Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 10656 - 10664
Received 05 March 2021; Accepted 01 April 2021.

Technology of Preparation of Seeds of Rod-Shaped Millet (*Panicumv Virgatum* L.)

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ABSTRACT

Goal. Development of technology for preparation of seeds of rod-shaped millet for sowing, which would reduce the biological state of rest and significantly increase its germination. Methods. Field, laboratory, visual, measuring and weighing, mathematical and statistical. Results. The technology of preparation of seeds of rod-shaped millet for sowing has been developed and scientifically proved. It includes coarse cleaning of large and small impurities, sorting by aerodynamic properties and specific mass to obtain seeds with high quality. It has been found that sorting of seeds of rod-shaped millet by aerodynamic properties is an effective technique. Even at an air velocity in the aspiration duct of 5.8 m/s. seed germination increased substantially - by 10%, and the mass of 1000 pieces - by 1.2 times compared to the control - without sorting. Increase in air velocity to 7.0 m/s. did not provide a significant increase in seed germination compared to the variant, where the air velocity was 5.8 m/s, and

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the loss of seeds in waste increased by 36.8%. The optimal sorting mode is one in which 32% of the seed falls into the waste, which provides a significant increase in the germination of the treated seeds. The most effective way to increase seed germination is to sort the seeds by specific mass, which is advisable to carry out in two stages. For the first main sorting the longitudinal angle of inclination of the working surface of the pneumatic table should be 2.00, transverse - 0.50, for repeated sorting: longitudinal - 2.50, transverse - 0.50. The frequency of oscillation of the working surface of the pneumatic table should be within 425-440 oscillations / minute. Conclusions. The developed technology of preparation of seeds of rod-shaped millet is not energy-intensive and it can be used in seed farms that have air-grate machine, aspiration column and pneumatic table.

Keywords: sorting mode, seeds, aerodynamic properties, specific mass, similarity, variety features.

INTRODUCTION

Developed countries of the world have great achievements in the development and use of biotechnology. Alternative energy sources have long and successfully been used in Europe (Austria, Denmark, the Netherlands, Norway, Finland and Sweden), with a share of 40 to 65%, and by 2020 it is planned to have 100% green bioenergy [1]. In Ukraine, green bioenergy is only 3% [2]. At the same time, Ukraine has great potential for biomass available for energy production.

The most promising types of bioenergy are the use of biomass of plant origin - phytoenergetics. Among the new promising energy crops introduced in Ukraine, special attention is paid to rod-shaped millet (Panicum virgatum L.), which is naturally distributed from Central America to southern Canada and is one of the dominant species of the Central North American prairies, belongs to plants with C4 photosynthesis [3].

Due to the increased demand for plant raw materials and the expansion of industrial areas of rod-shaped millet for the production of biofuels in Ukraine, there was a need to justify agrotechnical methods of its cultivation [4] and to develop effective technologies for pre-sowing seed treatment. Seeds are not only carriers of the genetic potential of the crop, but also one of the main elements of the technology of its cultivation [5].

Seed quality is formed not only with the creation of new varieties and conditions for its cultivation, but also in the process of pre-sowing, which is based on the removal of impurities by machines that work on the basis of the difference in the physico-mechanical properties of the components of the heap [6]. The technology of pre-sowing seed preparation of most crops includes a number of technological operations, namely: cleaning, grinding, calibration, sorting by aerodynamic properties and specific mass, treatment with protective-stimulating substances, inlaying and pelleting [7]. Most often, such properties as dimensions, shape, specific mass, surface features, aerodynamic properties (critical velocity), etc. are used for sorting [8]. The most effective way to increase seed germination is to sort by aerodynamic properties and specific mass. With this sorting it is possible to remove biologically defective seeds, improve its sowing qualities and isolate seeds with high yielding properties [9]. By cleaning and sorting the seed material by air flow (critical velocity) by aerodynamic properties, the separation of impurities from the crop seeds is achieved without significant loss of high-grade seeds [10]. Critical velocity is the velocity of air flow in meters at which a given body remains suspended. For a sorted seed, it is determined by its absolute and specific mass, which are closely related to the biological characteristics of the seed, the germination, the mass of the seedlings and, ultimately, its productivity. Separating yield by airflow at different speeds, we divide them into groups with different economic value [11].

