© 2013

**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 productivity during growing on the degraded soils for obtaining raw material for biofuel production are given. Phenological observations such as interphase period duration during the second year crop vegetation are made. The quantitative indexes of plant vegetative part, correlation of these indexes and influence on crop productivity are established. Switch-grass phytomass productivity of the experimented varieties with 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 is a perspective approach that secures energy deficit reduction and environment protection. Reduction of natural gas consumption and energy conservation development are the most important problems in Ukraine nowadays (1). Asswitch-grass, Panicum of virgatum of L. is one of phytoenergycrops, vegetative mass of which is used for solid fuel 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 why study of possibilities of growing this crop on this land is important (8). Erosion decreases and environment ecology improves due to switch-grass growing on this land.

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

Electric power production through gasification, combined incineration on coal plants, ethanol production for fuel and fuel pellets production are the main ways of switch-grass using. [14, 15].

Width between rows is an important factor that determines crop productivity in agrotechnology of switch-grass growing. Narrow row-spacing accelerates soil closure in spring and increase capacity of light that is taken up by plant during vegetation period, and this definitely influences on crop productivity and reduces weeding control necessity, in fact plants will grow in space between rows quicker on the less nutrition area. However at the same time there is a problem of
self-thinning out that 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-grass sown area were done.

So W. R. Ocumpaugh and other scientists (16) after comparison of research results of switch-grass growing with width of spaces between rows of 15, 30 and 50 cm proved 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 have greater productivity comparatively with narrow space 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 plants of 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 height leveling of the experimented switch-grass varieties is observed. This tendency was the same in relation to plant density on the unit of area but for more variety numbers (Phoresburg, Kanlou and Keiv-in-rok). It specifies that this index (plant density) can be more reliable characteristic than height in the estimation of switch-grass variety productivity for biomass production.

Other scientists (8) defined that Keiv-in-rok and Sunburst varieties form productivity, accordingly, 11.5 and 8.7 t/ha of dry biomass during spring sowing in the second vegetation year and summer sowing significantly decreases crop productivity. Scientists established that optimal conditions for switch-grass can be created by certain agrotechnical measures and facilities. It is necessary to select varieties taking into account regional agrobiological peculiarities 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 determine peculiarities of forming switch-grass phytomass productivity during growing on low-yield soils.

Research objective and tasks. Objective is to establish influence of harvest structure elements on productivity of switch-grass varieties phytomass during growing 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 of switch-grass varieties depending on space width between rows;
3. To determine varieties phytomass productivity (in terms of dry matter) during plant growing with space between rows of 30 and 45 centimetres;

4. To establish correlation between harvest structure elements and their influence on switch-grass dry phytomass productivity.

**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 involving five switch-grass varieties research was begun in the central part of forest-steppe of Ukraine (Poltava district). This report contains research results of three varieties: Keiv-in-rok, Kartadg and Phoresburg. The experiment chart contained variants of plant growing with space between rows of 30 and 45 cm on degraded soils that had following agrochemical indexes: humus content is 2.07%; nitrogen content is 44.8; phosphorus content is 65.0 and potassium content is 113.0 mg on 1 kg of soil.

Agrotechnology of experiments combined field diskng and cultivating (autumn and spring), sowing and soil rolling, weeding spaces between rows. Methodology of experiment is generally accepted, according to B.A. Dospekhov (3). Variant placing in the experiments is random; repetition is four times. Area of accounting land is 10 m².

Phenological observations during plant growth and development were carried out according to "Methodology of state variety testing of agricultural crops" (7) and according to classification of perennial herb development phases (13).

Calculation of quantitative switch-grass indexes (plant height, leaf and internode number on one plant and also plant number on 1 m²) was done in the period of plant vegetation completion.

Productivity was determined by plant mowing, weighing and counting by dry weight after determination of percentage of moisture. Obtained research results certified in experiment were processed according to modern statistics methods with application of Excel and Statistica 6.0 computer programs.

**Research results.** Last two years characterized by increased temperature and simultaneous rainfall decline that indicate to droughty conditions of crop vegetation in 2011 and 2012 were distinguished according to average daily temperature during switch-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 research place soil condition.

