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The Substantiation of The Seeding Rate of Spring Rape in The Conditions of Unstable Moistening of Forest-Steppe of The Middle Volga Region.

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ABSTRACT

In the conditions of Bessonovka Department of LLC "Telegino-agro" of Penza region in 2013-2015 was conducted a research on the variety of spring rape Geros to determine the optimum seeding rate for the formation of highly productive agricultural lands in the conditions of forest-steppe of the Middle Volga region. 1.5 - 4.0 million pieces/ha of germinating seeds were sown with an interval of 0.5 million. Weather conditions in the years of research were various, but the most favorable was formed in 2013. The increase in seeding rate from 1.5 to 4.0 million PCs./ha had no significant effect on the completeness of descents, which is the average for the study years was in the range of 76.0 per cent. This decreased the preservation of plants for harvest (84,6 - 75,4 %), branching (5.0 - 3.9 pieces/plant), the number of pods (26,2 - 17.6 PCs), the number of seeds in them (18.5 - 11.8 PCs) and the mass of 1000 seeds (2,68 - 2.35 g).Canola crops formed an optimum leaf surface area of 33.6 and 39.5 thousand m^2/ha during the budding phase at seeding rates of 2.0 and 2.5 million of germinating seeds per hectare. With the increase in seeding rate from 1.5 to 4.0 million seeds per hectare in a period of "rosette leaves – green pod" the photosynthetic potential increased from 932,9-2083,5 thousand m^2 per day./ha, the net productivity of photosynthesis decreased from 3,57 to 3.00 g/m2 per day.The optimum density of productive stalks of rapeseed (118,6-146,0 pieces/m2) and the highest yield of oilseeds (1.40 and 1.45 t/ha) was observed when sowing of 2.0-2.5 million of germinating seeds per hectare. The maximum yield of pure vegetable oil (0,59 and 0,61 t/ha) provided the same standards.

Keywords: seeding rate, hydrothermal coefficient, germination, preservation, photosynthesis, yield, oil, protein.

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INTRODUCTION

The main raw materials for the production of vegetable oils are oilseeds, which resources define the volume of production of vegetable oils and other products.

The leading place among them on the world stage is soy (about 50%), cotton (13%), rapeseed (12%), peanuts (10%) and sunflower (10%).

The situation is somewhat different with the production of oilseeds in Russia, where the main oilseed crop is sunflower. It accounts for over 80% of the total produced oilseeds. There is an opinion that in the coming years, the raps can compete with the basic oil culture of Russia – the sunflower, because it is able to give stable yields under more severe climatic conditions, improve soil structure, be a source of green mass used for feed purposes and as a green manure fertilizer, and is an excellent bee plant [4].

Rape seeds contain 40,1-48,0% of oil, 21.0-32.4 % of protein substances, 6.1-8.9% of the fiber, 4,3 - 5.2% of minerals. Rapeseed oils containing polyunsaturated fatty acids (linoleic acid (ω-6) - 22.4%, linolenic (ω-3) about 8%) meet the requirements of the Institute of nutrition of RAMS to a greater extent than sunflower, which belongs to the most consumed vegetable oils in the Russian Federation.

Secondary products of oil production (oilcakes and meals) are used for the production of vegetable protein for feed and food purposes, as well as for animal feed [6].

The increase in the production of vegetable oil and feed protein is a key problem in Russia. Every year, due to unbalanced on vital components feed rations, huge amounts of animal products are not supplied, and the shortage of their own produce, including vegetable oil, is covered by importing them [9].The food security doctrine of the Russian Federation provides a significant increase in the weight of domestic agricultural products and foodstuffs in the total volume of commodity resources of the internal market [10]. In connection with the economic sanctions the problem should be addressed comprehensively, including through the significant expansion of the acreage of cabbage crops, primarily rapeseed.

