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# ФОРМИРОВАНИЕ УРОЖАЙНОСТИ СОРТОВ ГОЛОЗЕРНОГО ОВСА ПРИ РАЗЛИЧНЫХ УСЛОВИЯХ ВОЗДЕЛЫВАНИЯ

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Представлены результаты изучения показателей урожайности голозерного овса при различных сроках посева и нормах высева. Исследования проведены в 2016–2020 гг. в полевом опыте в условиях Западной Сибири. Изучены образцы разных групп спелости культуры: среднеранний сорт Гаврош и среднеспелый сорт Офеня. На продолжительность вегетационного периода голозерного овса оказали влияние метеорологические факторы. Отмечена тенденция уменьшения продолжительности межфазных периодов и вегетационного периода в целом от раннего срока посева к более позднему на 4–10 дней у сорта Гаврош и на 8–10 дней у сорта Офеня. Урожайность у сорта Гаврош при раннем сроке посева достоверно превышала аналогичный показатель при среднем сроке на 17,6% и при позднем сроке – на 19,0%, у сорта Офеня – на 10,9% и на 16,2% соответственно. Увеличение урожайности раннего срока посева среднераннего сорта Гаврош относительно среднего и позднего сроков посева определялось большей крупностью зерна ($r$ = 0,6929…0,9535 при $R$ = 0,5140). У среднеспелого сорта Офеня в годы исследований на всех вариантах большее значение имело число продуктивных стеблей с единицы площади ($r$ = 0,7444…0,9054 при $R$ = 0,5140) и масса 1000 зерен ($r$ = 0,5350…0,8297 при $R$ = 0,5140). Наиболее оптимальная норма высева для сортов голозерного овса – 5,0–6,0 млн всхожих зерен/га. При данной норме отмечено не максимальное проявление отдельных показателей структурных элементов урожайности, а совокупность их средних значений.

**Ключевые слова:** голозерный овес, урожайность, срок посева, норма высева

# FORMATION OF PRODUCTIVITY OF NAKED OAT VARIETIES UNDER DIFFERENT CULTIVATION CONDITIONS

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The results of studying naked oat yield indicators depending on different sowing dates and seeding rates are presented. The study was carried out in 2016–2020 in a field experiment in Western Siberia. Samples of different groups of the crop ripeness were studied: mid-early variety Gavrosh and mid-ripening variety Ofenya. The duration of the growing season of naked oats was influenced by meteorological factors. There was a tendency observed for a decrease in the duration of interphase periods and the growing season as a whole from an early sowing date to a later one by 4-10 days for the Gavrosh variety and by 8-10 days for the Ofenya variety. The yield of the Gavrosh variety at an early sowing period significantly exceeded the same indicator at a mid-period by 17.6% and at a late period – by 19.0%, of the Ofenya variety – by 10.9% and 16.2%, respectively. The increase in the yield for the early sowing period of the mid-early variety Gavrosh relative to the middle and late sowing dates was determined by a larger grain size (r = 0.6929 ... 0.9535 at R = 0.5140). For the mid-

ripening variety Ofenya, the number of productive stems per unit area (r = 0.7444 ... 0.9054 with R = 0.5140) and the weight of 1000 grains (r = 0.5350 ... 0.8297 at R = 0.5140) were of more importance in the years of research on all variants. The most optimal seeding rate for naked oat varieties is 5.0–6.0 million germinating grains/ha. At this rate, it was not the maximum manifestation of individual indicators of the yield structural elements, but a combination of their average values was noted.

**Keywords**: naked oats, yield, sowing time, seeding rate

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## INTRODUCTION

At present, the Russian Federation is the world's largest producer of oats. The world harvest of oats in Russia is 22%, in Canada - 14, in the USA - 7, in Poland - 6, in Australia - 5%. In terms of production, oats ranks seventh in the world, bending to corn, rice, wheat, barley, sorghum and millet. In Russia, the cultivation of oats is on the fourth place (3.0%) after wheat (36.8%), barley (10.7%) and corn for grain (3.6%) (according to Rosstat data as of 2020[1]). At the same time, there is a downward trend in the gross harvest of this crop; in 2015 it amounted to 4.3% of the total gross harvest, in 2020 - 3.1%.

