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GROWTH DYNAMICS OF ENERGY WILLOW (SALIX) DURING THE FIRST YEAR OF GROWING IN SOIL AND CLIMATIC CONDITONS OF WOODLANDS OF UKRAINE

The research shows results of studies and observations of Salix spp. plantations in ground and climatic conditions of Woodlands of Ukraine.

Keywords: *studies, technologies, Salix spp., weed plants.*

Introduction. Ukraine belongs to countries with deficit for energy resources. Ukraine is not able to provide energy sector with fossil fuels. Consequently, it is an important task for our state to develop alternative energy.

The promising renewable fuel is biomass of herbaceous and woody crops. Among woody energy crops the largest plantations have poplar and willow. According to the literature data poplar is more productive than willow in southern regions with low rainfall. Willow shoots are sensitive to summer drought. In climatic conditions of moderate-atlantic climate with high moisture level we have better yield on willow plantations approximately 19 t/ha of dry weight, while the poplar yield was 17 t/ha. [1]

The value of the yield of willow, like other crops, depends on its biological characteristics and levels of nutrients, moisture, heat, soil conditions, production technologies, etc. [2].

Nowadays, the main effect of environmental conditions and cultivation technologies on yield and quality of crops is exposed in many scientific publications

and literature [3-6]. However, currently the issues of the impact of growing technologies and soil and climatic factors on plant growth and development of energy willow (*Salix*) in conditions of Woodlands of Ukraine were not studied and discussed in scientific publications.

The purpose of the research. Determination of growth and development in energy willow (*Salix*) under conditions of Woodlands depending on the elements of growing technology.

Research Methodology. In the research fields of the Lviv branch of UkrNDIPVT named after L. Pohorilyi were laid research areas for growing energy willow with the purpose of development of phytoenergy industry.

The lands of the Institution are located in the area of Small Woodlands. Research areas are characterized by sod-podzolic sandy soils with 57 cm humus layer in depth and contain batteries: 82.2 mg of nitrogen, phosphorus and potassium 194.3 mg 66.6 mg per kilogram of soil. Agrochemical and agro-technical characteristics of research test sites are shown in Table 1.

Table 1

Agrochemical and agro-technical characteristics of soil on research test sites

Indicators	Methods of evaluation	Weighted average by years of survey (2009-2012)
The depth of the humus layer, cm	Kaczynski	57
Physical depth,%	Kaczynski	35,9
Soil density, g / m ³	Kaczynski	1,28
Stock of productive moisture in 10 cm layer		156
Acidity mh-ekv./100 g	Kappen	7,2
The content of humus in the soil	Turin	2,97
The batteries mg / kg soil: - nitrogen	Kornfeld	82,2
Moving compounds: - phosphorus	Chirikov	194,30
- potassium	Chirikov	66,55
Agrochemical score in points		52

Soil preparation consisted of the following manufacturing operations: flaky stubble, plowing and cultivation before planting. For the purpose of cutting roots, destroying wheat grass and other root weeds, peeling was performed to a depth of 15 cm by disc harrow BDVP-3,6 in the unit with the tractor T-150K. The next technological operation was the plowing of the soil to a depth of 26 cm with the help of plow of general purpose PLN-4-35 with tractor T-150K.

Two weeks after plowing, we made loosening of the soil to a depth of 12 cm by rotary cultivator KPSP 4-tooth harrows. It allowed destroying the germinated weeds and leveling the surface of the field.

Thus, for the preparation of soil tillage were used national cultivating machines of general purpose.

Planting willows at the experimental site was carried out on an area of 1 ha on 2th of April. The scheme of planting: 2,0 m × 0,5 m, row spacing is 2 m, the distance between the spears in a row is 0.5 m, spears are planted by hand in the cracks that have been sliced by a converted cultivator CA-4,5 in the unit with the tractor T - 150K. Spears are planted in the ground so in order to leave a few inches above the surface (2-4 buds).

For planting were used spears with length 20-21 cm, diameter - 0,08-1,00 cm. There are 5-16 cells on each cutting. During spears planting buds were in dormant state. The distance between buds were from 2.3 cm to 4.5 cm (Figure 1).

