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SEED GERMINATION OF SWITCHGRASS (*PANICUM VIRGATUM* L.) DEPENDING ON ITS BIOLOGICAL PECULIARITIES

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Abstract

The research results of some peculiar aspects of millet seed formation depending on its biological peculiarities are presented in the paper. It has been found out that seed germination does not depend on its maturation state at harvest time which does not limit the choice of a seed harvesting practice - direct combining or two-stage method. A year of crop vegetation and groups of cultivar maturation had a significant effect on seed germination. The lowest germination was (37%) recorded when seeds were harvested from the plants of the first vegetation year and the cultivars of average-early, average-late, late and very late groups of maturation. Very late-yielding cultivars had the lowest germination - 17%.

Key words: seed germination, groups of cultivar germination, years of vegetation, maturation, seed drying.

Introduction

In recent years the number of common energy-carriers - oil and gas - has decreased rapidly both in the world and in Ukraine. So, the issue consists in their partial replacement for alternative sources of energy. A special attention is paid to the cultivation and processing of raw materials of plant origin and organic wastes for the production of bio-fuel. Such plants as sugar beets, switchgrass, sugar sorghum, miscanthus (Mozharivska, 2013), willow and poplar tress (Fuchylo, Sbytna, Fuchylo, Litvin, 2009) present a practical interest. Among new promising energy plants of a grain family, introduced in Ukraine, a perennial grain crop which can accumulate large amounts of bio-mass due to photosynthesis. Switchgrass is of great importance; it is spread from Central America to the south of Canada and is one of dominating species of central north-American prairies, it belongs to the plants with photosynthesis type C_4 (Shcherbakova, Rakhmetov, 2017). The crop is characterized with a low production cost, it requires small inputs, provides high yield of bio-mass even in non-productive soils (Vogel, Brejda, Walters *et al*., 2002). However extensive introduction of switchgrass into production is restrained by its low seed germination and a long dormancy state. Seeds are not only the carriers of a genetic potential of a crop, they are one of the main elements of the cultivation technology (Kravchenko, Doronin, Polishchuk, 2013). So, all the researches have to be aimed at reducing a seed dormancy period and in turn - increasing its germination which will favor a widespread crop introduction into production.

The propagation of switchgrass with seeds and rhizome is possible, but seed propagation is the most favorable practice. This crop has relatively small seeds with a high level of a dormancy period, in particular right after harvesting. Because of a high level of a dormancy period a large number of freshly-harvested seeds of switchgrass do not usually germinate and may have only 10% of germination (Elbersen, Bassen *et al*., 2001). Nowadays the research aimed at the increase of biomass yield capacity for bio-fuel production is carried out both in foreign countries and Ukraine. The elements of the crop production technology are worked out (Kassidy Nikole, 2011; Mandrovska, Balan, 2015), the efficiency of its use for bio-fuel production is studied (Petrychenko, Herasymenko, Honcharuk, 2011). Also the research is done to work out the method of seed quality determination

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(Doronin, Kravchenko, Honcharuk, Doronin, Shevchenko, Karpuk, 2016; Doronin, Kravchenko, Busol, Doronin, Mandrovska, Honcharuk, 2015) and the increase of its germination (Doronin, Kravchenko, Busol, Doronin, Mandrovska, 2015). There were also studies to identify the reasons for a seed dormancy state. According to S.W Adkins *et al.,* (2002) a state of a seed biological dormancy can be caused by the decrease of embryo activity or various properties of its covering (a protective shell). Along with this, biological processes in seeds do not stop instead a slow metabolism occurs which supports metabolism of an embryonic tissue. The US scientists have found out that ambient structures of a seed (protective shell - pericarp) of switchgrass act as barriers to regulate oxygen incoming to embryo which is the reason of its low germination (Duclos, Ray, Johnson, Taylor, 2013). One of the ways to break a biological dormancy of millet seeds is to cool them to a lower temperature during a given period, as a rule at 4°C for about 14 days (Adkins, Bellaires, Loch, 2013), or to do seed stratification (Shen, Parrish, Wolf and Welbaum, 2001). Usually newly-harvested seeds do not germinate and have 10% of germination. However, the extension of a post-harvest maturation during a year or a longer storage in warm and cool conditions or performing stratification-all this increases seed germination considerably (Haynes Jonine, Wallace, Pill, 1997). But the lack of sufficient information concerning the effect of biological peculiarities of switchgrass on the formation of seed quality has become the purpose of our research.

