international scientific project "Pellets for power" and according to activity of international industrial park"Natureenergy " beginning from 2011 the experiment involvingfive switch-grassvarieties research was begun in the central part of forest-steppe of Ukraine(Poltava district).This report containsresearch results of three varieties: Keiv-in-rok,Kartadg and Phoresburg. The experiment chart contained variants ofplant growing with space between rows of 30 and 45 cm on degraded soils that had following agrochemical indexes: humus content is 2,07%; nitrogencontentis 44,8; phosphoruscontentis 65,0 and potassiumcontentis 113,0 mg on 1 kg of soil.

Agrotechnology of experiments combined field disking and cultivating(autumn and spring), sowing and soil rolling, weeding spaces between rows. Methodology of experiment is generally accepted, according toB.A. Dospekhov(3). Variant placing in the experiments israndom; repetition is four times. Area of accounting land is 10 м^2.

Phenologicalobservations during plantgrowth and development were carried out according to "Methodology of state variety testing of agricultural crops" (7)and according to classification of perennial herb developmentphases.(13).

Calculation of quantitative switch-grass indexes (plant height, leaf and internode numberon one plant and also plant number on 1 м^2) was donein theperiod of plant vegetation completion.

Productivity was determined by plant mowing, weighing and counting by dry weight after determination ofpercentage of moisture. Obtainedresearch results certified in experimentwere processed according to modern statistics methods with application of Excel and Statistaca 6.0computer programs.

Research results. Last two years characterized by increased temperature and simultaneous rainfall decline that indicatesto droughty conditions of crop vegetation in 2011 and 2012 were distinguished according to average daily temperature duringswitch-grass vegetation period (May-October).

It is possible to affirm that humus and nitrogen content is low, phosphorus content is middle and potassium content is increased according to analysis of researchplace soil condition.

It is established thatinterphase period duration ofexperimentedswitch-grassvarieties Kartadg, Phoresburg andKeiv-in-roklasted for 31 days from time of vegetationrenewal to bushing out time, time of vegetation renewal is leaf-tube formation- 60 days. In future the terms of next periods differed according tovarieties: period from leaf-tube formation to panicle formation of Kartadg

variety lastedfor 8 days, of Phoresburg varietylastedfor 11 days, and of Keiv-in-rokvariety lastedfor 9 days; from panicle formation to flowering ofKeiv-in-rok and Kartadgvarietiesperiods lasted, accordingly 33 and 36 days, of Phoresburg variety - 24 days. Kartadg and Keiv-in-rokvarieties had the longest period from flowering to seed ripening (vegetation completion time), accordingly, 77 and 72 days, period of Phoresburg variety lastedfor 67 days(figure 1).

Vegetation period ofvarietiesKartadg,Keiv-in-rokand Phoresburgwas 181, 174 and 162 days accordingly.