The Kemerovo region (Kuzbass) produces 11 thousand tons of seeds of spring oats of Siberian breeding varieties, including 6.8 thousand tons of seeds of varieties selected by the Kemerovo Research Institute of Agriculture - a branch of the SFSCA RAS, of which - 1.1 thousand tons of naked oats.

The naked forms of oats are the most valuable of cereals in terms of the biochemical composition of the grain, which determines its dietary and therapeutic and prophylactic properties. This makes it possible to use them in the development of products for children, functional and specialized purposes [1]. Naked oats are a unique crop in its properties. The grain of naked oats contains a large amount of proteins (up to 18–20%), oils (up to 8–12%), water-soluble polysaccharides of beta-glucans (up to 6–8%). Also, naked oats are rich in micro and macro elements (potassium, magnesium, calcium, silicon, phosphorus, sodium, etc.). In terms of the content of vitamins of group A, B, E, K, naked forms of oats demonstrate the highest rates. Oats are the only cereal containing globulins or avenins with a mass fraction of 80% of the total protein. Globulins are water-soluble, so that oats can be converted into a milky liquid. The proteins of naked oats are characterized by an increased content of arginine and an essential acid, lysine, which is almost 2 times higher in comparison with other cereals, including chalky oats [2–7].

The potential of the naked grain of oats, determined by such indicators as hoodness (0.5–0.9%), kernel content (99.1–99.5%), indicates the possibility of processing such oats for food production. The high proportion of the kernel in comparison with the grain of the scarious varieties and the uniformity make it possible to determine a potentially higher yield of finished products at correspondingly lower production costs [8–10].

Naked oat varieties are more demanding in terms of growing conditions than the scarious oats, which is due to their morphological

[1]Federal State Statistics Service. Agriculture, hunting and forestry URL: https: // rosstat. gov.ru/enterprise_economy (date of access 04/27/2021).

and biological characteristics. Technological methods of cultivation allow regulating the water and temperature conditions [11, 12].

An essential place in a number of technological methods of cultivation is occupied by the correct choice of the seeding rate and sowing time. The seed application rate determines the density of plants, the provision of agrophytocenosis with nutrients, moisture and light, its productive properties, the yield of conditioned seeds and their sowing qualities [13]. The creation of an optimal crop density is determined by the following factors: biological (potential productivity, bushiness, lodging resistance), agrotechnical (fertilization, predecessors, terms and methods of sowing), natural (natural soil fertility, physical soil properties, field relief), economic (weediness of fields, the purpose of crops - for grain, hay, green mass), agrometeorological (provision with light, heat, moisture during the growing season, depending on the changing needs of plants in ontogenesis) [14].

The choice of the sowing time is an important technological indicator, which is largely influenced by the weather conditions. It significantly changes the conditions of germination and growth of spring oats at all stages of the growing season and the formation of the yield of agricultural crops [15, 16].

The aim of the research is to study the indicators of productivity of naked oats varieties under different cultivation conditions.

## MATERIAL AND METHODS

The studies were carried out in the northern forest-steppe of the Kemerovo region on the experimental field of the Kemerovo Research Institute of Agriculture - a branch of the Siberian Federal Scientific Center of Agrobiotechnology of the Russian Academy of Sciences (Kemerovo Research Institute of Agriculture - a branch of the SFSCA RAS) in 2016–2020. The objects of research were the naked oats varieties: the mid-early variety Gavrosh and the mid-season variety Ofenya. The research conditions were unstable both over the years and within the same growing season. So, 2016 and 2017 were characterized as arid (HC May - August = 0.9 and 1.0), 2018 and 2020 - excessively humidified (HC May - August = 1.6 and 1.4), 2019 - sufficiently moisture supplied, with an optimal temperature regime (HC May - August = 1.2), which influenced the formation of the harvest of naked oats.

The predecessor was pure fallow. Sowing was carried out on three dates: the first was at the onset of physical maturity of the soil (27.04-14.05), the subsequent dates were sown at 8-10-day intervals (9-21.05 and 21-28.05). The following seeding rates were studied for each date: 4.0; 4.5; 5.0; 5.5; 6.0 million germinated grains/ha. Sowing was carried out with a SN-10C seeder on a plot area of 10 $m^2$ in quadruple replications. The plot arrangement was randomized. Records, observations, statistical processing of data were performed in accordance with the approved guidelines[2-4].