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Rod-shaped millet has a relatively small size of seeds with a high level of dormancy, so technological methods of pre-sowing seed preparation should be aimed at reducing the biological dormancy of the seeds and increasing the intensity of its germination. Such technological methods include grinding (scarification) of seeds, cleaning them from large and small impurities, sorting by aerodynamic properties and specific mass.

The purpose of the research is to develop a technology for the preparation of seeds of rod-shaped millet for sowing, which would reduce the biological dormancy and significantly increase its germination.

MATERIALS AND METHODS OF RESEARCH

The research program envisages the development of the technology of pre-sowing preparation of seeds of rod-shaped millet, which will ensure a reliable increase in its germination. The studies were carried out in the laboratory of seed science and seed production of the Institute of Bioenergy Crops and Sugar Beets of the NAAS during 2018-2019 using laboratory equipment - the aspiration column of the company "Petkus" (Fig. 1a) and the pneumatic sorting table of the firm "Vestrub"(Fig. 1b). Seed germination was determined according to the methodology developed by the Institute of Bioenergy Crops and Sugar Beets [12].

In order to find out the efficiency of sorting rod-shaped millet seeds by aerodynamic properties, studies have been conducted the scheme of which provides its sorting at different air velocity in the aspiration channel from 5,2 to 7,0 m/s. Scheme of experiment for sorting rod-shaped millet seeds by specific mass is provided sorting in different modes, namely: changes in the longitudinal and transverse angles of inclination of the working (sieve) surface of the pneumatic sorting table, the frequency of oscillation of the working surface and the speed of air supply.

a). aspiration column b). pneumatic table

Fig. 1. Laboratory equipment for seed sorting

Statistical processing of experimental data in all experiments was carried out by the methods of variance and correlation analysis according to the Fischer method, described in Dospekhov B.A. book [13] using the Statistica 6.0 computer program.

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RESEARCH RESULTS

The technological scheme of preparation of seeds of rod-shaped millet in contrast to the technology of preparation of seeds of other crops is simpler and involves less technological operations. The main task of pre-sowing seed preparation is to purify all impurities and improve its physico-mechanical (increase in seed weight) and biological properties (increase seed germination).

The first stage of pre-sowing treatment is primary (coarse) cleaning, which is performed on air-grinding machines or other cleaning machines (Fig. 2), where all large and small impurities, dust and too small seeds are removed.

a). vibration separator b). air-grinding machine

Fig. 2. Machines for primary seed cleaning

The next stage of seed preparation is sorting by aerodynamic properties in order to increase its germination (Fig. 3). The air velocity in the aspiration duct of the column was set based on the amount of seed sent to the waste. These two technological operations of seed preparation for sowing are possible in any seed farm where there are sorting machines equipped with an aspiration channel.

Fig. 3. Aspiration column for sorting seeds by aerodynamic properties

It is established that when sorting rod-shaped millet seeds by aerodynamic properties at an air velocity in the aspiration duct of 5.8 m/s seed germination increased substantially - by 10%, and the mass of 1000 pieces - by 1.2 times compared to the control - without sorting. Increase in air velocity to 7.0 m/s. did not provide a significant increase in seed germination compared

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to the variant, where the air velocity was 5.8 m/s, and the loss of seeds in waste increased by 36.8% (Fig. 4)..

The highest intensity of seed germination was in the first 7 days of its sorting at an air velocity in the aspiration channel 7 m/s, which ranged from 21-35% to 27-45% in control.