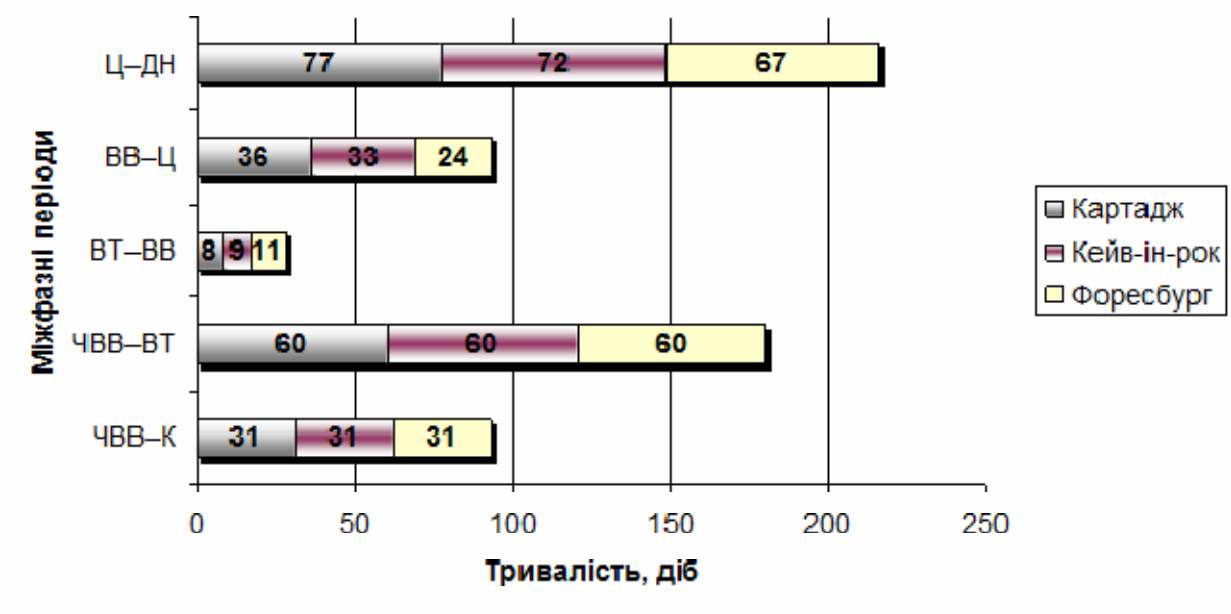

Figure 1. Duration of interphase periods of experimented switch-grass varieties of the second vegetation year, 2012

Comment: TVR- time of vegetation renewal, LTF - leaf-tube formation, PF - panicle formation, F- flowering, SR -seed ripening.

Considerable variation of harvest structure elements on varieties depending on plant nutrition areawas established (table.).

Harvest structure elements of the second switch-grass vegetation year, 2012

Variants		Plant height, cm	Internode number on a plant, items.	Leaf number on a plant, cm
Varieties	Spacebetweenrows, cm			
Keiv-in-rok	30	98,3	3,9	4,3
	45	92,8	3,4	5,6
Kartadg	30	84,2	3,4	4,2
	45	80,5	2,2	3,9

Phoresburg	30	88,5	2,6	4,1
	45	70,5	2,0	4,5
HIP $_{05}$ (varieties)		4,21	1,07	0,14
HIP $_{05}$ (spacebetweenrows)		3,44	0,41	0,12

During switch-grassgrowing on degraded soils in time of vegetation completion plants were thehighest and had the greatest internode number on the stem of Keiv-in-rokvariety at space between rows of 30 cm, varietiesKartadg and Phoresburg had substantially less number.Opposite situation was observed withleaf number on plant, at space between rows of 45 cm all varieties had more leaves.

PhoresburgandKeiv-in-rok varieties had the greateststemnumber on 1 **м^2**at space between rows of 45 cm. Phoresburg had 450 items/м^2, Keiv-in-rok had 360items/м^2;Kartadghad 290 items/м^2.

Phytomass productivity in terms of dry matter was established during researches of switch-grassplants of the second vegetation year.

(figure. 2).

