Artículo de investigación

Peculiarities of growing gold-of-pleasure for oilseeds and its use in feed production in the non-chernozem zone of Russia

Peculiaridades del cultivo de oro de placer para las semillas oleaginosas y su uso en la producción de alimentos en la zona no chernozem de Rusia

Peculiaridades do crescimento do ouro-prazer para oleaginosas e seu uso na produção de ração na zona não-chernozem da Rússia

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Abstract

At present, gold-of-pleasure attracts wide attention due to its unpretentiousness and early maturity, high and stable yield.
In Russia, edible oils are mainly obtained from sunflower seeds, soybeans, rapeseed and seeds of other oil plants (flax, mustard, castor oil plant and bird rape) and are processed in relatively small amounts. Gold-of-pleasure (Camelina sativa (L.) Crantz) in the Non-Chernozem zone of Russia is not a traditional crop. The expansion of areas for this crop sowing is constrained by the lack of developed recommendations on the technology of its cultivation. This is the basis of the research.
The purpose of this experiment was to identify the features of forming gold-of-pleasure productivity and optimizing the main elements of varietal technology (seeding rate and seeding time) in the conditions of the region.
The research was carried out at Ryazan State Agrotechnological University, on the experimental fields of the agrotechnological experimental station of Ryazan oblast, on gray forest soils.
The object of the research is gold-of-pleasure, variety Yubilyar.

Resumen

En la actualidad, el oro del placer atrae una amplia atención debido a su falta de pretensiones y madurez temprana, rendimiento alto y estable.
En Rusia, los aceites comestibles se obtienen principalmente de semillas de girasol, soja, colza y semillas de otras plantas oleaginosas (linaza, mostaza, aceite de ricino y coles) y se procesan en cantidades relativamente pequeñas. El oro del placer (Camelina sativa (L.) Crantz) en la zona de Non-Chernozem de Rusia no es un cultivo tradicional. La expansión de las áreas para esta siembra de cultivos está limitada por la falta de recomendaciones desarrolladas sobre la tecnología de su cultivo. Esta es la base de la investigación.
El propósito de este experimento fue identificar las características de la formación de la productividad del oro del placer y la optimización de los elementos principales de la tecnología varietal (tasa de siembra y tiempo de siembra) en las condiciones de la región.
La investigación se llevó a cabo en la Universidad Agrotecnológica Estatal de Ryazan, en los campos experimentales de la estación experimental agrotecnológica de Ryazan oblast, en suelos de bosques grises.

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It has been revealed that in order to obtain a stable yield of gold-of-pleasure, it is necessary to have at least 420-440 plants per 1 m² to harvest, and 400-450 plants per 1 m² are considered the optimal density. Increasing the seeding rate, above 8 million pcs. of the seeds / ha, led to the formation of a strongly crowded crop, which ultimately contributed to a decrease of the yield and seeds quality. The most optimal seeding rate for gold-of-pleasure is 7.0 million germinated seeds per hectare. The overestimation of the norm to 8.0 million pieces / ha did not significantly increase the yield, but led to an excessive consumption of seeds, deteriorated seed quality, the risk of lodging and diseases. The best seeding time in experiments is the first decade of May.

Key words: gold-of-pleasure, yield, seeding time, seeding rate, Non-Chernozem zone of Russian.

El objeto de la investigación es el oro del placer, variedad Yubilyar.
Se ha revelado que, para obtener un rendimiento estable de oro de placer, es necesario contar con al menos 420-440 plantas por cosecha de 1 m², y 400-450 plantas por 1 m² se consideran la densidad óptima. Incrementando la tasa de siembra, por encima de 8 millones de pcs. de las semillas / ha, llevó a la formación de un cultivo muy poblado, que en última instancia contribuyó a una disminución del rendimiento y la calidad de las semillas. La tasa de siembra más óptima para el oro del placer es de 7.0 millones de semillas germinadas por hectárea. La sobrestimación de la norma a 8,0 millones de piezas / ha no aumentó significativamente el rendimiento, pero condujo a un consumo excesivo de semillas, deterioro de la calidad de las semillas, el riesgo de alojamiento y enfermedades. El mejor tiempo de siembra en experimentos es la primera década de mayo.

Palabras claves: Oro del placer, rendimiento, tiempo de siembra, tasa de siembra, zona no Chernozem de Rusia.