## RESULTS AND DISCUSSIONS

During the study of naked oats varieties, the differences in the duration of the passage of ontogenetic phases from weather conditions were noted. A tendency was noted for a decrease in the duration of both interphase periods and the entire growing season as a whole from an early sowing date to a later one by 4–10 days in the Gavrosh variety and by 8–10 days in the Ofenya variety. On average, over the years of research, the duration of the growing season of the medium-early variety Gavrosh at early sowing dates was 86 days, at average - 83 days, at later - 78 days. The duration of the growing season of the mid-ripening variety Ofenya at different sowing dates was 93, 88 and 83 days, respectively.

Of no small importance in the structure of the growing season is the time of emergence of seedlings, i.e. the number of days from the moment of sowing the seeds to the emergence

[2]Methodology for state variety testing of agricultural crops. M., 1985.270 p.
[3]Dospekhov B.L. Field experiment technique. M.: Agropromizdat, 1985.352 p.
[4]Sorokin O.D. Applied statistics on the computer. Krasnoobsk: GUP RPO SO RASKhN, 2004.162 p.

of seedlings. It affects the further growth and development of plants and largely depends on the meteorological conditions during this period. The time of emergence of seedlings had a greater influence on the plant height (r = –0.7123 ... –0.8004 at R = 0.5140), panicle length (r = –0.6980… –0.7365 at R = 0.5140), the number of flowers in a panicle (r = –0.6507… –0.8408 at R = 0.5140). With early sowing dates, the duration of the sowing - sprouting period for the Gavrosh variety averaged 13 days, for the Ofenya variety - 15 days. In the middle and late stages, with an increase in air temperature and humidity, the period of seed germination was reduced to 12–10 days in the Gavrosh variety, and to 14–13 days in the Ofenya variety. When analyzing the obtained experimental data, the influence of the duration of the germination time on the formation of the yield of varieties (r = –0.8798 ... –0.9982 at R = 0.5140) was noted, therefore, when calculating the duration of the entire growing season as a whole, it is necessary to take into account the value of this subperiod.

The change in the duration of the growing season was more influenced by the interphase period of seedlings - peeling (r = 0.8255 ... 0.9875 at R = 0.5140), the value of which averaged 42 days in the Gavrosh variety at early sowing, with an average of 39 , with a late one - 38 days, with the Ofenya variety - 46, 44 and 39 days, respectively. The determining criterion was the nature of soil moisture during this period (r = 0.6934 ... 0.9795 at R = 0.5140) in order to pass this period.

The duration of the interphase period between flowering and ripening in the variants differed slightly and was 44-40 days in the Gavrosh variety and 47-44 days in the Ofenya variety.

The highest yields of the studied varieties Gavrosh and Ofenya were formed in 2019. (2.89 and 3.07 t/ha) under optimum moisture conditions (GTC = 1.2). The minimum yield was obtained in the drought year 2017. (GTC = 1.0) - 1.50 and 1.70 t/ha, respectively.

In the mid-early variety Gavrosh the advantage of early sowing dates with an average yield of 2.73 t / ha was noted, while with an average period it was 2.25 t / ha, with a late one - 2.21 t / ha. At the same time, for all sowing terms, the best results were obtained at increased seeding rates of 5.0 and 6.0 million germinating grains / ha (see Table 1).

In the mid-ripening variety Ofenya, with an early sowing period, the yield was 3.03 t / ha, with an average - 2.70, with a late sowing - 2.54 t / ha. A higher yield of this variety was formed at a seeding rate of 5.5 and 6.0 million germinating grains / ha at all sowing dates (see Table 2). On average, according to experience, the yield of the Ofenya variety exceeded the productivity of the Gavrosh variety by 15%.

On average, over the years of research, a significant advantage of early sowing dates was noted: by 17.6% to the average date and by 19.0% to the late date in the Gavrosh variety; by 10.9% by the average term and by 16.2% by the late term in the Ofenya variety.

The excess yield of the early sowing period of the medium early variety Gavrosh was determined by the larger grain size (r = 0.6929 ... 0.9535 at R = 0.5140) relative to the average and late sowing dates, especially in drier years. On average, according to the experiment, the mass of 1000 grains in the Gavrosh variety at an early period was 23.2 g, with an average - 22.6, with a late one - 21.5 - 24.1 g (see Table 3).