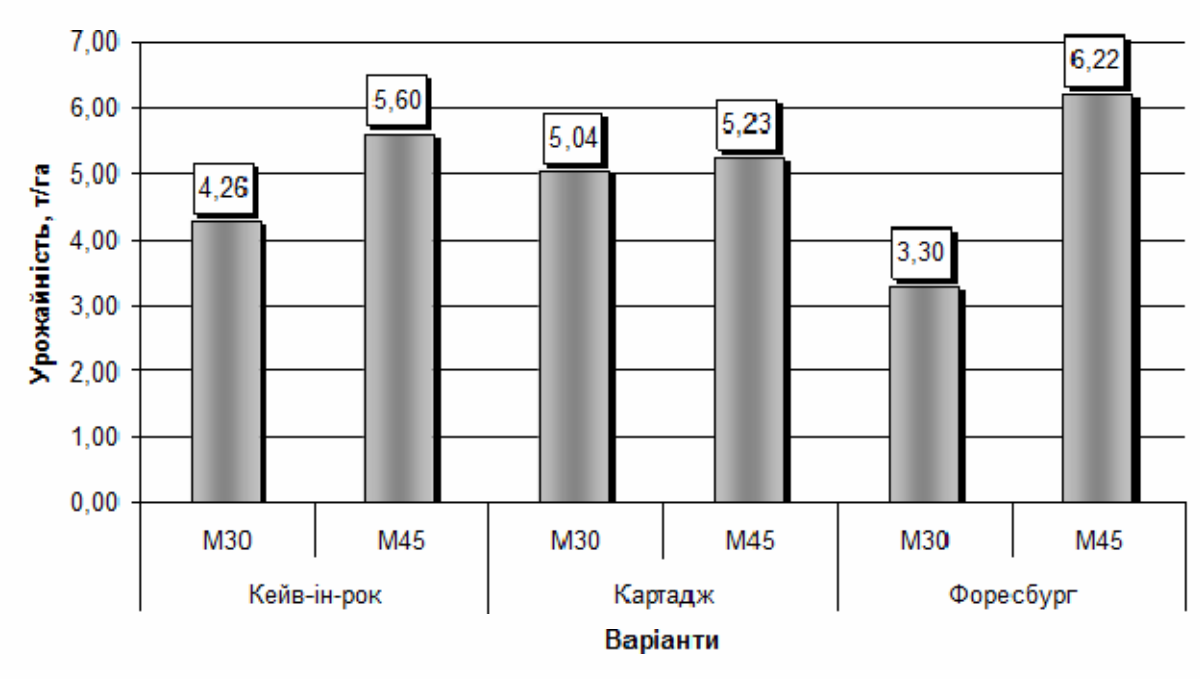

Figure 2. Productivity (plant dry mass) of switch-grass of the second vegetation year, (t/ha), 2012

Comment: SBR 30 - space between rows of 30 cm, SBR 45 - space between rows of 45 cm

Among experimentedswitch-grassvarieties of the second vegetation year Phoresburg varietyformed the greatest productivity of 6,22 t/hawithspacewidth between rows of 45 cm, Keiv-

in-rok variety also at space between rows of 45 cm(5,60 t/ha) and Kartadgon the same nutrition area had 5,23 t/ha.

Connection between harvest structure elements andswitch-grassphytomass productivity of the experimentedvarietiesare established (figure 3-5).

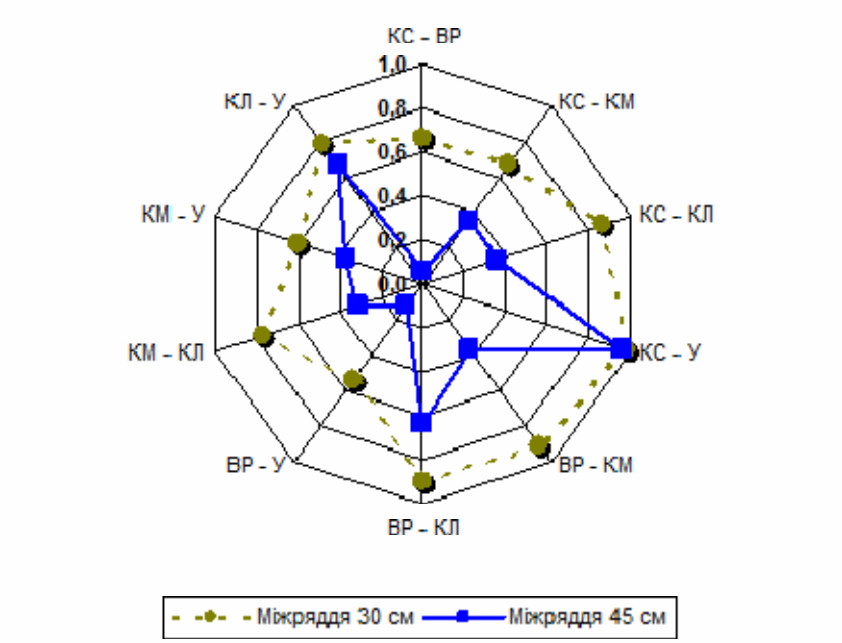

Figure 3. Correlation coefficients between harvest structure elements and productivity of dry phytomass of the second vegetation year switch-grass, Keiv-in-rok variety, 2012

Comment: SN- stem number, IN- internode number, LN – leaf number, PH – plant height, P – productivity of dry phytomass.

Stem and leaf number is a determinant factor of productivity level of switch-grass phytomass of Keiv-in-rok variety of the second vegetation year (both at space between rows of 30 cm and of 45 cm).Correlation coefficient with these indexes is high. Plantheight has more significant influence on productivity with less nutrition area growing.