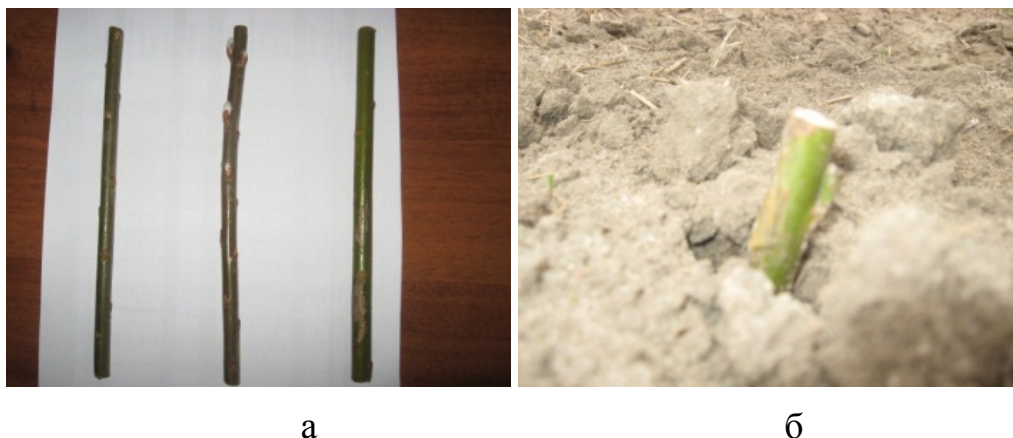


Figure 1. Spears of willow: a - general view, b - planted in the soil

At 12 days after planting, we carried out the harrowing of willow plantings. To perform technological operations were used BZSS-0,8 harrows. They were joined

to the coupling and were aggregated to the tractor MTZ-82.

Rotary cultivator, developed by affiliates, performed loosening of the soil and dweeding in between rows of willow. The cultivator was equipped with the distributor for the basal feed of energy crops. (Fig. 2).



Fig. 2. Interrow cultivator during cultivation of willow plantations

To control weeds and create air regime of soil during the growing season was carried out three inter-row cultivations. To avoid damaging the bark of plants by working bodies of a cultivator, interrow cultivation is not carried out after reaching a height of willow over 50 cm.

Alongside the growing season, from April to November, the temperature was in the range from +8,2 ° C to +24,5 ° C, relative humidity was from 62.4% to 79.4%. During the months the number of rainy days were from 3 to 8 days (Fig. 3).