At the same time, at an early and medium term, a high yield was noted on variants with an increased number of productive stems per unit area (r = 0.6437 ... 0.7899 at R = 0.5140), which characterized variants with increased seeding rates - 5.5 and 6.0 million germinating grains / ha. However, high values of individual elements of the yield structure, such as productive tillering, the number of grains in the panicle, and the mass of grain from the main panicle were observed at low seeding rates - 4.0 and 4.5 million germinating grains / ha. The yield of the variants of the late sowing period was formed with average indicators of structural elements.

The number of productive stems per unit area (r = 0.7444 ... 0.9054 at R = 0.5140) and the mass of 1000 grains (r = 0.5350 ... 0, 8297 at R = 0.5140) was of the decisive importance in the formation of the yield of the mid-ripening variety Ofenya in the years of research on all the

**Табл. 1.** Урожайность голозерного овса Гаврош, т/га, 2016–2020 гг.
**Table 1.** Yield of naked oats Gavrosh, t/ha, 2016–2020

| Sowing time | Year of study | Seeding rate, million germinating grains / ha | | | | | Average by term |
|---|---|---|---|---|---|---|---|
| | | 4,0 | 4,5 | 5,0 | 5,5 | 6,0 | |
| Early | 2016 | 2,43 | 2,50 | 2,55 | 2,57 | 2,55 | 2,52 |
| | 2017 | 1,41 | 1,37 | 1,37 | 1,29 | 1,51 | 1,39 |
| | 2018 | 3,22 | 3,20 | 3,07 | 3,28 | 2,80 | 3,11 |
| | 2019 | 4,27 | 4,20 | 4,27 | 4,09 | 4,14 | 4,19 |
| | 2020 | 2,28 | 2,30 | 2,43 | 2,41 | 2,73 | 2,43 |
| | Average by norm | 2,72 | 2,71 | 2,74 | 2,73 | 2,75 | 2,73 |
| Medium | 2016 | 2,55 | 2,57 | 2,69 | 2,71 | 3,00 | 2,70 |
| | 2017 | 1,54 | 1,30 | 1,29 | 1,41 | 1,30 | 1,37 |
| | 2018 | 2,61 | 2,45 | 2,58 | 2,44 | 2,26 | 2,51 |
| | 2019 | 2,60 | 2,44 | 2,49 | 2,54 | 2,52 | 2,52 |
| | 2020 | 1,99 | 2,07 | 2,13 | 2,36 | 2,27 | 2,16 |
| | Average by norm | 2,26 | 2,17 | 2,24 | 2,29 | 2,27 | 2,25 |
| Late | 2016 | 2,50 | 2,40 | 2,40 | 2,47 | 2,76 | 2,51 |
| | 2017 | 1,54 | 1,66 | 1,76 | 1,80 | 1,67 | 1,69 |
| | 2018 | 2,45 | 2,16 | 2,65 | 2,66 | 2,34 | 2,45 |
| | 2019 | 1,87 | 1,94 | 2,03 | 2,00 | 2,00 | 1,97 |
| | 2020 | 2,24 | 2,50 | 2,35 | 2,42 | 2,65 | 2,43 |
| | Average by norm | 2,12 | 2,13 | 2,24 | 2,27 | 2,28 | 2,21 |

Note. LSD 0.5 factor A (year) = 0.08; factor B (grade) = 0.04; factor C (sowing time) = 0.05; factor D (seeding rate) = 0.07.

**Табл. 2.** Урожайность голозерного овса Офеня, т/га, 2016–2020 гг.
**Table 2.** Yield of naked oats Ofenya, t/ha, 2016–2020