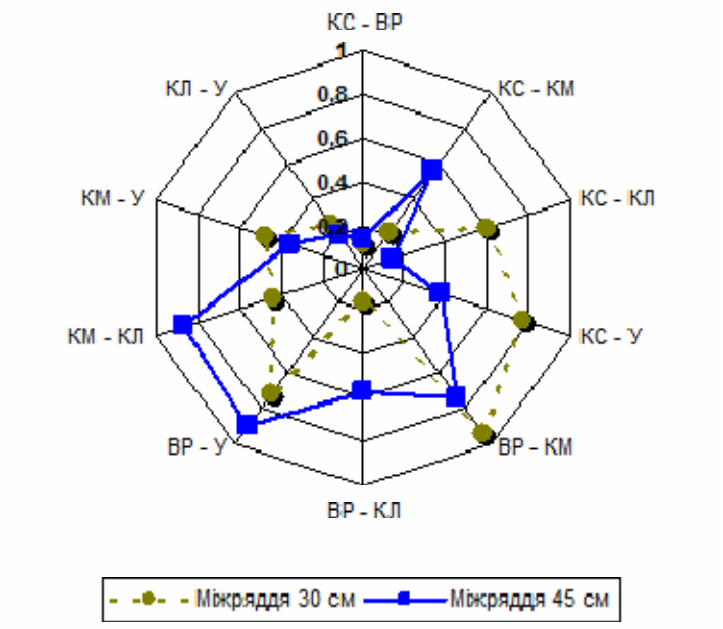

Figure 4.Correlation coefficients between harvest structure elements and productivity of dry phytomass of the second vegetation year switch-grass, Kartadg variety, 2012

Comment: SN- stem number, IN- internode number, LN – leaf number, PH – plant height, P – productivity of dry phytomass.

Closeness of connection between plantheight and phytomassproductivityincreases during growing Kartadg variety with space between rows of 45 cm, in comparison to 30 cm.Soplantheight has determining influence on productivity formation.

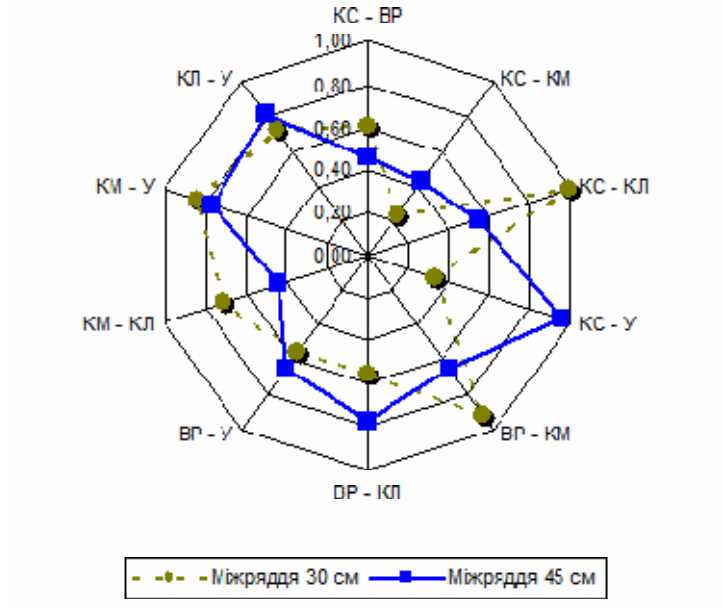

Figure 5.Correlation coefficients between harvest structure elements and productivity of dry phytomass of the second vegetation year switch-grass, Phoresburg variety, 2012

Comment: SN- stem number, IN- internode number, LN – leaf number, PH – plant height, P – productivity of dry phytomass.

Close correlation between stem number ona plant, leaf number and phytomassproductivity is established for switch-grass Phoresburg variety with space between rows of 45 cm. These indexes have more significant influence on cropproductivity with more nutrition area growing.

Conclusions:

1. Switch-grassgrowing on the degraded soils for obtaining raw material for biofuel production is important and urgent problemnowadays.

2. According to vegetation periodduration in the conditions of central part of forest-steppe, Phoresburg variety belongs to early varieties, Keiv-in-rok varietyis middle andKartadgis late one. It depends on weathergrowingconditions, variety origin and also variety genetic nature.

3. Stem number on 1 $м^2$ comparatively with space between rows of 30 cm, was the greatestwith space between rows of 45 cm.Varieties of the second vegetation year Phoresburg and Keiv-in-rok had accordingly 450 and 360 items./ $м^2$, Kartadgvariety had 290 items./$м^2$.

4. Harvest structure elements have substantial influence on productivity of dry phytomass of the second year switch-grass: productivity of Keiv-in-rok varietyincreases when space between rows is 30 and 45 centimetreswith increase of stem and leaf number on unit of area.These indexes of Phoresburgvariety influence on productivity only on space between rows of 45 centimetres. Plant height on space between rows of 45 centimeters is determinative in productivity formation of Kartadgvariety.