It is established that interphase period duration of experimented switch-grass varieties Kartadg, Phoresburg and Keiv-in-rok lasted for 31 days from time of vegetation renewal to bushing out time, time of vegetation renewal is leaf-tube formation- 60 days. In future the terms of next periods differed according to varieties: period from leaf-tube formation to panicle formation of Kartadg...
variety lasted for 8 days, of Phoresburg variety lasted for 11 days, and of Keiv-in-rok variety lasted for 9 days; from panicle formation to flowering of Keiv-in-rok and Kartadg varieties periods lasted, accordingly 33 and 36 days, of Phoresburg variety - 24 days. Kartadg and Keiv-in-rok varieties had the longest period from flowering to seed ripening (vegetation completion time), accordingly, 77 and 72 days, period of Phoresburg variety lasted for 67 days (figure 1).

Vegetation period of varieties Kartadg, Keiv-in-rok and Phoresburg was 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 area was established (table.).

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

<table>
<thead>
<tr>
<th>Variants</th>
<th>Space between rows, cm</th>
<th>Plant height, cm</th>
<th>Internode number on a plant, items.</th>
<th>Leaf number on a plant, cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keiv-in-rok</td>
<td>30</td>
<td>98,3</td>
<td>3,9</td>
<td>4,3</td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>92,8</td>
<td>3,4</td>
<td>5,6</td>
</tr>
<tr>
<td>Kartadg</td>
<td>30</td>
<td>84,2</td>
<td>3,4</td>
<td>4,2</td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>80,5</td>
<td>2,2</td>
<td>3,9</td>
</tr>
</tbody>
</table>
During switch-grass growing on degraded soils in time of vegetation completion plants were the highest and had the greatest internode number on the stem of Keiv-in-rok variety at space between rows of 30 cm, varieties Kartadg and Phoresburg had substantially less number. Opposite situation was observed with leaf number on plant, at space between rows of 45 cm all varieties had more leaves.

Phoresburg and Keiv-in-rok varieties had the greatest stem number on 1 m² at space between rows of 45 cm. Phoresburg had 450 items/m², Keiv-in-rok had 360 items/m²; Kartadg had 290 items/m².

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

(figure 2).

<table>
<thead>
<tr>
<th>Variety</th>
<th>SBR 30</th>
<th>SBR 45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phoresburg</td>
<td>45</td>
<td>45</td>
</tr>
<tr>
<td>Keiv-in-rok</td>
<td>6,22</td>
<td>4,26</td>
</tr>
<tr>
<td>Kartadg</td>
<td>3,30</td>
<td>5,04</td>
</tr>
</tbody>
</table>

*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 experimented switch-grass varieties of the second vegetation year Phoresburg variety formed the greatest productivity of 6,22 t/ha with space width 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 and switch-grass phytomass productivity of the experimented varieties are 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. Plant height 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 phytomass productivity increases during growing Kartadg variety with space between rows of 45 cm, in comparison to 30 cm. So plantheight 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 on a plant, leaf number and phytomass productivity is established for switch-grass Phoresburg variety with space between rows of 45 cm. These indexes have more significant influence on crop productivity with more nutrition area growing.

**Conclusions:**

1. Switch-grass growing on the degraded soils for obtaining raw material for biofuel production is important and urgent problem nowadays.

2. According to vegetation period duration in the conditions of central part of forest-steppe, Phoresburg variety belongs to early varieties, Keiv-in-rok variety is middle and Kartadgis late one. It depends on weather growing conditions, variety origin and also variety genetic nature.

3. Stem number on 1 m² comparatively with space between rows of 30 cm, was the greatest with space between rows of 45 cm. Varieties of the second vegetation year Phoresburg and Keiv-in-rok had accordingly 450 and 360 items./m², Kartadg variety had 290 items./m².

4. Harvest structure elements have substantial influence on productivity of dry phytomass of the second year switch-grass: productivity of Keiv-in-rok variety increases when space between rows is 30 and 45 centimetres with increase of stem and leaf number on unit of area. These indexes of Phoresburg variety 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 Kartadg variety.

5. Among varieties of the second vegetation year switchgrass Phoresburg variety formed the greatest productivity of 6.22 t/ha with width between rows of 45 cm, Keiv-in-rok was also highly productive on space between rows of 45 cm (5.60 t/ha), and Kartadg on the same nutrition area - 5.23 t/ha. Substantially less productivity was recorded during these varieties growing on space between rows of 30 centimetres. It is necessary to extend and continue research in this direction taking into account that switch-grass is a new, perspective phytoenergycrop for solid fuel production.

**REFERENCE:**


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