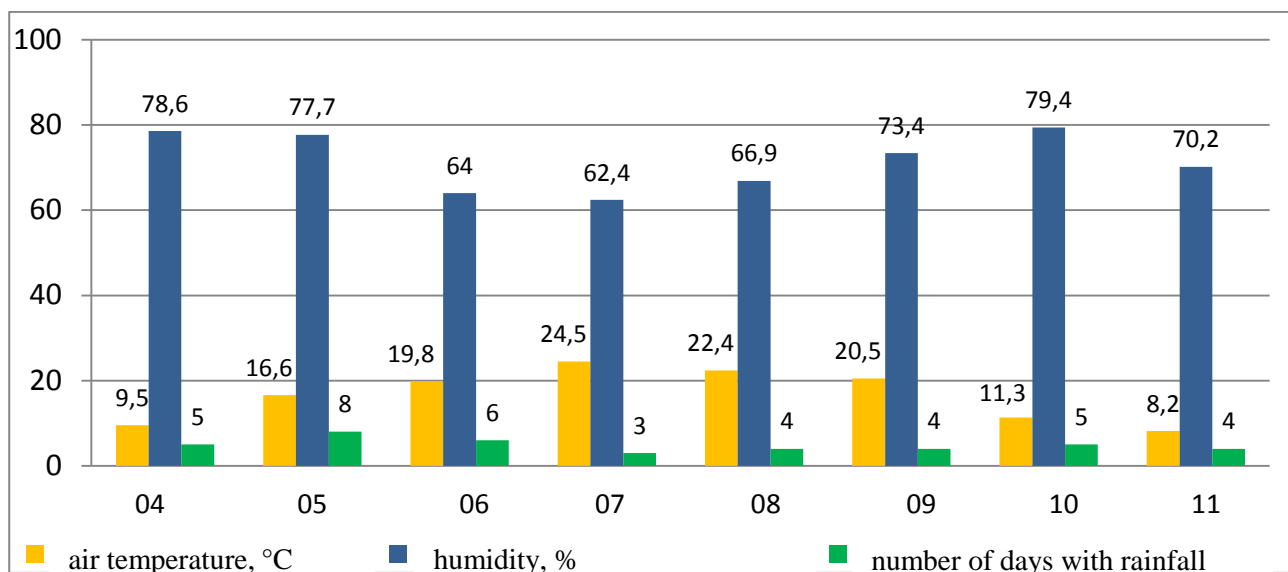


Fig. 3 Climatic conditions of the willow growing season

During the first half of the growing season period we observed 22 rainy days. In the second half of the period of plant growth and development there were 13 days with precipitations. Most rains were in May and June.

The hottest month during the growing season was July. This month had the highest temperature and the lowest levels of rainfalls and humidity.

Results of studies. Applied hardware provided satisfactory preparation of the soil for planting energy willow (*Salix*). Fuel consumption for the preparation of the soil was about 42 kg / ha, labor costs were 3.2 people hr/ ha. The level of effort for manual planting of willow spears was 61 people hr / ha (Table 2).

Table 2

List of manufacturing operations for planting energy willow

№ п/п	Name of an operation	Unit structure	Productivity ha/hr.	Fuel costs, kg/ha	Labor costs, hr/ha	Movement speed, km/hour.	Term of implementation
1	Peeling stubble	T-150K + БДВП-3,5	1,700	12,3	0,6	7	25.10
2	Plowing	MT3-82 + ПЛН-3-35	0,600	18,7	1,6	7	12.04
3	Cultivation	MT3-82 + КПСП-4	2,100	5,3	0,5	7	26.04
4	Cutting slits	MT3-82 + КР-5,4	2,200	5,3	0,5	7	1.04
5	Implantation	Manually	0,016	-	61	-	2.04
6	Harrowing	MT3-82 + 3П-6 + БЗСС-0,8 (8шт.)	2,300	4,7	0,4	10	14.04

Harrowing willow plantings helped to preserve soil moisture and control weeds provided in the phase of the white string. Consumption of fuel during application of this technology operations was 4.7 kg/ha, and labor costs were 0.4 people hr/ha.

After cultivator trekking for inter-row tillage the part of wiped out weeds between rows was 90%. The cultivator practically did not hurt willow plants (the number of damaged plants is less than 2%). Productivity performance of technological operations was 0.7 ha/h. (Table 3)

Results of studies of inter-row cultivation of willow plantings

Indicators	Value
Working width, m	1,8
Operating speed, km / h.	7,5
Depth, cm	6,0
Width of protection zone line, cm	30,0
Width of treated band, cm	90,0
Trimming weeds, %	90,0
Damage to plants, %	2,0
Productivity, ha / h.	0,7
Fuel consumption, kg/ha	10,1

Conducting three-row cultivation ensured the complete destruction of germinating weeds between rows in the first half of the vegetation of willow. However, in the lines within the protection zone, weeds continue to grow. Therefore, to control weeds in the rows, and in the second half of vegetation period in rows, it was necessary to use manual weeding, which required considerable manual labor.

Phenological survey of the willow at the site was conducted two weeks after planting spears (18.04.). The following was found out:

- willow buds in a state imbibition;
- on 1 m running there are two spears;
- every 1-2 spears have turgid buds;
- weeds are absent.

Turned aside willow plants began to appear at the end of April in the climatic and soil conditions.