5. Among varieties of the second vegetationyear switchgrassPhoresburg variety formed the greatestproductivity of 6,22 t/hawith width between rows of 45 cm, Keiv-in-rok was alsohighly productiveon space between rows of 45 cm (5,60 t/ha), and Kartadgon the same nutrition area - 5,23 t/ha. Substantially less productivity wasrecordedduring these varieties growing on space between rows of 30 centimetres. It is necessary to extend and continueresearch in this direction taking into account that switch-grass is a new, perspective phytoenergycrop for solid fuel production.

REFERENCE:

1. Використання біомаси на енергетичні потреби / За ред. докт. техн. Наук В. І. Кравчука. – Дослідницьке: УкрНДІПВТ ім. Л. Погорілого, 2009. – 72 с.

2. Гументик М. Я. Перспективи вирощування багаторічних злакових культур для виробництва біопалива / М. Я. Гументик // Цукровібуряки. – 2010. – №4. – С. 21–22.

3. Доспехов Б. А. Методика полевого опыта / Борис Александрович Доспехов. – М.: Колос, 1985. – 336 с.

4. Кулик М. І. Ботаніко-біологічні особливості проса лозовидного (PanicumvirgatumL.) / М. І. Кулик М. І., H. W. Elbersen, П. А. Крайсвітній та ін. // Матеріали Міжнародної науково-практичної конференції «Біоенергетика: вирощування енергетичних культур,

виробництво та використання біопалива», Київ, Інститут біоенергетичних культур і цукрових буряків. – 2011. – С. 25–27.

5. Кулик М. І. Вплив умов вирощування на кількісні показники рослин світчграсу (PanicumvirgatumL.) першого року вегетації / М. І. Кулик // Вісник Полтавської державної аграрної академії. – Полтава, 2012. – №3. – С. 62–67.

6. Кулик М. І. Раціональне використання деградованих земель для вирощування енергетичних культур і виробництва біопалива / М. І. Кулик, О. В. Рій, П. А Крайсвітній // Енергозбереження. – Київ, 2012. – Вип. №4. – С. 12–13.

7. Методика Государственного сортоиспытания сельскохозяйственных культур: Фенологические наблюдения за растениями зерновых, крупяных и зернобобовых культур / Под ред. М. А. Федина. – М.: Агропромиздат, 1988. – 121 с.

8. Мороз О. В. Світчграс як нова фітоенергетична культура / О. В. Мороз, В. М. Смірних, В. М. Курило [та ін.] // Цукровібуряки. – Київ, 2011. – Вип. №3 (81). – С. 12–14.

9. Писаренко П. В. Рослини: джерелоенергії / П. В. Писаренко, П. А. Крайсвітній, М. І. Кулик та ін. // Енергозбереження. – Київ, 2010. – Вип. №11. – С. 10–11.

10. Роїк М. Ефективність вирощування високопродуктивних енергетичних культур / М. Роїк, В. Курило, М. Гументик та ін. // Вісник Львівського національного аграрного університету. – Львів, 2011. – №15(2). – Режим доступу: http://www.nbuv.gov.ua/portal/Chem_Biol/Vldau/Agr/2011_15_2/files.

11. Bransby D. I., R. H. Walker and M,S. Miller. 1997. Development of optimal establishment and cultural practices for switchgrass as an energy crop. Five year summary report.Oak Ridge National Laboratory, Oak Ridge, TN.

12. Knight B. Global growth / B. Kniglt, A. Westwood // The world biomass market: Renewable energy world. 2005. – Vol. 8. – №1. – P. 118–128.

13. Metcalfe D. S., and C. J. Nelson. The botany of grasses and legumes, In: M.E. Heath et al. (eds.), Forages: The science of grassland agriculture. Iowa State Univ. Press, Ames, IA., 1985. – P. 52–63.

14. Samson R. A. and J. A. Omielan. Switchgrass: A potential biomass energy crop for ethanol production Thirteenth North American Prairie Conference. Windsor, Ontario. – 1992. – P. 253–258.

15. Turhollow A. F. Screening herbaceous lignocellulosic energy crops in temperate regions of the USA. Bioresource Technology. – 1991. – №36. – P. 247–252.

16. Ocumpaugh, W.R., M.A. Sanderson, M.A. Hussey, J.C. Read, C.R. Tischler and R.L. Reed. 1997. Evaluation of switchgrass cultivars and cultural methods for biomass production in the southcentral U.S. Final report. Oak Ridge National Laboratory.