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Effect of Seeding Methods on Productivity of Alfalfa Crops

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Abstract

Alfalfa is a perennial legume characterized by a wide range of applications, exceptional adaptive ability to natural conditions and high productivity. For successful development of the alfalfa seed production system, it is necessary to use new high-yielding varieties and improved technologies for its cultivation. According to the results of preliminary studies, since 2016, the researchers of our institute have been studying features of new alfalfa varieties with high productivity and resistance to major pests and diseases, among which Bagira, Bazhena and Feya are one of the best varieties. Currently, research on ecological, biological and technological features of alfalfa production for seed purposes is being carried out. The biological ability of Feya to produce a large volume of seeds in the first year was observed. The research results revealed a dominant role of spatial distribution of alfalfa plants, providing sufficient illumination and ventilation in crops and effective pollination of crops by wild pollinators.

Keywords: alfalfa, seed production, seeding rate, sowing method, generative shoots, seed productivity

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1. Introduction

The rapid growth of the population is far ahead of agricultural production. To increase production of meat products, it is necessary to increase the food supply.

When creating a forage base for livestock, development and widespread use of intensive technologies for cultivation of fodder crops, including perennial crops, are necessary. Alfalfa is a perennial fodder legume characterized by adaptability to natural conditions, high productivity and multipurpose applications. Alfalfa is the best precursor for many crops [3, 5, 6].

At the end of the 1980s, in the Chechen Republic, production of alfalfa seeds gained widespread industrial development. More than 37 thousand hectares of land were used

for producing alfalfa seeds. As a result, many farms of the republic were provided with alfalfa seeds [1, 4, 7].

Unfortunately, the alfalfa seed production system was destroyed in the 1990s.

The reforms caused serious damage to animal husbandry and fodder production which affected the agricultural industry. According to Novoselov, the strategic direction of development of field fodder production should be expansion of the crops of perennial leguminous grasses to 72--75 % instead of 20 %. It is necessary to create an effective seed production system [5].

According to the current program developed in the Chechen Republic, it is planned to have up to 18 thousand hectares of alfalfa in crop rotations. For the successful implementation of this program, it is necessary to use new high-yielding varieties and improved technologies.

According to the results of preliminary studies on new alfalfa varieties conducted by researchers of our institute, Bagira, Bazhena and Feya selected by Krasnodar Research and Development Institute are highly productive and resistant to major pests and diseases [12].

The purpose of this article is to study ecological, biological and technological factors contributing to the genetic potential of seed productivity of promising alfalfa varieties, in particular Feya.

Scientific novelty. For the first time, in the conditions of the Chechen Republic, the technological features of new highly productive alfalfa varieties have been studied in order to intensify seed production.

2. Metod and Materials

The methodology of the experiment. Field experiments were conducted on the experimental field of the Chechen Research Institute of Agriculture. Seeds were sowed in April 2017 according to the method by B.A. Dospekhov and the guide developed by E.D. Adinyaev and others.

The experiment was two-factor. It was conducted by the method of split plots. Various methods of seed sowing (with row spacing of 30, 45 and 60 cm) and sowing rates (2, 3 and 4 kg/ha) were studied. The plot area was 36 m2. The repetition was fourfold. The agrotechnology was generally accepted.

The research area was moderately moist, hot, with a hydrothermal coefficient of 0.9...1.2. The sum of active temperatures during the growing season of agricultural crops

was 3,400... 3,600 ˚C with precipitation of 450 mm. The soil of the test plot was black soil with underlying gravel, humus content was 3.9 %. The reaction of the soil solution is close to neutral -- pH 6.9. The content of phosphorus and nitrogen was average, and potassium -- high.

3. Results

Alfalfa sowed in spring (2017) was strong. The first frosts (up to --5.2 ˚C) began at the end of November and repeated in the middle of December in the conditions of moisture deficit. January and February 2018 were characterized by elevated temperatures and precipitation by 2 degrees higher than the norm, exceeding the mean annual values by 60...70 %. March was warmer by one degree, and precipitation was twice as high as normal. April was characterized by increased temperatures with a small (5 %) shortage of precipitation. The maximum air warmed up to 28 degrees. In the second decade, there were night frosts (--4.4 ˚C).

From April to June, at elevated temperatures, there was a lack of precipitation of 22...48 %. The period from July to August turned out to be hot with precipitation exceeding the norm by 30...80 %. However, the rains were torrential, with long intervals. As a result of high evaporation, their efficiency was negligible. The prevailing weather conditions satisfied the needs of the seed crops of alfalfa.

The analysis of the main growth indicators in the second year showed an increase in the growth of shoots with an increase in row spacing. Plant height increased with an increasing seeding rate. In the bean formation phase, alfalfa crops with a seeding rate of 4 kg/ha had the highest plant height (87 cm on average); the maximum plant height (95 cm) was observed for a 60 cm row spacing (Table 1).

With an increase in the seeding rate from 2 to 4 kg/ha, the mass of individual plants decreased by 200 g/m^2. A similar trend was observed for the leaves, flowers and beans. Before the beans have been formed, alfalfa formed a green mass in the range of 25...41 tons per hectare. The largest green mass (41.3 tons per hectare) was formed in the variant with a norm of 2 kg/ha. In the variant with a seeding rate of 4 kg per hectare and with a row spacing of 60 cm, the green mass of 32.8 tons per hectare was produced.