State of willow plants at different stages of development is shown on Figure 5

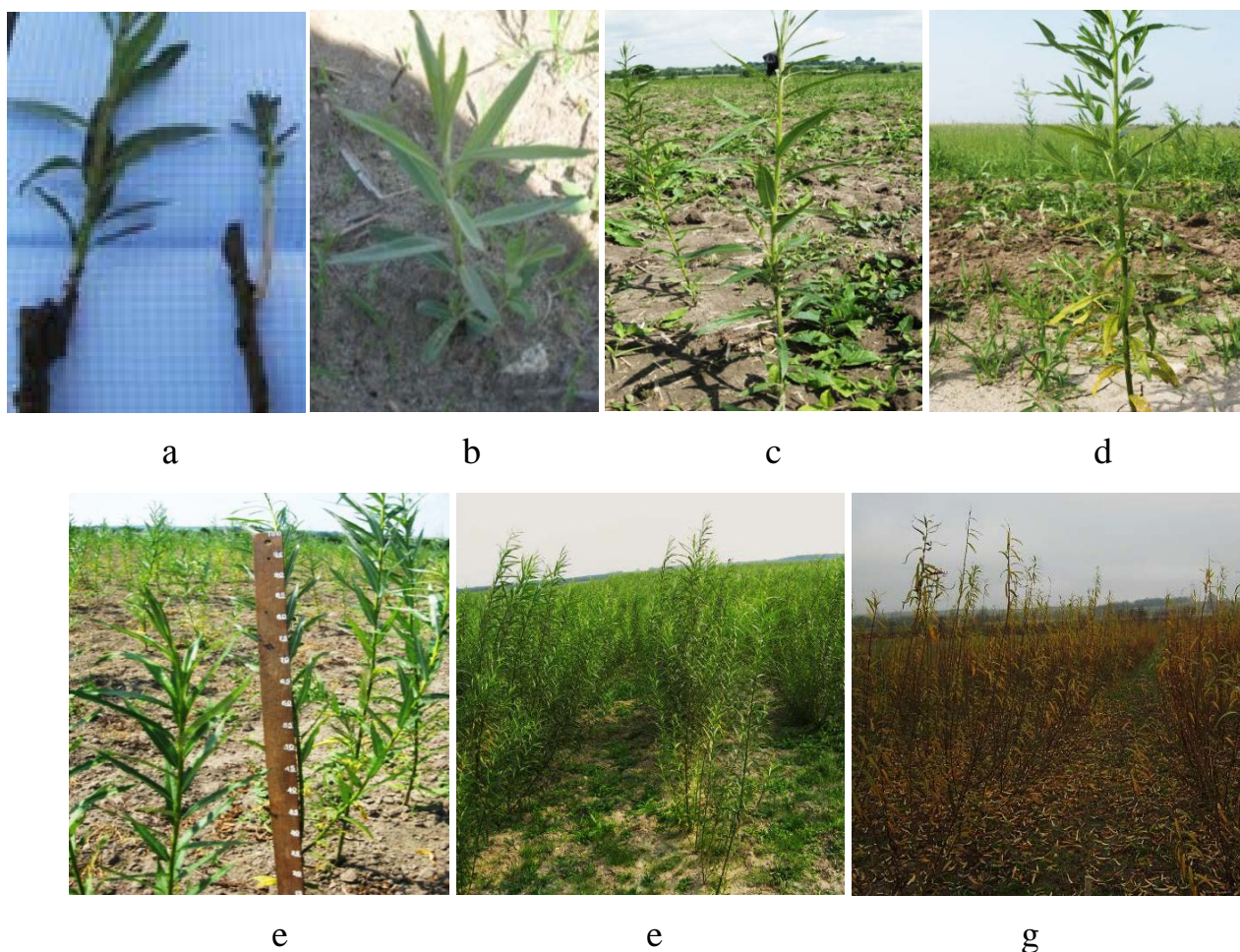


Figure. 5. Willow plants at different stages of development:

a) beginning of an upraise(4.05); b) upraise (21.05); c) beginning of branching (25.06); d) branching (14.09); e) defoliation

On 4.05 the height of spears of willow ranged from 5 cm to 10 cm and the number of weeds was 53 plants/m² (Fig.6). At this time, to wipe out weeds and to loosen the soil to improve its air regime carried out inter-row tillage. The organization of this manufacturing operation helped to improve the intensity of shoot growth. Plant height at 10 days increased by 17 cm and in average was 24 cm. Also we saw increasing number of true plant leaves, and the leaves became wider and more developed.

Despite the significant amount of rainfall in May, the plants have grown to a height of 35 cm. It is due to the fact that at present the spears do not have time to take root well.

The most intensive growth of willows was observed in June. The height of sprouts increased by more than 80 cm.

The beginning of the phase of willow branching was recorded on 07.06. Currently, plant height was recorded 30-48 cm. Every plant had several side branches.

In the first decade of July began the phase of a branching. During this month the height of bushes grew by 65 cm. Number of shoots on the bush willow is from 5 to 10.