Resumo

No presente, o ouro-do-prazer atrai grande atenção devido à sua despretensão e maturidade precoce, rendimento alto e estável. Na Rússia, os óleos comestíveis são obtidos principalmente a partir de sementes de girassol, soja, colza e sementes de outras plantas oleaginosas (linho, mostarda, mamona e colza) e são processados em quantidades relativamente pequenas. Ouro-do-prazer (Camelina sativa (L.) Crantz) na zona não-Chernozem da Rússia não é uma cultura tradicional. A expansão de áreas para esta semeadura de culturas é limitada pela falta de recomendações desenvolvidas sobre a tecnologia de cultivo. Esta é a base da pesquisa.

O objetivo deste experimento foi identificar as características da formação da produtividade de ouro de prazer e otimizar os principais elementos da tecnologia varietal (taxa de semeadura e tempo de semeadura) nas condições da região.

A pesquisa foi realizada na Universidade Agrotecnológica do Estado de Ryazan, nos campos experimentais da estação experimental agrotecnológica de Ryazan oblast, em solos de floresta cinza.
O objeto da pesquisa é o ouro-do-prazer, variedade Yubilyar.

Foi revelado que, para se obter um rendimento estável de ouro-de-prazer, é necessário ter pelo menos 420-440 plantas por 1 m² para a colheita, e 400-450 plantas por 1 m² são consideradas a densidade ideal. Aumentando a taxa de semeadura, acima de 8 milhões de unidades. das sementes / ha, levou à formação de uma cultura fortemente lotada, o que acabou por contribuir para a diminuição do rendimento e qualidade das sementes. A taxa de semeadura mais ideal para o ouro-do-prazer é de 7,0 milhões de sementes germinadas por hectare. A superestimação da norma para 8,0 milhões de peças / ha não aumentou significativamente o rendimento, mas levou a um consumo excessivo de sementes, deterioração da qualidade das sementes, risco de alojamento e doenças. O melhor tempo de semeadura em experimentos é a primeira década de maio.

Palavras-chave: Ouro-de-prazer, rendimento, tempo de semeadura, taxa de semeadura, zona não-Chernozem da Rússia.

Introduction

Interest in gold-of-pleasure (Camelina sativa (L.) Crantz) is also due to the high seed productivity, up to 2.5 t / ha, and the fact that seeds can contain up to 40-46 % of drying oil, the use of which is multifaceted (Evtishina et al, 2018; Semenova et al, 2007).

The production of vegetable fatty oils has undeniable economic advantages compared to the production of animal fats. In addition, while oil seeds processing, it is possible to obtain not only oil but some dietary proteins, the importance of which increases due to the acute problem of protein resource deficit in the world (Scherbakov & Lobanov, 2003).

The largest share in gold-of-pleasure oilseeds is polyunsaturated fatty acids, including linoleic (C 18:2) and α-linolenic (C 18:3). Their content reaches 20 and 40 %, correspondingly. The erucic acid content (C 22:1) is low and is 0.5-1.1 %. According to this indicator, the gold-of-pleasure oil corresponds to the requirements for food vegetable oils (not more than 5 %) (Scherbakov & Lobanov, 2003).

Gold-of-pleasure is a relatively cold-resistant plant. In the initial phases of growth and development, gold-of-pleasure tolerates spring and autumn short-term frosts (Scherbakov & Lobanov, 2003; Prakhova & Prakhov, 2012). One of the characteristics of gold-of-pleasure is the ability to assimilate nutrients that are difficult for other plants, which play a certain physiological role for gold-of-pleasure and can't be replaced by others.

A scientifically grounded set of crops in a crop rotation makes it possible to use land resources rationally, reduce energy costs for growing a unit of production, reduce the pesticide load, which allows improving the ecological state while preserving the beneficial entomofauna (Vinogradov et al, 2018; Shchur et al, 2016a; Shchur et al, 2016b; Khabarova et al, 2018; Mustafayev, 2010; Oreshkin et al, 2000). Gold-of-pleasure like many Criciferae give an opportunity for positive solution of questions like saturation of crop rotation under the sunflower and grain crops, preservation of the level of oil production and effective use of land.