Area of rapeseed in Russia in 2015 has reached 1380,0 thousand hectares [8], in Penza region – to 11.0 thousand hectares, which amounted to 1.0% in the structure of sown areas of agricultural crops [7]. The steady increase in the gross yield of rapeseeds is the result of strong demand for raw materials from processing enterprises. In addition, the cultivation of rapeseed stimulate the biodiesel producers. Scientific institutions have created high-yielding varieties for all rape-sowing regions, zonal technologies of the culture cultivation are also being developed [2].

In this regard, the aim of the research was to determine the optimum seeding rate of spring rape for the formation of highly productive agricultural lands in the conditions of forest-steppe of the Middle Volga region.

MATERIALS AND METHODS

Experimental work was carried out in 2013-2015 in the terms of Bessonovka Department of LLC "Telegino-agro" of Penza region in a steam link of a crop rotation on leached loam black soil with humus content in the topsoil of 6.9%, mobile phosphorus - 86-89 and exchange potassium – 127-140 mg/kg soil, pH salt - 5.3, the amount of absorbed bases – 41,0-44,0 mg-EQ./100 g of soil.

The object of research – spring rapeseed Geros (Brassica narusoleiferaannua, Metzger) included in the state register on the Middle Volga(7) region. The grade is of 00 type. Six seeding rates of 1.5 to 4.0 million PCs./ha of germinating seeds at intervals of 0.5 million were studied.

The repetition of the experience is fourfold. The placement of plots is systematic , the plot area is 120 m^2. The predecessor is winter wheat. The method of sowing is rowed with spacing of 15 cm. The seeding depth is 2-3 cm. All the seeds were treated before sowing with a protectant insecticide with systemic action (D. V. thiamethoxam 350 g/l).To combat the pests and weeds in the phase of rosette leaves there was done a spraying with a tank mixture consisting of the contact action insecticide (D. V. alpha-cypermethrin 100 g/l) and

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herbicide (D. V. clopyralid 300 g/l). In the budding phase there was used the insecticide against rapeseed blossom weevil and flea beetles.

THE EXPERIMENTAL PART

The potential productivity of the culture depends primarily on its biological characteristics and climatic conditions (temperature and moisture supply of plants). The meteorological conditions of the study period differed both in years and in comparison with average perennial indicators. The most favorable was 2013 (figure 1), which growing period can be characterized as humid (hydrothermal coefficient – 1,2). A major role in the accumulation of a crop has played precipitation of late July – early August, as they occurred in the period of plant development, corresponding to the ripening phase, but their abundance (124,0 mm) during green pod - ripening phase delayed the vegetation period.