| Sowing time | Year of study | Seeding rate, million germinating grains / ha | | | | | Average by term |
|---|---|---|---|---|---|---|---|
| | | 4,0 | 4,5 | 5,0 | 5,5 | 6,0 | |
| Early | 2016 | 3,24 | 3,26 | 3,45 | 3,40 | 3,55 | 3,38 |
| | 2017 | 1,71 | 1,68 | 1,88 | 1,83 | 1,77 | 1,77 |
| | 2018 | 3,60 | 3,74 | 3,61 | 3,62 | 3,93 | 3,70 |
| | 2019 | 3,56 | 3,37 | 3,60 | 3,69 | 3,43 | 3,53 |
| | 2020 | 2,39 | 2,84 | 2,78 | 2,86 | 3,05 | 2,78 |
| | Average by norm | 2,90 | 2,98 | 3,06 | 3,08 | 3,15 | 3,03 |
| Medium | 2016 | 3,12 | 3,22 | 3,60 | 3,50 | 3,67 | 3,42 |
| | 2017 | 1,61 | 1,69 | 1,83 | 1,67 | 1,63 | 1,69 |
| | 2018 | 2,71 | 2,82 | 3,09 | 2,88 | 2,57 | 2,81 |
| | 2019 | 2,92 | 3,15 | 3,17 | 3,22 | 3,21 | 3,13 |
| | 2020 | 2,46 | 2,34 | 2,62 | 2,39 | 2,52 | 2,47 |
| | Average by norm | 2,56 | 2,64 | 2,86 | 2,73 | 2,72 | 2,70 |
| Late | 2016 | 3,22 | 3,07 | 3,00 | 3,12 | 3,31 | 3,14 |
| | 2017 | 1,62 | 1,90 | 1,73 | 1,74 | 1,66 | 1,73 |
| | 2018 | 2,33 | 2,21 | 2,37 | 2,21 | 2,56 | 2,33 |
| | 2019 | 2,37 | 2,64 | 2,34 | 2,71 | 2,66 | 2,54 |
| | 2020 | 2,63 | 3,06 | 3,18 | 2,98 | 3,04 | 2,98 |
| | Average by norm | 2,43 | 2,58 | 2,52 | 2,55 | 2,65 | 2,54 |

Note. LSD 0.5 factor A (year) = 0.09; factor B (grade) = 0.04; factor C (sowing time) = 0.07; factor D (seeding rate) = 0.09.

**Табл. 3.** Агробиологическая характеристика голозерного овса сорта Гаврош, 2016–2020 гг.
**Table 3.** Agrobiological characteristics of naked oats of the Gavrosh variety, 2016–2020

| Sowing time | Seeding rate, million germinating grains / ha | Number of productive stems, pcs / m$^2$ | Productive bushiness, pcs. | The number of grains in a panicle, pcs. | Splitting of filmy grains, % | Grain weight from the main panicle, g | Weight of 1000 grains, g | Natural weight, g / l |
|---|---|---|---|---|---|---|---|---|
| Early | 4,0 | 344 | 1,8 | 40,8 | 2,2 | 0,89 | 23,1 | 626 |
| | 4,5 | 374 | 1,8 | 36,3 | 2,3 | 0,80 | 23,1 | 628 |
| | 5,0 | 380 | 1,7 | 34,8 | 2,4 | 0,76 | 23,4 | 627 |
| | 5,5 | 372 | 1,5 | 29,7 | 2,2 | 0,69 | 23,2 | 628 |
| | 6,0 | 392 | 1,5 | 32,9 | 2,3 | 0,73 | 23,1 | 621 |
| | Average | 372 | 1,7 | 34,9 | 2,3 | 0,77 | 23,2 | 626 |
| Me- | 4,0 | 344 | 1,9 | 43,6 | 2,8 | 0,96 | 22,6 | 609 |
| dium | 4,5 | 329 | 1,9 | 41,7 | 2,9 | 0,91 | 22,7 | 607 |
| | 5,0 | 353 | 1,9 | 37,7 | 2,5 | 0,86 | 22,4 | 618 |
| | 5,5 | 413 | 1,9 | 32,7 | 2,6 | 0,72 | 22,5 | 608 |
| | 6,0 | 411 | 1,8 | 34,2 | 2,9 | 0,72 | 22,6 | 617 |
| | Average | 370 | 1,9 | 38,0 | 2,7 | 0,83 | 22,6 | 612 |
| Late | 4,0 | 392 | 2,0 | 40,5 | 1,3 | 0,88 | 21,3 | 597 |
| | 4,5 | 404 | 2,0 | 41,0 | 1,6 | 0,86 | 22,0 | 594 |
| | 5,0 | 391 | 1,8 | 40,0 | 1,5 | 0,84 | 21,6 | 603 |
| | 5,5 | 398 | 1,8 | 34,0 | 1,7 | 0,71 | 21,4 | 597 |
| | 6,0 | 403 | 1,6 | 34,3 | 1,7 | 0,73 | 21,2 | 594 |
| | Average | 398 | 1,8 | 38,0 | 1,6 | 0,80 | 21,5 | 597 |

variants. Thus, a greater number of productive stems was noted at early sowing dates of 334 pcs / m$^2$, with medium and late dates - 302 and 312 pcs / m$^2$, respectively. The weight of 1000 seeds in terms of sowing time was 27.7; 26.5 and 24.6 g (see Table 4).