In August the intensity of increasing the height of willow bush decreased and consisted 55 cm per month. However, the number of shoots in the bush increased to 10-15.

In mid-September, the height of the bush was in the range from 240 cm to 280 cm, and the number of shoots in the bush was from 15 to 20 units.

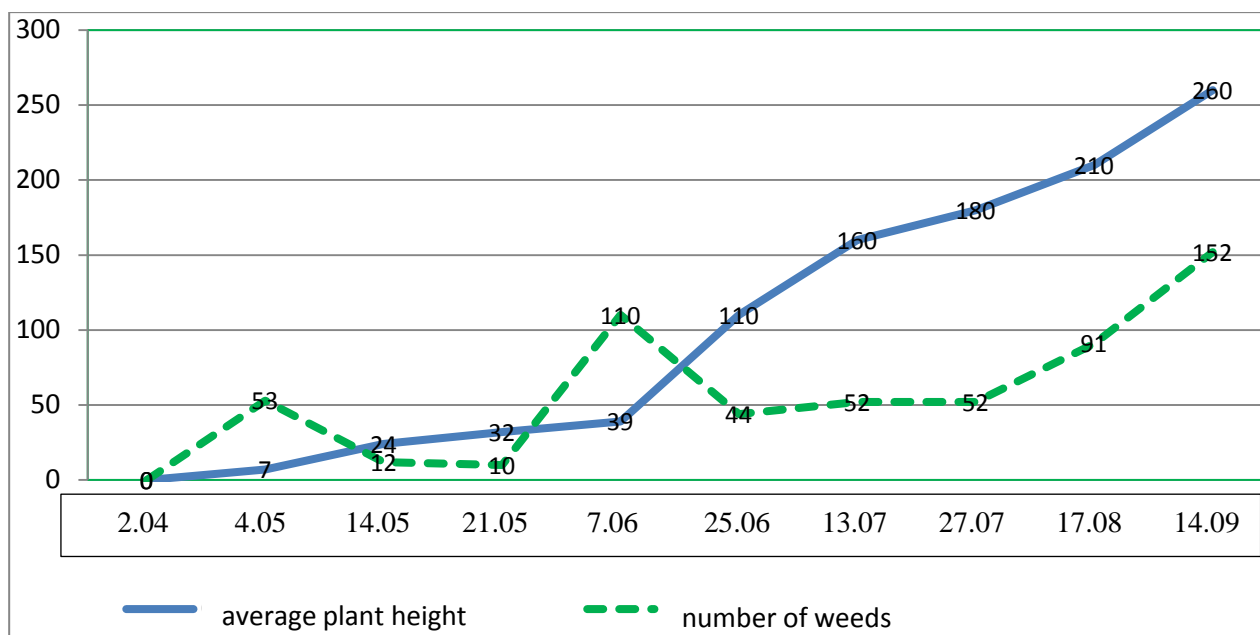


Figure 6. The results of phenological observations of willow plantations.

Analyzing the dynamics of weed quantity change, it was found out that during the growing season there was intense increase in weed-infested willow plantings. The use of mechanical cultivation allowed to control the weed-infested threshold for

acceptable levels (declining value of the line on the graph Figure 6). However, after a period of cultivation appeared more upraises of annual and perennial weeds. On 14.09. number of weeds was 152 pieces/m² but weeds could not harm a well-developed plants willow.

Conclusions. In Woodlands during the first year of growing willow plants reach up to 3 m in height. The most intense increase in plant height occurred in June. Application of technology of cultivation, which is based on intensive row cultivation can control the level of weed-infested stands of willow, which creates favorable conditions for the growth and development.

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Анотація

Курило В.Л., Журба Г.І.

Динаміка росту енергетичної верби в перший рік вирощування в ґрунтово-кліматичних умовах Полісся України

Наведено результати досліджень та спостережень за посадками верби в ґрунтово-кліматичних умовах Полісся.

Ключові слова: дослідження, технологія, енергетична верба, бур'яни.

Аннотация

Курило В.Л., Журба Г.И.

Динамика роста энергетической вербы на первом году выращивания в почвенно-климатических условиях Полесья Украины

Приведены результаты исследований и наблюдений за посадками энергетической вербы в почвенно-климатических условиях Полесья Украины.

Ключевые слова: исследования, технология, энергетическая верба, сорняки.