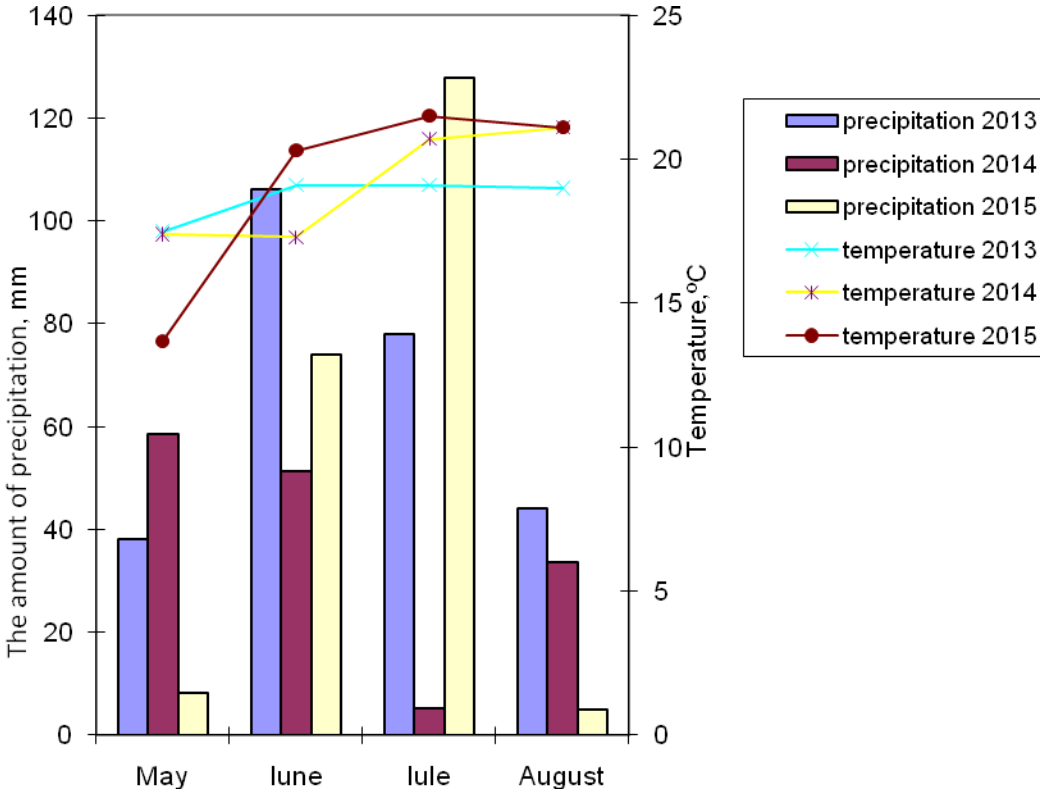

Figure 1 – Weather conditions of vegetation periods 2013-2015

In 2014, during the growing season of rape there was 2.3 times less precipitation than in the same period of 2013, with the sum of positive temperatures 2104,1°C. The deficit of moisture and hot weather during flowering and seed maturation (hydrothermal coefficient – 0,04-0,30) had a negative effect on the fruit and seed formation.

In 2015, over the growing period of rape there were 271,6 mm of rainfall with the sum of positive temperatures 2388,0 °C, and in may the average daily air temperature was at the level of 13.7 °C, and precipitation was 5.2 times less than normal, which prolonged the process of germination of rape seeds up to 30 days (hydrothermal coefficient – 0.3 mm).

The management of the productivity elements formation during the growing season is closely connected with the ability to obtain a complete, friendly and well-developed seedlings in time, as the level of productivity is 50% dependent on the density of productive plant stand [5]. In addition, germination is the most important factor in the survival of plants.

The fullness of seedlings in 2013 was almost the same – 84,1-85,0%, the number of plants ranged between 126,0-338,4 pieces/m^2. In 2014 and 2015 some part of the seeds in the wet soil sprouted, but for the further development there was not enough moisture, and therefore, due to the increased sensitivity of small grain varieties to the draining of the topsoil, the seedlings did not appeared.As a result, the field germination in 2014 was 73,1-74,0%, the density of seedlings - 110,1-295,6 pcs / m^2, in 2015 - 70,8-71,8% and 114.5 -305.7 pcs. / m^2, respectively. The average 3-year field germination was within 76,3-76,5%.

During the period of rape growing there occurs partial destruction of plants as a result of self-thinning, damaging by pests, weeds and diseased. The more the crops are thickened, the more the degree of thinning is. On average, the safety of plants amounted to 75.4%,the decrease in seed rate 2.5 times increased it by 6.2% during the years of study at a seeding rate of 4.0 million of germinating seeds / ha. The density of plant stand before harvesting ranged from lesser to greater seed rate within 93,5-239,8 pcs. / m^2.

The level of photosynthetic activity of plants can be judged by the intensity of accumulation of the dry matter of plants that is associated with the magnitude of the leaf surface and net photosynthetic productivity [3]. The reduction of leaf surface per plant is due to the changes in the size and the number of leaves. However, increasing the seeding rate increases plant stand density, and thus there is an increase in the leaf surface per hectare.

During the research years the assimilative surface in the phase of rosette leaves was at the level of 14.1-33.2 thousand·m^2 /ha with the increase in seeding rate from 1.5 to 4.0 million seeds per hectare. The plants reached the maximum leaf area (28,0-57.7 thousand·m2/ha) in the budding phase due to their greater foliage. With the growth of the stem during the flowering phase the leaf mass is reducing, the number of flowering shoots is increasing, which leads to a decrease of leaf surface index to 22.3-49.4 thousand·m^2 /ha.In the phase of green pod the assimilation surface was minimal, as the leaves fell off after drying, and on average it was 8,4-19,6 thousand. · m^2 / ha.