Gold-of-pleasure in the Non-Chernozem zone is an unconventional crop, along with other oilseeds like flax, various kinds of mustard, bird rape and crambe. The expansion of areas for sowing is constrained by the lack of a system of seed production and developed recommendations on the technology of its cultivation. This is the basis of our research.

Methods

The research was carried out on the experimental fields of the agrotechnological experimental station of Ryazan State Agrotechnological University Named after P.A. Kostychev in Ryazan oblast. Gray forest soils are typical for the Non-Chernozem zone of Russia. According to the combination of morphological features and properties, they occupy a transitional position from sod-podzolic soils of the southern taiga subzone to chernozem soils of the forest-steppe.

The object of the research is gold-of-pleasure, variety Yubilyar. Thesoilisgray forest, weeds and biocenoses are total.

Variety Yubilyar is included in the State Register for the Russian Federation for cultivation zones for using as seeds. The mass of 1000 seeds is high. Seeds are reddish-brown. The rosette is strong. The leaf is green, there is no pubescence of the upper side and no dissection of the edge. The flower is yellow. The plant is medium high. Ripening time is early. The pod is pear-shaped. The tendency to form inflorescences when being sown at the end of the optimal spring planting season is very strong. The average yield of seeds is 21.4 dt / ha. The plants are 78 cm high. The vegetation period is 76 days. The fat content in seeds is 38.7 %. The erucic acid content is 3.2-3.7 %. According to the applicant, the plant was not affected by powdery mildew and fusariosis.

The soil of the experimental plot was characterized by an average phosphorus content, on average 15.2 mg / 100 g of soil and potassium 14.5 mg / 100 g of soil. On the average, for the layer 0-40 cm, humus content in the soil is 2.6-3.5 % and pH is 5.2-5.6. Accounting and observations during the vegetation period were carried out on the basis of the "Methodology of the state variety testing of agricultural crops" (1985). Mathematical processing of data was carried out by the method of variance analysis according to R. Fisher in the presentation of B.A. Dospekhov (1985) on the PC.

The field experiment had fourfold repetition. Factor A - seeding time: 1st decade of May and 2nd decade of May; factor B - seeding rates: 5; 6; 7; 8 million germinated seeds per 1 hectare.
Agrotechnical measures for gold-of-pleasure growing were in accordance with existing zone recommendations.
On a well-leveled autumn plowing and fallow areas after early-spring harrowing, other treatments before sowing can't be carried out. However, in some years, as experiment shows, wintering and perennial weeds can actively grow on these lands. In this case, it becomes necessary to perform some intermediate cultivation to a depth of 4 to 5 cm in the aggregate with harrows. Winter wheat was the annual predecessor. The preparation of the soil before sowing in the experiments included primary tillage and autumn plowing to the depth of the arable layer. In spring the soil had early harrowing, then 10-12 cm cultivation and 2-3 cm cultivation before sowing the gold-of-pleasure. When the second pre-plant cultivation, fertilizers were applied in a dose of N135P60K60(background). Ammonium nitrate, nitrophoska and potassium sulfate in terms of the active substance were used. The crop was planted to a depth of 1-1.5 cm, at the time established by the experiment time, in a single ordinary way. After sowing the mandatory packing with ZKKSh-6 took place.
For the destruction of cruciferous flea in the period from shoots to the appearance of four real leaves, insecticide treatment with Fastac 0.15 l / ha with an application rate of 250 l / ha took place. Harvesting was mechanized - Tarion-2010. The height of the cut was 6-8 cm.

Results and discussion

A short period of vegetation is one of the economically important biological characteristics of gold-of-pleasure. Rapid and even ripening of gold-of-pleasure allows the harvesting technique to be used, in mid-July, when the main crops are still in the phase of milky ripeness. The variety Yubilyar was characterized as drought-resistant for all years of investigations.

Weather conditions of 2015-2018 had significant influence on the plant phenophases during the years of investigations. The vegetation period of the crop in the experiment was 66-72 days.
Gold of pleasure consumes nutrients from the soil evenly enough throughout the growing season before flowering. After this phase, the need for nutrients increases, since during this period, the formation of pods, the formation of seeds and the accumulation of fat happen. In the maturation phase, the intake of nutrients decreases, and then ceases.

