Spring vetch Mega mixed crops productivity at different seeding rates

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Abstract. Spring vetch is the most well-known annual legume forage crop. With the cultivation and application of various methods and terms of harvesting crops, not only for green fodder and hay, but also for haylage, silage, grain-growing, the requirements for the quality of the mown mass were reduced, but the need to create non-growing crops suitable for machine harvesting increased. In the gene pool of spring vetch, there are no forms with a strong, resistant to lodging stem, so the only way to solve the problem is to support the supporting culture. According to the results of research for two years, for the cultivation of vetch for green mass, the best option is vetch mixed with oats with a seeding rate of 1.2 million vetch, oats of 3 million germinating seeds per hectare. For grain cultivation, the best option is a mixture of vetch and oats with a seeding rate of 1.8 million and 3 million germinating seeds, respectively. For obtaining a grain crop for seed-growing purposes, the best option for two years of research is vetch mixed with spring wheat with a seeding rate of 1.8 and 3 million germinating seeds per hectare.

1. Introduction

In 2020, a new variety of spring vetch "Mega" was added to the State Register of Breeding Achievements of the Russian Federation. The variety was registered in the State Register of Protected Breeding Achievements in 2020 and was recommended for cultivation in the North-Western, Central, Volga-Vyatka and Central Chestnut soils regions of Russia.

The most important section of research on mixed crops is the determination of optimal seeding rates of the spring vetch in its pure form and in mixtures with other crops reliably forms a green mass in various meteorological conditions [1, 2]. In the mixture with various crops, it is an undoubted participant in the green conveyor, it is widely used in intermediate crops (mowing, re-sowing, stubble). In connection with the lodging of spring vetch in pure sowing, it is necessary to use supporting crops: oats, spring wheat, barley, etc.

According to many authors, mixed crops contribute to a more economical, less costly use of mineral fertilizers and herbicides to control weeds [4, 5]. Thus, the production of legumes reduces the application of nitrogen mineral fertilizers for the main crops of crop rotation by 15-20%. After their harvesting, 2.3-6.7 t/ha of root and crop residues remain, which contain nitrogen, potassium, and phosphorus that are easily available for subsequent crops.
In the search for the optimal method for obtaining spring vetch seeds, we studied different seeding rates of vetch and the cereal component in mixed sowing with the decrease in the seeding rate of cereals [6, 7]. It is proposed to consider the influence of vetch different seeding rates and partially reduced norms of the cereal component on the degree of lodging, the amount of grain mixture yield and the yield of vetch grain.

2. Materials and methods

The results of mixed crops with different seeding rates of the zoned variety of spring vetch Mega with varieties of cereals: spring wheat, oats and barley in terms of grain yield and green mass are considered. The research objectives were to identify the reaction of the spring vetch Mega variety with oats 28H2369, spring wheat Rima and barley Moskovsky 86, to evaluate the number of mixtures, to determine the optimal ratio of components [8, 9].

Spring vetch Mega. The originator is the Federal Research Center “Nemchinovka” (FRC "Nemchinovka"). Botanical features. Type: Vicia sativa, a type of immaculate (immaculata). The variety is medium-early, with a growing season of 90-100 days. The optimal temperature for seedlings is 12-14 °C, for filling grain - 18-20 °C. The sum of active temperatures above 10 °C is 2000-2200 °C. The seeds are of medium size, with simultaneous maturation, which facilitates harvesting and seed production. The stem is medium-sized (100-150 cm), branched, the leaves are large with 16-18 pairs of leaflets. The variety has a sign of physiological non-germination, forms an equalized stem, which does not lie when sown with medium-ripened oat varieties. Economically valuable properties. The variety has a high yield potential in mixed crops with oats and barley (green mass - 38-41 t/ha, including vetch 20-21 t/ha, seeds up to 3.5 t/ha, including vetch 2.0 t/ha). It does not lie down in mixed crops, is resistant to drought and waterlogging. It is highly resistant to peronosporosis, root rots, etc. diseases.