The photosynthesis processes depend not only on the leaf surface, but also on the duration of the functioning of green leaves. The longer the assimilation surface of the leaves lasts, the more the organic matter is created in crops.

A positive impact on photosynthetic potential (PP) of spring rape had a thickening of the agrocoenosis. For example, during the "leaf rosette – budding" phase, the FP increased from 356,9 thousand to 754,3·m^2·day./ha, in the phase of "budding – flowering" from 214,9 to 525,1 thousand·m^2·day./ha. The phase of "flowering – green pod" is longer (25 days) so the plants accumulate more energy from the sun, their PP is higher – 361,1-804,1 thousand·m^2·day./ha.

During the three years of research in the leaf rosette stage with increasing seeding rate the net photosynthetic productivity (NPP) decreased from 2.30 to 1.79 g / m^2 • day, as in the thickened crops there occurs inter-shading of plants. Then the NPP value increased and was at a high level until the leaf fall. In the budding phase, when photosynthetic activity prevailed above the level of consumption of the photosynthesis products by plants, the NPP rate was the highest (4,25-3,75 g / m^2 • day). In the flowering stage due to the reducing of the leaf area the increments of dry matter decreased 1.40 times compared to the previous definition. At the end of the growing season, when there was the formation of pods and seeds, the net photosynthesis productivity was minimal and was at the level of 1,07-0,81 g / m^2 • day.

The productivity of seeds determines the optimal ratio of the number of plants per 1 ha and productivity of each plant [5]. The elements of the crop structure are multifactorial and dependent both on the technology of cultivation and on external conditions [1]. In this regard, in the constantly changing environmental conditions all agronomic rapeseed cultivation techniques should be directed to the maximum formation of productive branches, pods and seeds at their highest quality.

When sowing 1.5 million. germinating seeds of rape / ha, at each plant there formed 5.0 branches of the first order. Increasing the seeding rate led to the thickening of crops and reducing of branching. When sowing 4.0 million. germinating seeds / ha, the number of branches of the first order was reduced to 3.9 pcs. / plant. At the same time the number of pods per plant (from 26.2 to 17.6 pcs.) and number of seeds per pod (from 18.5 to 11.8 pcs.) reduced.

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An important feature that determines the productivity of the plant is the weight of 1000 seeds, which decreased with an increase in seeding rate from 2.68 to 2.35, the largest seeds during the years of research have been formed at a rate of 1.5 million sowing seeds / ha, (2.68 g). When sowing 2.0-2.5 mln. of seeds / ha, the weight of 1000 seed was 0,05-0,12 g less. However, this decrease is compensated by the number of surviving plants before harvesting.

The optimum plant density is particularly important since it greatly affects the fineness and evenness of seeds. Increasing the plant stand leads to a decrease in the number and size of generative organs on the plant, resulting in the productivity sharp decrease. Thus an increase in the seeding rate of up to 4.0 mln.pcs. / ha, reduced the yield by 0,19-0,24 t / ha, and it amounted to 1.21 t / ha (figure 2). However, in sparse crops of rape the individual productivity of plants at a rate of 1.5 million. germinating seeds/ ha, does not compensate the excessive thinning of crops and also leads to lower yields up to 1.25 t / ha. The harvesting of seeds at the level of 1,40-1,45 t / ha at a sowing rate of 2.0-2.5 mln. seeds/ ha, exceeded the value of this indicator both in the a more and in the less thickened crops.