In the years of investigations, the crop sprouts were even: the first shoots appeared on the 7-8thday. The formation of real leaves of the gold-of-pleasure began in 5-6 days after emergence, and this was typical for all seeding rates. In the first 18-25 days the development of plants was rather slow. The beginning of flowering was noted 30-33 days after emergence and lasted for 12-18 days, depending on the variant.
Phenological observations of the crop growth and development have shown that increased seeding rates of up to 8 million seeds / hectare extended the vegetation period of the crop for 3-7 days, compared to the sowing rate of 5-6 million pieces / ha, pushing the harvesting time out. The rate of sowing also increased the duration and interphase periods by an average of 2-4 days.

Increase in seeding rates from 5.0 to 8.0 million pcs. of seeds / ha reduced the conservation of plants on average by 1.85-6.8 %. With the increase in the rate of seeding, the competition between the gold-of-pleasure plants increased and the crop loss also increased.

The results of the experiments show that in order to obtain some stable yield of the gold-of-pleasure, it is necessary to have at least 420 plants to be harvested, and 400-450 plants per 1 m2 are considered the optimal density. Further increase in the seeding rate, above 8 million seeds / ha, led to the formation of a rather dense crop, which ultimately reduced the yield and quality of the seeds.

The yield of gold-of-pleasure depended mainly on the following structural parameters: the density of crops, the mass of seeds and the number of seeds from a single plant (Table 1).

The mass of 1000 seeds is a varietal characteristic of different crops. Thus, gold-of-pleasure variety Yubilyar differed by larger seeds and on average this index was 1.7-1.9 g.The mass of 1000 seeds largely depended on the seeding rate and weather conditions during the seeding period. Similar tendencies were also obtained by other authors with other crops (Prakhova, 2013; Vasileva & Kertikov, 2007a; Vasileva & Kertikov, 2007b; Antipova & Vasileva, 2017). With the increase in the seeding rate, the mass of 1000

seeds did not decrease significantly, on average by 0.1 g between the variants.

Table 1 - Structure of the gold-of-pleasure yield, depending on the seeding rate and the seeding time, on average for 2015-2018

Seeding rate mln pcs / ha	Cropdensitybyharvest, pcs / m2	Seeds in 1 pod, pcs	Pods per 1 plant, pcs	Mass of 1000 seeds, g	Plant height, cm
1st seeding time – 1st decade of May					
5	361.4	11.9	262.7	1.94	71.8
6	424.4	11.6	253.5	1.93	75.4
7	484.8	11.4	232.6	1.80	79.2
8	540.9	11.2	208.7	1.73	79.9
2ndseeding time – 2nddecade of May					
5	394.1	11.7	239.1	1.79	70.8
6	461.3	11.4	219.7	1.74	73.4
7	521.9	11.4	208.0	1.69	75.0
8	588.5	11.2	191.9	1.63	77.3