There is an inverse correlation between the velocity of the air in the aspiration duct and the number of purified seeds. The correlation coefficient is 0.84.

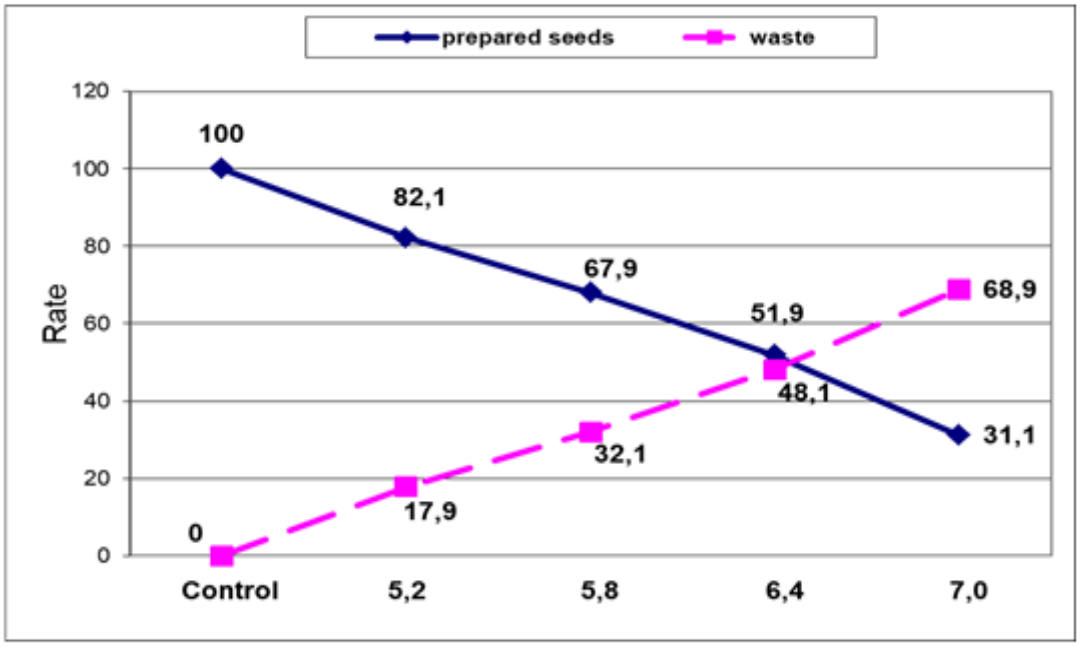
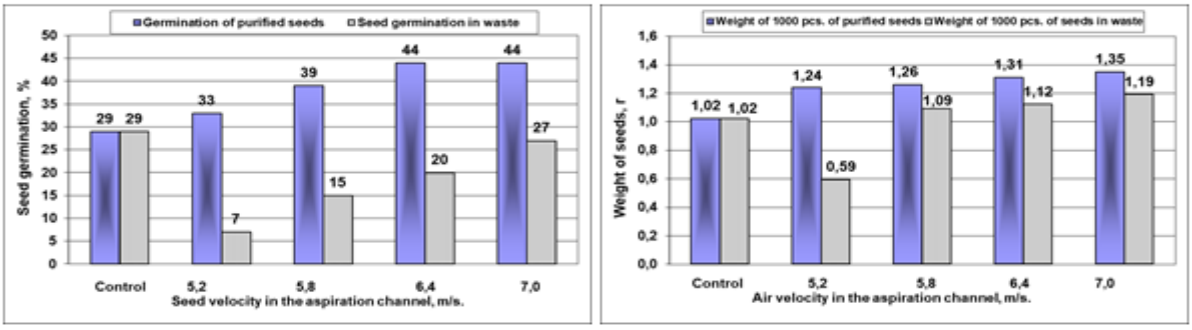


Fig. 4. Seed yield and its loss when sorted by aerodynamic properties

Increase in germination of rod-shaped millet seeds and in the mass of 1000 of its seeds is due to the selection of light and with a lower seed germination, as evidenced by the quality of seed waste (Fig. 5).