The oat line 28N2369 was bred in the laboratory of oat breeding of the FRC "Nemchinovka" as the result of crossing the lines 77h1944 × 15h1880 (Bulany). It is a kind of mutic. It has been studying at the FRC since 2016. It matures five days later than the standard Steed. It is resistant to dust smut damage, lodging and grain shedding. The line is coarse-grained, with a good grain filling, stable in yield and protein content in the grain. During the years of research on grain yield, the line exceeded the Yak standard by 2 t/ha. Weight of 1000 seeds 36-47 g. It is promising in use for grain-foraging purposes. In contrast to the varieties of Jacob and Buckskin does not displace the legume component of the stand. It is suitable for cultivation with peas and vetch to produce green mass and seeds.

Spring wheat Rima. The originator is the Federal State Scientific Institution "Ryazan Research Institute of Agriculture" in conjunction with FRC "Nemchinovka". Botanical features. It belongs to the variety of lutescens. The bush is intermediate, the straw is hollow, there is no leaf pubescence during the tillering period. The spike is pyramidal, white, with a strong waxy coating, with short spinous processes. Spikelet scales with strongly pronounced nervation, the tooth is short, slightly curved, the shoulder is of medium length, rounded-straight. the grain is red, egg-shaped, with a groove of medium depth, the weight of 1000 grains are from 35 to 42 g. Economic and biological features. The variety is medium-ripe, matures in 75-95 days. It is resistant to lodging, plant height 93-109 cm. It is much less affected by brown rust, powdery mildew.

Spring barley Moskovsky 86. The originator is FRC "Nemchinovka". It belongs to the variety of nutans. The bush is intermediate. The waxy coating on the hose of the flank leaf is strong, on the spike is weak. The ear is semi-erect, cylindrical, loose. The pubescence of the main grain bristle is long. The grain is rounded, of medium size, with an undisturbed ventral groove. The weight of 1000 grains are 45-52 g. It is a medium-ripened variety, the growing season is 75-90 days. It is resistant to lodging. It has good adaptability and is suitable for cultivation on soils of various types of cultivation. But for the full realization of the yield potential, land that is well supplied with nutrients and moisture is preferred. It is relatively resistant to leaf-stem diseases.

The research was carried out in 2019-2020 in the selection crop rotation No. 2 on sufficiently cultivated loamy soils. Under cultivation before sowing, Azofoska was introduced at the rate of 48 kg
of active substance per 1 ha. The experiment was laid in 4-fold repetition with the seeding rate in mixtures of 1.2, 1.5 and 1.8 million of germinating seeds per 1 ha of spring vetch and 3 million germinating seeds per 1 ha of the cereal component. In its pure form, spring vetch was sown with a seeding rate of 2.4 million germinated seeds per 1 ha and 3 million of germinating seeds. Sowing was carried out in early May, with a SSK - 6-10 seeder, the area of the plot is 10 m² in 4-fold repetition. The harvesting was carried out with the full maturation of the plants by the Xege-125 selection combine.

The phenological observations, measurements and records were carried out according to the Methodology of the State Commission for Variety Testing of Agricultural Crops (part 2, 1989).

The growing season for the years of research (2019-2020) is characterized by contrasting weather conditions. The sum of active temperatures for the study period (May-August) in 2019 exceeded the long-term average (17 °C) by 1.5 °C, while in 2020 it was lower by 2.8 °C and amounted to 14.2 °C. There were also significant differences in precipitation. If in 2019, the lack of precipitation during the growing season was 128 mm less than the average long-term amount (318 mm) and amounted to 190.2 mm, then in 2020, on the contrary, this indicator was higher than the long-term average by 144 mm and amounted to 462 mm. The weather conditions over the years of research significantly influenced the results.

3. Results and discussion
The results of studies on spring vetch Mega mixed crops with cereals are shown in Table 1, 2.

Table 1 shows that due to arid weather conditions in 2019, the average plant height of both spring vetch and cereal crops was low and varied within 50-90 cm, which affected the low yield of green mass.

In the variants with spring wheat, in comparison with other spring crops, the yield of green mass was low. A high indicator only with a seeding rate of 1.2 million germinating seeds per 1 hectare and is 177 dt/ha.

The oat line 28H2369 in 2019 turned out to be the best component for cultivation with spring vetch for green mass. The indicators for three different seeding rates exceeded all other options. The high yield of the green mass of 350 dt/ha was with a seeding rate of 1.8 million germinating seeds per 1 ha.