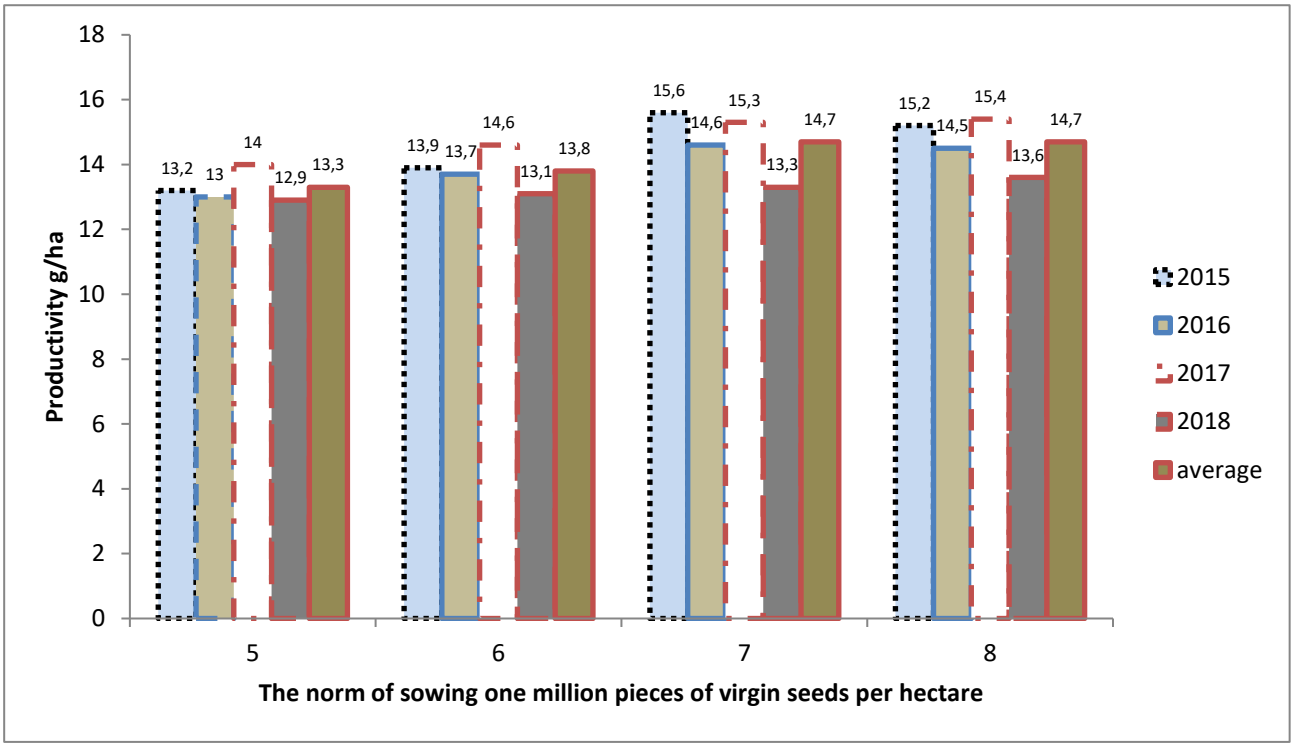
The height of the crop differed in the years of the investigation and depended on weather conditions of the year, the seeding rates and averaged 70.8-79.9 cm. In 2016, the height of the plants was lower - 61.7-77.1 cm and in 2017 it was high - 76.0-92.1 cm. The difference in the years of the investigation was 14.7-16.0 cm.

Weed infestation of crops depended on moisture of the growing season, secondary tillage, seeding time and seeding rates. In 2015-2018 were favorable for weeds. Therefore, the crops of gold-of-pleasure were very weedy. Gold-of-pleasure is a crop that actively suppresses weeds, especially in the second half of the growing season. Gold-of-pleasure agrocenoses is capable of self-regulation due to internal cenotic competition. Since the flowering phase, the number of weeds began to decline, although their mass continued to increase to the phase of milky ripeness. At the same time, the species composition of weeds did not change significantly.

Reducing the seeding rate led to some increase in the degree of weed infestation of crops. The maximum number of weeds was observed at a low seeding rate (5.0 million pieces / ha). When the seeding rate was increased, the contamination was reduced in all variants of the experiment. A low number of weeds was observed at a seeding rate of 7.0-8.0 million pieces / ha. So, by the time of registration of weed infestation, the variants with a seeding rate of 7-8 million seeds / ha had lost weeds, which apparently did not survive the competition with the crop plants.

The number of perennial weeds, according to the years of investigations, was at the same level in the range of 3.0-4.3 pcs / m2 and was practically independent of seeding rates and seeding time.

Productivity is mainly characterized by the variability and interconnection of various characteristics and properties. High crop yield is closely related to the nature of plant growth and development, which is associated with the creation of the most favorable conditions for them. Gold-of-pleasure yield in the experiments depended on weather conditions during the growing season, as well as on the application of the agricultural techniques being studied (Fig. 1).