The best indicators of structural elements in the Ofenya variety were also noted at seeding rates of 4.0 and 4.5 million germinating grains / ha. At the same time, a high yield on options 5.5 and 6.0 million germinating grains / ha was formed with a combination of average values of structural elements.

**Табл. 4.** Агробиологическая характеристика голозерного овса сорта Офеня, 2016–2020 гг.
**Table 4.** Agrobiological characteristics of naked oats of the Ofenya variety, 2016–2020

| Sowing time | Seeding rate, million germinating grains / ha | Number of productive stems, pcs / m$^2$ | Productive bushiness, pcs. | The number of grains in a panicle, pcs. | Splitting of filmy grains, % | Grain weight from the main panicle, g | Weight of 1000 grains, g | Natural weight, g / l |
|---|---|---|---|---|---|---|---|---|
| Early | 4,0 | 274 | 1,8 | 45,7 | 4,7 | 1,38 | 27,7 | 605 |
| | 4,5 | 314 | 1,8 | 44,9 | 5,1 | 1,21 | 27,8 | 611 |
| | 5,0 | 342 | 1,9 | 40,8 | 4,6 | 1,22 | 27,6 | 612 |
| | 5,5 | 382 | 1,8 | 41,2 | 5,8 | 1,14 | 27,7 | 607 |
| | 6,0 | 357 | 1,8 | 41,8 | 6,0 | 1,11 | 27,5 | 603 |
| | Average | 334 | 1,8 | 42,9 | 5,3 | 1,21 | 27,7 | 608 |
| Me- | 4,0 | 292 | 1,6 | 41,1 | 3,1 | 1,12 | 26,6 | 605 |
| dium | 4,5 | 289 | 1,6 | 40,6 | 3,0 | 1,10 | 26,5 | 598 |
| | 5,0 | 327 | 1,9 | 34,7 | 3,1 | 0,96 | 26,5 | 604 |
| | 5,5 | 337 | 1,7 | 37,2 | 3,8 | 0,97 | 26,9 | 606 |
| | 6,0 | 302 | 1,6 | 36,2 | 4,1 | 0,95 | 25,2 | 600 |
| | Average | 309 | 1,7 | 38,0 | 3,4 | 1,02 | 26,5 | 603 |
| Late | 4,0 | 273 | 1,7 | 46,4 | 1,4 | 1,09 | 24,3 | 567 |
| | 4,5 | 327 | 1,8 | 44,6 | 1,5 | 1,02 | 24,3 | 569 |
| | 5,0 | 308 | 1,7 | 45,2 | 1,3 | 1,04 | 24,7 | 572 |
| | 5,5 | 327 | 1,7 | 40,2 | 1,3 | 0,95 | 25,0 | 574 |
| | 6,0 | 327 | 1,6 | 43,8 | 1,7 | 1,01 | 24,8 | 571 |
| | Average | 312 | 1,7 | 44,0 | 1,4 | 1,02 | 24,6 | 571 |

Different variants of the experiment also influenced the plumpness and density of the grain of naked oats, which are characterized by the full-scale weight of the grain. This indicator was influenced by the conditions of moisture supply during the tillering period – forming into a tube (r = 0.7344 ... 0.8147 at R = 0.5140) and ripening (r = 0.6004 ... 0.6442 at R = 0.5140). There was a tendency to decrease the natural weight from early to late sowing in both varieties. A plump caryopsis of a higher quality was observed in the varieties Gavrosh and Ofenya on the variants of 5.0 and 5.5 million germinating grains / ha: 603–628 and 574–606 g / l, respectively.

## CONCLUSION

As a result of a long-term study of naked oat varieties Gavrosh and Ofenya under various cultivation conditions elements of varietal technology have been identified that ensure high productivity of varieties in Western Siberia. The advantage of sowing naked oats in the early stages was noted, the yield exceeded by later sowing dates in the mid-early variety Gavrosh is 17-19%, in the mid-ripening variety Ofenya - 11-16%. The most optimal seeding rate for naked oat varieties is 5.0–6.0 million germinating grains / ha.