Materials and Methods

The program envisages the research of the effect of biological peculiarities of a switchgrass genotype on the formation of its seed quality. The research was conducted at the Institute of bio-energy crops and sugar beets of NAAS and Yaltushkiv experimental-breeding station of IBCSB of NAAS in the years of 2018-2019. The cultivars of various maturation groups were used in the experiment: very early (Dacotah), early (Forestburg), average-early (Nebraska, Sunburst), late (Carthage), average-late (Cave-in-rock) and very late (Kanlow).

Fig. 1: Experimental plots of switchgrass.

To determine the effect of the efficiency of seed maturation, seed samples, threshed after seed plants were mowed down and those threshed after they were dried on the mowed down plants, were chosen. Seed plants were mowed down when panicle browning was 100%. The experiment focuses on the hypothesis that in the process of seed drying on the mowed plants the outflow of nutrients from a plant to seeds takes place which can enhance their germination. Five-fold replication of the experiment was applied. Seed germination was determined on the 20th day by the method, worked out at the Institute of BCSB of NAAS (17), which implied seed germination at 20^{o}C with pre-cooling in a moist substrate at 10^{o}C within 14 days. The period of pre-cooling is not included in the determination term of germination.

Statistical processing of the experimental data was carried out with help of dispersive and correlative analyses by Fisher method, (2006) using software Statistica 6.0 from company StatSoft.

Results and Discussion

According to Kulyk, M. *et al*., (2013), a high dormancy state is typical for switchgrass seeds right after harvesting. So it has been important to find out how the intensity of seed germination changes depending on the maturation degree-seed maturation on the threshed plants in swaths and maturation of threshed seeds in storage piles.

It was found out that switchgrass seed germination neither depended on a maturation state during seed plant mowing down nor on post-harvest maturation on mowed plants (Fig. 2).

Seed germination was almost the same. And a share of the effect of "maturation" factor on the formation of seed quality was only 11%, the effect of soil-climatic conditions and farm-practices of the crop cultivation was 76%. Considering these results, a conclusion can be made

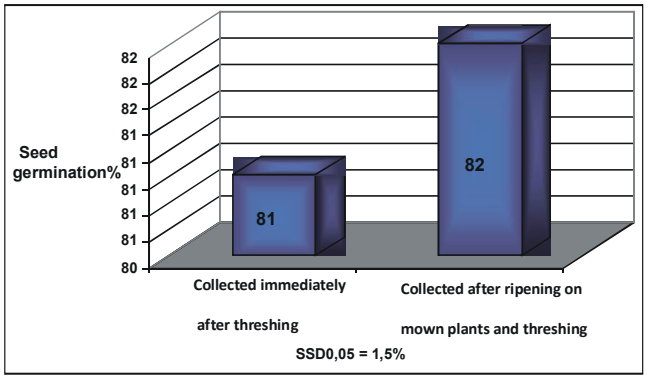

Fig. 2: Seed germination depend on their maturation state (average value in 2018-2019).

Table 1: Seed quality depending on the year of switchgrass vegetation (average value by 5 cultivars, 2018).

Variant – vegetation year	Germinated seeds on the 10th day, %	Germination, %	Mass of 1000 seeds, g
First year	36	37	1,64
Second year	73	73	1,60
Third year	62	63	1,60
Fifth year	85	86	1,72
$SSD_{0.05}$	7,1	6,7	0,20

that switchgrass seed harvesting can be done both by direct combining - seed plant mowing and seed threshing are done simultaneously and seeds mature and dry bulking outside the plants - and by two-stage practice - seed plants are mowed down, plants and seeds mature and dry in a swath.

According to the statistics of I.I. Rozhko *et al*., (2018), cultivar Cave-in-rock formed the highest seed yield capacity - 0.011- 0.064 kg/M^2 - in the first and up to the third year of vegetation, the lowest one was formed by cultivars Zorianyi and Forestburg. However, the authors did not advise what seed germination was. Which is why, the research of seed germination depending on the year of crop vegetation was carried out. It was established that reliably low seed germination was recorded in the first year of switchgrass vegetation (Table 1).