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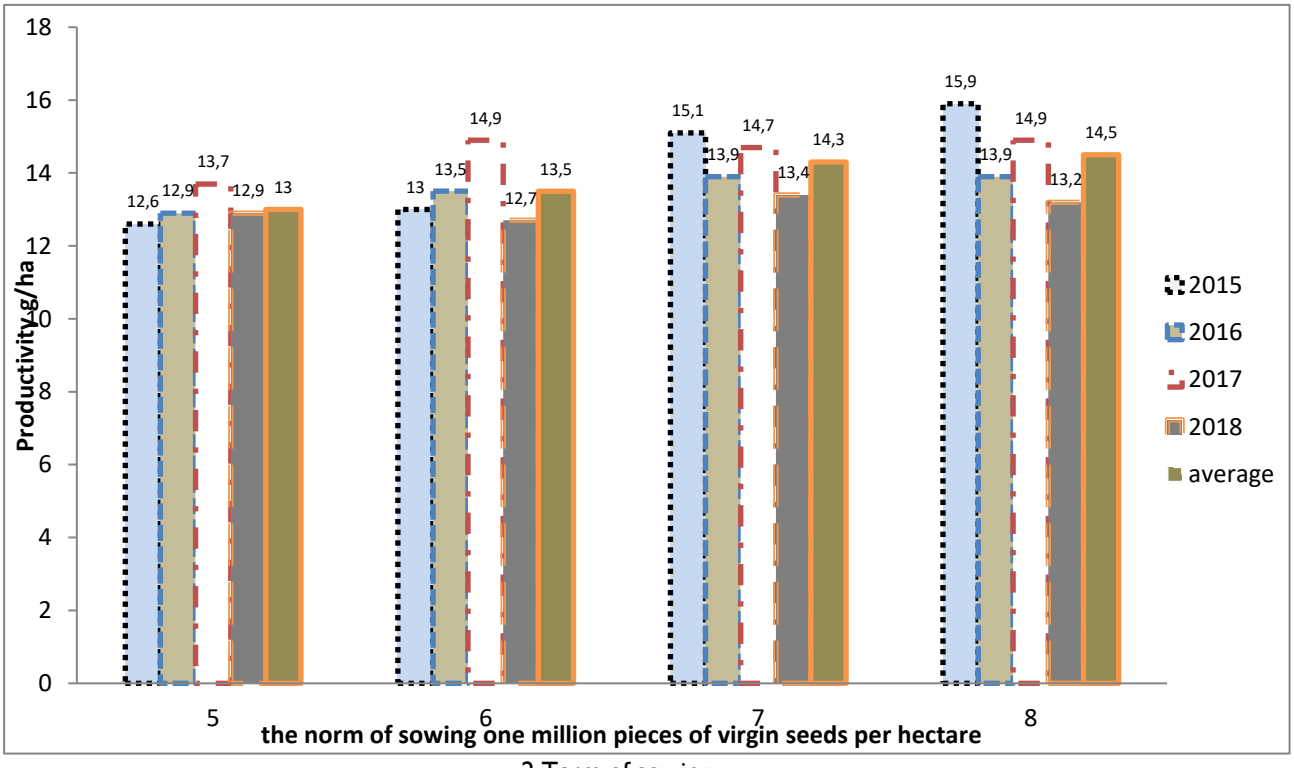

2 Term of sowing

Figure 1 – Gold-of-pleasure yield depending on seeding time and seeding rates, dt/ ha.

The seeding rate had significant influence on the crop yield. The maximum number of seeds was obtained in crops with a seeding rate of 7.0; 8.0 million seeds / ha (14.7 dt / ha) of the first sowing season, in the first decade of May.

Unlike other oilseeds, gold-of-pleasure ripened evenly, it was easily threshed and it was convenient to harvest it by direct combining. In the experiments, the harvest was started in the phase of full economic maturity of seeds, when the lower pods grew brown and the seeds in them solidified.

The crop features affect not only the quantity of products received, but also its quality.

The protein content in the gold-of-pleasure seeds in the years of investigations was 25.1-31.3 % (Fig. 2).