## СПИСОК ЛИТЕРАТУРЫ

1. *Попов В.С., Сергеева С.С., Барсукова Н.В.* Функциональные и технологические свойства зерна овса и перспективный ассортимент продуктов питания на его основе // Вестник технологического университета. 2016. № 19. С. 147–151.
2. *Баталова Г.А., Вологжанина Е.Н.* Влияние элементов технологии возделывания на формирование качества зерна голозерного овса // Достижения науки и техники АПК. 2012. № 10. С. 35–37.
3. *Полонский В.И., Сумина А.В., Шалдаева Т.М.* Содержание белков и углеводов в зерне ячменя и овса сибирской селекции // Успехи современного естествознания. 2018. № 1. С. 49–55.
4. *Николаева Л.С., Кардашина В.Е.* Зерновая и кормовая продуктивность сортов овса универсального использования в зависимости от метеорологических факторов // АПК России. 2017. № 3. С. 618–623.
5. *Баталова Г.А.* Перспективы и результаты селекции голозерного овса // Зернобобовые и крупяные культуры. 2014. № 2 (10). С. 64–69.
6. *Безгодов А.В., Ялунина А.Д.* Оценка сортов голозерного овса по продуктивности и реакции на климатические условия Среднего Урала // Интерактивная наука. 2016. № 10. С. 94–101. DOI: 10.21661/r-114765.
7. *Sterna V., Zute S., Brunava L.* Oat Grain Composition and its Nutrition Benefice // Agriculture and Agricultural Science Procedia. 2016. № 8. P. 252–256. DOI: 10.1016/j.aaspro.2016.02.100.
8. *Баталова Г.А.* Значение, селекция и элементы технологии возделывания овса голозерного // Селекция, семеноводство и генетика. 2015. № 1. С. 26–31.
9. *Айдиев А.Я., Новикова В.Т., Кабашев А.Д., Власенко Н.М., Шумаков А.В., Дугина С.А.* Результаты экологического испытания пленчатого и голозерного овса // Вестник Курской государственной сельскохозяйственной академии. 2018. № 9. С. 102–107.
10. *Rasane P., Jha A., Sabikhi L., Kumar A., Unnikrishnan V.S.* Nutritional advantages of oats and opportunities for its processing as value added foods – a review // Journal of Food Science and Technology. 2015. Vol. 52. № 2. P. 662–675. DOI: 10.1007/s13197-013-1072-1.
11. *Икоева Л.П., Хаева О.Э., Бацазова Т.М.* Влияние норм и способов посева на урожайность голозерного овса при возделывании в предгорной зоне Рсо-Алания // Известия Горского государственного аграрного университета. 2017. Т. 54. № 2. С. 116–121.
12. *Усанова З.И., Булюкин Е.С.* Продуктивность голозерного овса при возделывании по разным технологиям с применением некорневых подкормок // Достижения науки и техники АПК. 2018. Т. 32. № 6. С. 21–25. DOI: 10.24411/235-2451-2018-10605.
13. *Баталова Г.А., Горбунова Л.А.* Урожайность и качество семян овса в зависимости от нормы высева // Доклады Российской академии сельскохозяйственных наук. 2009. № 1. С. 16.
14. *Бобровский А.В., Косяненко Л.П.* Норма высева как биологический ресурс увеличения производства зерна овса // Вестник КрасГАУ. 2012. № 6 (69). С. 47–51.

15. *Givens D.I., Davies T.W., Laverick R.M.* Effect of variety, nitrogen fertiliser and various agronomic factors on the nutritive value of husked and naked oats grain // Animal Feed Science and Technology. 2004. Vol. 113. P. 169–181.
16. *Усанова З.И., Булюкин Е.С.* Влияние агротехнологий на продуктивность посевов сортов голозерного овса в условиях Верхневолжья // Вестник Алтайского государственного аграрного университета. 2014. № 6 (116). С. 30–35.