a) germination of seeds b) mass of 1000 seeds

Fig. 5. Seed quality depending on the regime of its sorting by aerodynamic properties (average for 2018-2019)

So, for sorting seeds at an air velocity in the aspiration column of 5.2 m/s, seed germination was low and was 7%. With increasing air velocity up to 6.4 m/s. germination of waste seeds increased to 20%, and at maximum velocity (7.0 m/s) - to 27%. The mass of 1000 seeds in waste, depending on the sorting regimes, was in 1.1-2.1 times lower than that in purified seeds.

It was important to find out what may be the yield of rod-shaped millet seed depending on the

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varietal characteristics and location of the seeds on the plants. Sorting was performed at air velocity in the aspiration channel of the column of 6.4 m/s. It was found that there was no significant difference in seed yield after sorting, depending on the seed location on the plant. On average, in two varieties, the yield of seeds from the panicles of first tier (panicles that are most developed and higher than others) was 78.8%, the second tier (panicles that are less developed and smaller in height) - 78.6% (Table 1). .

Table 1. Seed yield (%) depending on varietal characteristics and placement of seeds on plants (average of 10 experiments, 2019)

Variety	Seeds harvested from the panicles	
	of the first tier	of the second tier
Starsburg	72,6	69,4
Cave-in-Rock	85,1	87,7
Average	78,8	78,6
$HIP_{0,05\ common}$	8,5	
$HIP_{0,05\ VARIETY}$	6,0	
$Hip_{0,05\ PLACEMENT\ ON\ THE\ PLANT}$	6,0	

Depending on the varietal characteristics, there was a significant increase in the yield of Cave-in-Rock variety compared to the Starsburg variety, collected from both the first and second tier panicles.

The most effective way to increase germination of seeds is to sort them by specific mass on gravity pneumatic sorting tables of the firm type "Hyde", Vestrub, Petkus and others (Fig. 6).

Sorting seeds by specific mass helps to improve the productive properties of varieties. It is possible to remove biologically inferior seeds by sorting them by specific mass, which is of great importance for the farms. Observation of seeds of all crops with a high specific mass showed that such seeds produce more viable and productive plants than seeds with low specific mass [14].

Fig. 6. Pneumatic sorting tables for sorting seeds by specific mass

Sorting seeds by specific mass ensures maximum germination of seeds, while removing not only the empty seeds, but also light, filled with reduced germination energy and productive properties.

The quality of sorting seeds by specific mass on the pneumatic table depends on its mode of operation - the longitudinal and transverse angles of inclination of the working surface, the air velocity, the frequency of oscillation of the working surface and the amount of seeds supplied for sorting, as well as the period of residence of the seeds on the working surface of the pneumatic table.

Numerous studies on the efficiency of sorting rod-shaped millet seed by specific mass found that it is advisable to carry out in two stages: the first stage of sorting at the longitudinal

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inclination of the working surface of 2.0^0, transverse - 0.5^0 and only about 60% of seeds prepared for sowing are selected, and the rest is sent to the intermediate fraction with subsequent re-sorting. Seeds that have fallen into the intermediate fraction are re-sorted at the longitudinal angle of the working surface of the table of 2.5^0, transverse - 0.5^0. In both sorting, the air velocity should be such as to ensure uniform coverage of the working surface of the pneumatic table with seeds, which affects the quality of its sorting. Seed sorting by such parameters when changing the frequency of oscillation of the working surface of the pneumatic sorting table from 425 to 440 oscillations per minute provided a seed germination increase of 31-44% compared to the control - without sorting.