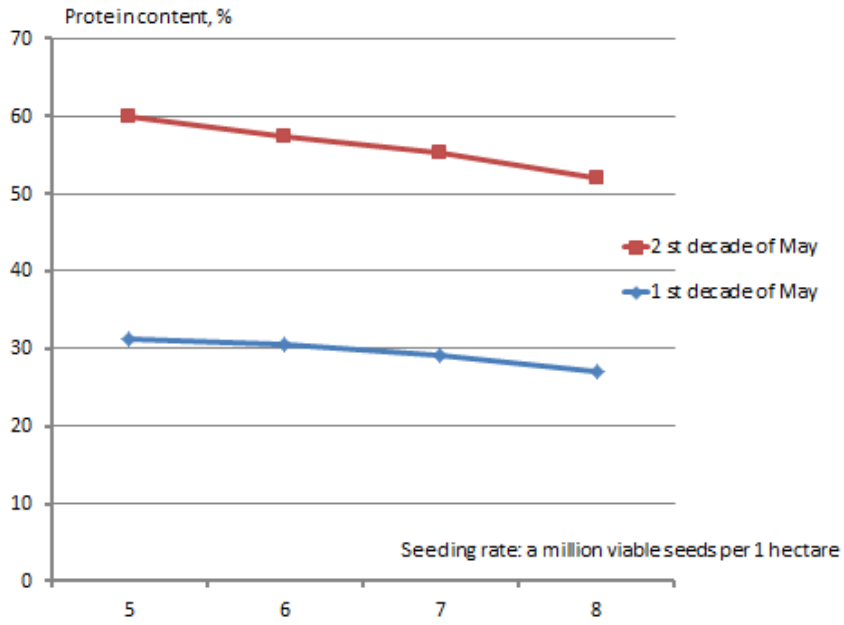

Figure 2 – Protein content in gold-of-pleasure seeds depending on seeding time and seeding rates

It should be noted that when producing golf-of-pleasure vegetable, the protein content is a secondary feature. It turns into cake or meal and has a value only in fodder production.

For oilseeds, the main qualitative parameter is the oil content of the raw materials, as well as the fractional composition of the oil. The process of fat formation in oil plants largely depended on climatic conditions and technology elements - the seeding period and the seeding rate.

In the experiment, the oil content in the seeds was practically independent on the seeding rate and amounted to 36.1-37.7 %. The increase in the seeding rate to 8 million pieces of seeds per hectare decreased oil in seeds a little (no more than 1.6 %), which can be explained by some decrease in the illumination of crops and the intensity of photosynthetic processes and oil formation.

At the same time, the first period of seeding the gold-of-pleasure resulted in some increase of the fat content in all variants of the studies, on average for each variant of the seeding rate, by 2.8 % higher (38.3-37.5 %) than in the second seeding period. Perhaps the greater accumulation of fat in seeds at the first seeding time can be explained by the large growing period of the crop, as a result of a longer period of oil accumulation.

For the studied crop, in terms of the fatty acid composition of the gold-of-pleasure oil, a low erucic acid content of 0.8-1.4 % was typical, which corresponded to medical requirements for food oil, although the content of eicosenic acid was high. We note that because of the high content of linoleic acid, the oil is unstable to oxidation and has a specific taste, but in Russia it has been a preferred food vegetable oil for a long time (Shmakov et al, 2008).

One can see that in studies, the average density of the gold-of-pleasure oil is 930 kg / m3 (at 150° C), the refractive index is 1.476 (at 200° C) and the pour point is minus 17° C.

The use of such products of gold-of-pleasure processing as cakes and meals was limited by the presence of substances in them causing poor digestion of animals (Shmakov et al, 2008). We can note that the new varieties of gold-of-pleasure have a low content of glucosinolates in seeds and do not contain erucic acid in oil. Therefore, the oil cakes (meal) obtained from seeds can be more widely used in feed mixtures for ruminants and poultry (Table 2).

Table 2 - Food value and chemical composition of the gold-of-pleasure cake

Parameter	Content, %	Parameter	Content, %
Crude protein	35.10	Lysine	0.86
Crude fiber	8.55	Leucine	3.01
Crude fat	16.12	Phenylalanine	1.80
Moisture	6.50	Arginine	3.52
Ash	2.34	Glycine	2.44
Glutamic acid	8.55	Threonine	1.27
Asparagic acid	4.01	Histidine	0.66

According to the results of biochemical investigations the gold-of-pleasure cake is considered suitable for feeding. Similar data lead and other researchers (Los et al, 2017; Lopatina, 2016 ; Gordeeva, 2016).

Conclusion

Summing up the above, we should note that the optimal seeding rate for the gold-of-pleasure is 7.0 million germinated seeds per hectare. The overestimation of the norm to 8.0 million pieces / ha did not substantially increase the crop yield, but resulted in excessive seed consumption, seeds quality deterioration, and the risk of crop lodging and diseases. The best time for seeding in experiments is the first decade of May.

The oil content in gold-of-pleasure seeds in the experiment was practically independent of the seeding rate (36.1-37.7 %) and depended on the seeding period. The higher oil content was at the first time of crop sowing. It should be noted that the total (gross) oil harvesting was mainly dependent on the seed productivity of the crops, and to a lesser extent on the oil content of the gold-of-pleasure seeds.

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