According to the indicators of the spring vetch grain yield in the mixture, it is worth highlighting the variant with spring wheat Rima with a seeding rate of 1.2 million germinating seeds per 1 ha, which amounted to 21.2 dt/ha. In all other variants, the indicator did not reach 20 dt/ha, compared to 2020.

A high indicator of the cereal component is noted in the variants with oats and barley with a seeding rate of 1.2 million germinating seeds per 1 ha is 3.1 and 2.1 pcs, respectively, and in single – barley species sowing - 2.4 pcs.

In contrast to 2019, 2020 was more rainy, which also affected the results of the research.

In terms of the spring vetch grain yield of in the mixture in 2020, the experience with Moskovsky 86 spring barley and Rima spring wheat in variants with a seeding rate of 1.8 million germinating seeds v per 1 ha., where the yield was 34.5 dt/ha and 31.3 dt/ha, respectively was distinguished. In the variants with the oat line 28H2369, the grain yield was lower than 27.5 dt/ha (with a seeding rate of 1.8 million germinating seeds per 1 ha), but the yield of the green mass was significantly higher than that of all other variants of 643 dt/ha (1.2 million germinating seeds per 1 ha).

As can be seen from the data for two years of research, all the variants of mixed crops for the total yield of grain and green mass exceeded the yield of a single-species crop. The exception was the option with oats (line 28H2369) in its pure form in 2020, showing high results in grain yield of 75.7 dt/ha and green mass of 702 dt/ha.

The height of plants allocated one-species planting of spring vetch with the index of 135 cm and lateral development of 1.6. One-species seeding of spring wheat with a plant height of 108 cm was allocated for lateral development, which was 2. You also need to note the productivity of oats in a monospecific crop, which was 2.3. In mixed crops, plant height grain crops allocated the options with
spring wheat ranging from 112 to 119 cm, at height of vetch options 78-85 cm. In the rest of the agricultural experience, the height of the vetch mixtures ranged from 57 to 109 cm.

**Table 1.** Results of Mega spring vetch mixed sowing with varieties of cereals, 2019.

| Variants                                                                 | Average height, cm | Lateral development, pcs | Green mass, dt/ha | Grain yield, dt/ha |
|-------------------------------------------------------------------------|--------------------|--------------------------|-------------------|--------------------|
| Vetch Mega (2.4 million germinating seeds per 1 ha)                      |                    |                          |                   |                    |
| Wheat Rima (5 million germinating seeds per 1 ha)                        |                    |                          |                   |                    |
| wheat (3 million germinating seeds per 1 ha) + vetch (1.2 million germinating seeds per 1 ha) | 60                 | 2.0                      | 175               | 22.9              |
| wheat (3 million germinating seeds per 1 ha) + vetch (1.5 million germinating seeds per 1 ha) | 69                 | 1.2                      | 125               | 14.2              |
| wheat (3 million germinating seeds per 1 ha) + vetch (1.8 million germinating seeds per 1 ha) | 70                 | 1.2                      | 76                | 9.1               |
| Oat 28H2369 (5 million germinating seeds per 1 ha)                       |                    |                          |                   |                    |
| oat (3 million germinating seeds per 1 ha) + vetch (1.2 million germinating seeds per 1 ha) | 85                 | 1.5                      | 390               | 34.2              |
| oat (3 million germinating seeds per 1 ha) + vetch (1.5 million germinating seeds per 1 ha) | 86                 | 3.1                      | 285               | 36.9              |
| oat (3 million germinating seeds per 1 ha) + vetch (1.8 million germinating seeds per 1 ha) | 87                 | 1.5                      | 255               | 37.3              |
| Barley Moskovsky 86 (5 million germinating seeds per 1 ha)               |                    |                          |                   |                    |
| barley (3 million germinating seeds per 1 ha) + vetch (1.2 million germinating seeds per 1 ha) | 65                 | 2.4                      | 210               | 25.2              |
| barley (3 million germinating seeds per 1 ha) + vetch (1.5 million germinating seeds per 1 ha) | 60                 | 2.1                      | 185               | 16.6              |
| barley (3 million germinating seeds per 1 ha) + vetch (1.8 million germinating seeds per 1 ha) | 64                 | 1.8                      | 135               | 18.6              |

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### Table 2. Results of Mega spring vetch mixed sowing with varieties of cereals, 2020.