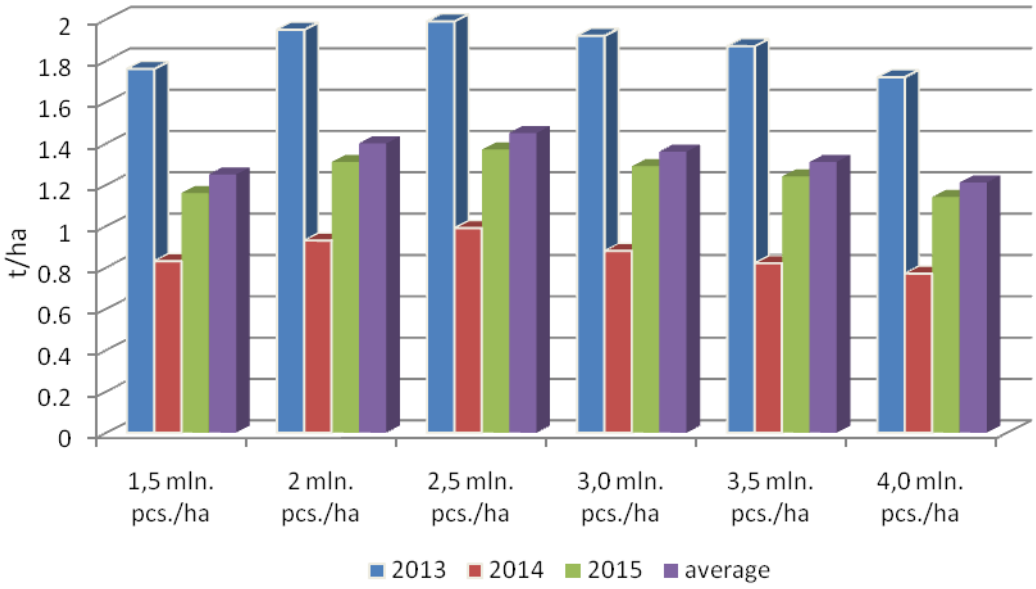

Figure 2 – The yield of spring rapet / ha
(MED_{05}: 2013 - 0.052 t / ha; 2014 - 0.055 t / ha; 2015 - 0.45 t / ha)

Between the number of plants per 1 square meter and the elements of seed production there is a strong negative correlation: (r = -0,92) y = 5,21974-0,0110166x; (R = -0,99) y1 = 33,9858-0,0810911x; (R = -0,99) y2 = 23,3063-0,0468393x; (R = -0,97) y3 = 3,00767-0,00215717x; (R = -0,98) y4 = 2,04839-0,00698734x where y - the number of first-order branches, pcs / plant .;. y1 - the number of pods per plant, pcs .; y2 - the number of seed per pod, pcs .; y3 the mass of 1000 seeds, g; y4 - the mass of seeds per plant, g; x - the number of plants, pc / m2.

The external growth conditions affect not only the processes of growth and formation of plants, but also the qualitative characteristics of the products. The determining factor of the oil content of spring rapeseed was plant density: the smaller the seed rate, the greater the accumulated oil in the seeds. With an increase in the seeding rate its content decreased from 41.18 to 40.95%. At the same time protein content simultaneously increased from 28.04 to 28.61%.

The highest yield of pure plant oil per unit area (0.59 and 0.61 t / ha) provided the seed rate of 2.0-2.5 mln. pcs. / ha. Their increase (4.0 mln. pcs./ ha) and decrease (1.5 mln. pcs. / ha) led a reductionin the value of this indicator to 0.51 and 0.53 t / ha.

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CONCLUSIONS

Thus, the cultivation of spring rape for oilseeds may be one of the most important ways to increase the production of good quality vegetable oil and feed protein. When thickening of crops there is an increase of leaf surface per hectare. The greatest area of leaves the plants have reached in the phase of budding and with an increase in seeding rate from 1.5 to 4.0 mln seeds per hectare, the area was 28,1-57,7 thousand. · m^2 / ha. They formed the optimum photosynthetic potential (1205,2-1435,6 thousand m2 per day./ha) when sown with a seeding rate of 2.0-2.5 million of germinating seeds per hectare. The net productivity of photosynthesis during the period of "rosette leaves – green pod" with the increase in seeding rate decreased from 3,57 to 3.00 g/m^2•day. Crops with larger size and a physiologically active foliage provide the highest productivity of agrocenosis of spring rape, and the higher productivity (of 1.40 and 1.45 t/ha) was obtained when seeding rape with a seeding rate of 2.0-2.5 million of germinating seeds per hectare.

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