The highest germination of seeds - 86-94% was obtained from all positions of selection when sorting it by frequency of oscillation of the working surface 440 oscillations per minute, at the longitudinal angle of inclination of the working surface of the pneumatic table 2.50, transverse - 0.50 and such air supply, which provided a uniform coverage desktop with seeds. Under this sorting regime, seeds were found in the waste, with the lowest germination rate of about 28%. In other modes of sorting, seeds with germination of 70-73% got into the waste, which indicates poor sorting (Fig. 7).

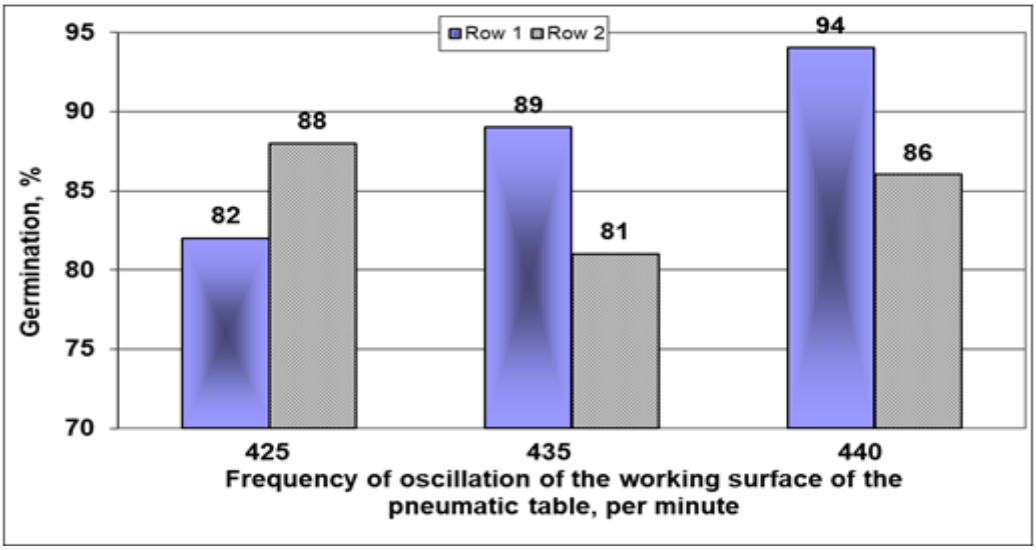

Fig. 7. Seed germination of rod-shaped millet, depending on the modes of sorting by specific mass

For all sorting regimes, the yield of seed prepared for sowing was in the range of 57.5 to 61.5%. The weight of 1000 pcs. in all sorting modes was higher than in the control, but there was no natural increase or decrease of it.

Studies have shown that the technology of preparation of seed of rod-shaped millet includes the following technological operations: rough cleaning of seeds from large and small impurities, sorting by aerodynamic properties and specific mass, which provides seeds with high quality. All these technological operations are carried out sequentially, and in the absence of a pneumatic table, seed preparation is limited by sorting by aerodynamic properties, which is available for each seed farm.

CONCLUSIONS

1. An efficient technology for the preparation of seed of rod-shaped millet, which includes the following technological operations: rough cleaning of seeds from large and small impurities, sorting by aerodynamic properties and specific mass, which provides seeds with high quality.

2. The sorting of the switchgrass seeds by aerodynamic properties provides a significant increase in its similarity. The optimal sorting mode is one in which up to 32% of the seed enters the waste, which provides a significant increase in the germination of the treated seeds. The sorting of the switchgrass seeds by regimes when more than 32% of the seed falls into the waste is impractical and leads only to unjustified losses. This method of preparing seeds for sowing is possible in any seed farm where there are sorting machines equipped with an aspiration channel.

3. Sorting of seeds by specific mass is advisable to carry out in two stages. For the first main sorting the longitudinal angle of inclination of the working surface of the pneumatic table should be 2.0^0, transverse - 0.5^0, for repeated sorting: longitudinal - 2.5^0, transverse - 0.5^0. In both sorting stages, the air velocity should be such as to ensure uniform coverage of the working surface of the pneumatic table with seeds.

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