| Variants | Average height, cm | Lateral development, pcs | Green mass, dt/ha | Grain yield, dt/ha |
|----------|--------------------|--------------------------|-------------------|-------------------|
| Vetch Mega (2.4 million germinating seeds per 1 ha) | 135 | 1.6 | 456 | 33.8 |
| Wheat Rima (5 million germinating seeds per 1 ha) | 108 | 2.0 | 398 | 37.9 |
| wheat (3 million germinating seeds per 1 ha) + vetch (1.2 million germinating seeds per 1 ha) | 112 | 1.4 | 175 | 27.1 |
| cereal | 85 | 1.6 | 298 | 31.4 |
| wheat (3 million germinating seeds per 1 ha) + vetch (1.5 million germinating seeds per 1 ha) | 119 | 1.4 | 179 | 29.9 |
| cereal | 80 | 1.6 | 321 | 21.7 |
| wheat (3 million germinating seeds per 1 ha) + vetch (1.8 million germinating seeds per 1 ha) | 118 | 1.5 | 113 | 31.3 |
| cereal | 78 | 1.5 | 409 | 20.2 |
| Oat 28H2369 (5 million germinating seeds per 1 ha) | 104 | 2.3 | 702 | 75.5 |
| oat (3 million germinating seeds per 1 ha) + vetch (1.2 million germinating seeds per 1 ha) | 109 | 1.4 | 218 | 18.1 |
| cereal | 101 | 1.8 | 425 | 45.3 |
| oat (3 million germinating seeds per 1 ha) + vetch (1.5 million germinating seeds per 1 ha) | 105 | 1.4 | 215 | 22.3 |
| cereal | 93 | 1.5 | 386 | 41.8 |
| oat (3 million germinating seeds per 1 ha) + vetch (1.8 million germinating seeds per 1 ha) | 102 | 1.4 | 196 | 27.5 |
| cereal | 89 | 1.4 | 367 | 41.9 |
| Barley Moskovsky 86 (5 million germinating seeds per 1 ha) | 66 | 1.9 | 235 | 17.0 |
| barley (3 million germinating seeds per 1 ha) + vetch (1.2 million germinating seeds per 1 ha) | 99 | 1.6 | 94 | 29.9 |
| cereal | 60 | 1.6 | 286 | 12.1 |
| barley (3 million germinating seeds per 1 ha) + vetch (1.5 million germinating seeds per 1 ha) | 93 | 1.5 | 78 | 33.1 |
| cereal | 57 | 1.5 | 348 | 11.5 |
| barley (3 million germinating seeds per 1 ha) + vetch (1.8 million germinating seeds per 1 ha) | 95 | 1.7 | 81 | 34.5 |
| cereal | 64 | 1.4 | 322 | 11.4 |

4. Conclusion
Meteorological conditions have a great influence on the development of plants, as can be seen from the data obtained over the years of research.

According to the results of research for two years, for the cultivation of vetch for green mass (silage, haylage, hay), the best option is vetch mixed with oats with a seeding rate of 1.2 million vetch, oats of 3 million germinating seeds per hectare.

For grain cultivation, the best option is a mixture of vetch and oats with a seeding rate of 1.8 million and 3 million germinating seeds per hectare.

For obtaining a grain crop for seed-growing purposes, the best option for two years of research is vetch mixed with spring wheat with a seeding rate of 1.8 and 3 million germinating seeds per hectare.

Mixed vetch crops with modern varieties of spring wheat, oats and barley ripen earlier than pure vetch, reduce harvesting costs due to greater resistance to lodging of crops, and use fertilizers more economically (natural and synthesized nitrogen, hard-to-reach phosphorus). The different crops and
varieties in the mixes make better use of moisture and resist weeds. In mixed crops, a higher yield is obtained than in single-species crops, enriched with vegetable protein, which allows to attribute mixtures of cereals with legumes to the method of obtaining concentrated feed. Further studies of the optimal selection of the crops and varieties seeding rate ratio can justify a scientific approach to the formation of environmentally friendly and effective methods for obtaining high-quality agricultural products.

Data from 2020 on single-species crops of spring wheat and oats show that the plants tolerate excessive waterlogging of the soil with productive bushiness of 2 and 2.3 pcs with good water content of the ear and panicle, showing high grain yields and green mass.

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