## REFERENCES

1. Popov V.S., Sergeeva S.S., Barsukova N.V. Functional and technological properties of oat grain and a promising range of food products based on it. *Vestnik tekhnologicheskogo universiteta = Bulletin of the Technological University,* 2016, no. 19, pp. 147–151. (In Russian).
2. Batalova G.A., Vologzhanina E.N. Influence of technological methods of cultivation on forming of quality of naked oats grain. *Dostizheniya nauki i tekhniki APK = Achievements of Science and Technology of AIC,* 2012, no. 10, pp. 35–37. (In Russian).
3. Polonskii V.I., Sumina A.V., Shaldaeva T.M. Proteins and carbohydrates content in barley and oats seeds at Siberian breeding. *Uspekhi sovremennogo estestvoznaniya = Advances in Current Natural Sciences,* 2018, no. 1, pp. 49–55. (In Russian).
4. Nikolaeva L.S., Kardashina V.E. Grain and fodder productivity of oat varieties for universal use depending on meteorological factors. *APK Rossii = Agro-Industrial Complex of Russia,* 2017, no. 3, pp. 618–623. (In Russian).
5. Batalova G.A. Prospects and results of naked oats breeding. *Zernobobovye i krupyanye kul'tury = Legumes and Groat Crops,* 2014, no. 2 (10), pp. 64–69. (In Russian).
6. Bezgodov A.V., Yalunina A.D. The productivity and reaction of naked oat breeds on weather conditions in the Middle Urals. *Interaktivnaya nauka = Interactive Science,* 2016, no. 10, pp. 94–101. (In Russian). DOI: 10.21661/r-114765.
7. Sterna V., Zute S., Brunava L. Oat Grain Composition and its Nutrition Benefice. *Agriculture and Agricultural Science Procedia,* 2016, no. 8, pp. 252–256. DOI: 10.1016/j.aaspro.2016.02.100.
8. Batalova G.A. Significance, breeding and elements of technology for cultivation of naked oats. *Selektsiya, semenovodstvo i genetika = Breeding, seed production and genetics,* 2015, no. 1, pp. 26–31. (In Russian).
9. Aidiev A.Ya., Novikova V.T., Kabashev A.D., Vlasenko N.M., Shumakov A.V., Dugina S.A. Environmental test results of hulled and naked oats. *Vestnik Kurskoi gosudarstvennoi sel'skokhozyaistvennoi akademii = Vestnik of Kursk State Agricultural Academy,* 2018, no. 9, pp. 102–107. (In Russian).
10. Rasane P., Jha A., Sabikhi L., Kumar A., Unnikrishnan V.S. Nutritional advantages of oats and opportunities for its processing as value added foods – a review. *Journal of Food Science and Technology*, 2015, vol. 52, no. 2, pp. 662–675. DOI: 10.1007/s13197-013-1072-1.
11. Ikoeva L.P., Khaeva O.E., Batsazova T.M. Influence of sowing rates and methods on naked oats yield when cultivating in the foothill zone of North Ossetia-Alania. *Izvestiya Gorskogo gosudarstvennogo agrarnogo universiteta = Journal of Proceedings of Gorsky State Agrarian University,* 2017, vol. 54, no. 2, pp. 116–121. (In Russian).
12. Usanova Z.I., Bulyukin E.S. Productivity of huskless oats at cultivation according to different technologies with foliage spraying. *Dostizheniya nauki i tekhniki APK = Achievements of Science and Technology of AIC,* 2018, vol. 32, no. 6, pp. 21–25. (In Russian). DOI: 10.24411/235-2451-2018-10605.
13. Batalova G.A., Gorbunova L.A. Influence of seeding rate on productivity and seed quality of oat. *Doklady Rossiiskoi Akademii sel'skokhozyaistvennykh nauk = Proceedings of the Russian Academy of Agricultural Sciences,* 2009, no. 1, pp. 16. (In Russian).
14. Bobrovskii A.V., Kosyanenko L.P. Seeding rate as the biological resource for the oat grain manufacture increase. *Vestnik KrasGAU = The Bulletin of KrasGAU,* 2012, no. 6 (69), pp. 47–51. (In Russian).
15. Givens D.I., Davies T.W., Laverick R.M. Effect of variety, nitrogen fertiliser and various agronomic factors on the nutritive value of husked and naked oats grain. *Animal Feed Science and Technology*, 2004, vol. 113, pp. 169–181.
16. Usanova Z.I., Bulyukin E.S. Effect of cultivatin technologies on yields of hull-less oat varieties in Verkhnevolzhye (Upper Volga regin). *Vestnik Altaiskogo gosudarstvennogo agrarnogo universiteta = Bulletin of Altai State Agricultural University,* 2014, no. 6 (116), pp. 30–35. (In Russian).

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