On the average by 5 cultivars, 36% of sprouts were received in the first vegetation year on the 10th day; germination was 37% on the 20th day which was significantly lower than in the second and following years of crop vegetation. Significantly higher seed germination – 86% – was recorded on the fifth year of switchgrass vegetation as compared with both the first vegetation year and the second and the third years of vegetation. As to the mass of 1000 seeds, a tendency to its decrease and increase depending on the crop vegetation years was recorded; however a significant deference was not found.

Maturation groups of the cultivars are expressed on plant biometric indicators (height and number of stems per area unit) and dry biomass yield: they were the highest for average and late cultivars which was characterized by the extended vegetation period as compared with early cultivars (Kulyk, Yurchenko, 2014).

The research of the effect of maturation groups of the cultivars on switchgrass seed germination showed an opposite dependence: very early and early cultivars had the highest seed germination, late and very late cultivars had the lowest seed germination (Fig. 3).

The formation of low germination seeds by average-early, average-late, late and very late cultivars is explained by a short light day and the insufficient quantity of active temperatures (over 10°C) and precipitations during the vegetation. Researchers L.E. Moser and K.P. Vogel, (1995) have pointed out that the main factors which determine the adaptation area of a cultivar are the response to the length of a light day, the amount of precipitation and moisture. A comprehensive estimation of switchgrass cultivars has shown that most of the cultivars are suitable for propagation in soil-climatic conditions of the Forest-steppe zone of Ukraine and ensure high bio-mass yield for the production of bio-fuel (Mandrovska, 2013). But average-early, average-late, late and very late cultivars do not mature biologically which affects seed quality - their germination is very low. In this case, we believe, any farm practice will not help increase this indicator. To solve the task of getting high quality seeds of the cultivars of these maturation groups, it is required to concentrate their cultivation in other soil-climatic conditions, which are favorable for the quality seed formation of the crop.

To widely introduce the cultivars into production, it is necessary to have a sufficient quantity of quality seeds. It is expedient to grow the seeds of very early and early cultivars in the conditions with sufficient and unstable moisture of the Forest-steppe zone of Ukraine where they form quality seeds, it is advisable to grow the seeds of the cultivars of other maturation groups in the conditions of sufficient moisture of the Forest-steppe zone and insufficient moisture of the Steppe zone of Ukraine on irrigation.

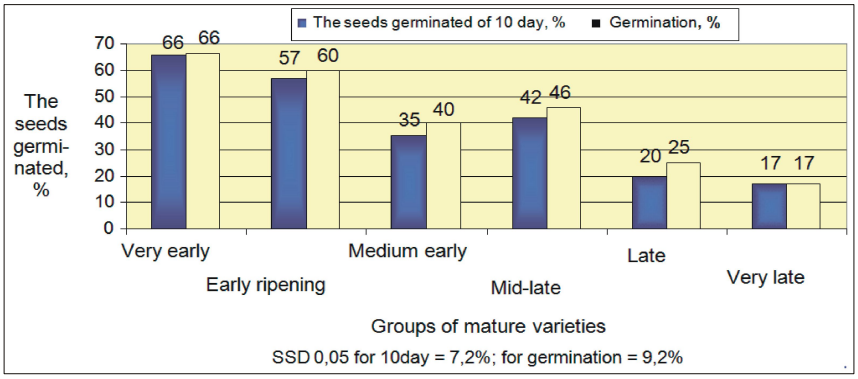

Fig. 3: Seed quality depending on maturation groups (average values in 2018-2019).

Conclusions

It has been established that switchgrass seed germination does not depend on the maturation state - seed drying on mowed plants with their threshing afterwards or threshed seeds and drying in bulk outside the plants, which does not limit the choice harvesting practices.

When growing seeds, it is expedient to harvest them from seed

plants of the second and consecutive vegetation years, as in the first year of vegetation the germination is very low - 37%.

Seed germination depends on switchgrass maturation groups considerably. Very early and early cultivars have reliably higher seed germination. Very late cultivars have the lowest germination - 17%.

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