However, in this variant, some plants were weak, while in the variants with norms of 2 and 3 kg per hectare, the plants were resistant, strong. The plants were well illuminated, flowers were pollinated by local pollinators. Oleshko, Abadouz, Tiejun and Wenxu Zhang observed that in wide-row crops with moderately rarefied herbage, illumination and

aeration of plants are improved, while conditions for moistening, feeding and pollination become optimized [6, 8--10].

It was revealed that the height of alfalfa plants until seed formation and harvesting was influenced by the seeding rate which was especially noticeable in the variant with the norm of 4 kg per hectares, where the plants had a height of 15 cm less (Table 2).

TABLE 1: Biometric analysis of Feya variety, 04.06.2018.

Variants		plant height, cm	mass, g / m^2					Green mass, tons per hectare
seeding rate, kg per hectares	seeding method, cm		shoots	branches	leaves	flowers	beans	
2	30	79	1319	514	1033	388	129	33,8
	45	80	1560	713	1151	564	142	41,3
	60	90	1401	513	970	429	146	34,6
3	30	76	1613	440	897	305	143	34,0
	45	89	1142	310	762	310	26	25,5
	60	91	1256	664	883	407	192	34,0
4	30	82	1178	651	712	123	69	27,3
	45	85	1145	504	651	253	59	26,1
	60	95	1355	435	1098	353	37	32,8
HCP_{05}								5.9
HCP_{05} A. B								3.4

At rates of 2 and 3 kg / ha, the height of plants was 113 cm. A similar correlation was observed for the mass of plants. The dry mass of plants with a seeding rate of 4 kg / ha was 670 g / m^2, which is by 53 and 46 g less than in variants with a seeding rate of 2 and 3 kg / ha, respectively.

The effect of seeding rates on bean formation was more pronounced. With an increase in the seeding rate, the number of beans per shoot decreased. Moreover, if the difference between the first two variants (2 and 3 kg / ha) was small and amounted to 18 pieces, with an increase in the rate of up to 4 kg / ha, the number of beans per shoot decreased to 41 pcs. In 2017, the number of beans in crops with a seeding rate of 2 kg / ha was 23 pcs per generative shoot, and at a rate of 3 and 4 kg / ha, their number decreased by half (up to 12 pcs.) [9].

On average, the number of seeds was 2.1...2.2 and only in the variant with a seeding rate of 4 kg/ha and a row spacing of 60 cm.

Table 2: Harvest and structure of the harvest of alfalfa seeds (Feya variety), 08/01/2018.

Variant		plant height, cm	number of shoots per m^2	mass of shoots, g/m^2	number of beans per 1 shoot	Number of seeds per one bean	mass of 1000 seeds, g	Seed yield c/ha
norm, kg/ha	method, cm							
2	30	106.9	113	675.7	98.7	2.22	2.38	5,9
	45	116.3	106	894.6	109.8	2.11	2.82	6,9
	60	118.5	123	597.8	86.1	2.31	2.28	5,6
	сред.	113.9	114	722.7	98.2	2.21	2.49	6,1
3	30	116.9	129	923.0	80.2	2.41	2.05	5,1
	45	113.4	127	815.3	72.5	1.87	2.20	3,8
	60	108.7	107	409.8	88.9	1.94	1.87	3,5
	сред.	113.0	121	716.0	80.5	2.07	2.04	4,1
4	30	113.3	166	969.6	44.5	2.29	1.89	3,2
	45	102.4	179	651.6	36.9	2.38	1.73	2,7
	60	80.7	192	386.9	41.6	1.63	1.74	2,3
	сред.	98.8	179	669.4	41.0	2.10	1.79	2,7
HCP_{05}								0.29
$HCP_{05}AB$								0.16

By the mass of 1000 seeds equal to 2.49 g, the variant with a seeding rate of 2 kg / ha was productive. In the variants with norms of 3 and 4 kg / ha, the mass of 1000 seeds decreased to 2.04 and 1.79 g, respectively. Alfalfa responded ambiguously to the spwing method of sowing. In the variants with a row spacing of 45 cm, alfalfa seeds had an average mass of 1000 seeds of 2.25 g. In crops with a 60 cm row spacing, the seed decreased by 0.2... 0.3 g.

No significant difference was found in plant height, the number of generative shoots per 1 m^2, the number of beans per shoot. There was a noticeable decrease in the mass of the stems at the same seeding rate with an increasing row spacing. If the mass of plants in crops with a 30 cm row spacing averaged 860 g, in the variants with a row spacing of 45 and 60 cm, their mass decreased to 790 and 465 g / m^2, respectively, i.e. with an increase in the row spacing, the weight of plants decreased by 46 %.

The increase in a row spacing at an equivalent rate thickens the plants; their distribution per unit area is disturbed which leads to poor lighting, pollination and decreases the seed yield.

If crops with a row spacing of 30 and 45 cm produce 4.7 and 4.5 c / ha, crops with a row spacing of 60 cm produce 3.8 c / ha of seed yields. With a seeding rate of 3 and 4 kg / ha, the seed yield was 3.5 and 2.3 c / ha, respectively.

The researchers believe that when plants are rarely standing, the nutritional area increases, more generative shoots with a large number of brushes are formed, lighting is improved and more favorable pollinating conditions are created [5, 8, 11, 12].

According to the mass of shoots, number of beans, seeds, seed mass, the variant with a seeding rate of 2 kg / ha and a row spacing of 45 cm is preferable. At a rate of 2 kg / ha and a row spacing of 30 and 60 cm, high yields of seeds were obtained. In 2017, in the first year, the best result was obtained at 2 kg/ha. The largest number of seeds (more than 11 thousand units) with a mass of 21.0 g/m^2 was obtained in the variant with a seeding rate of 2 kg / ha and a row spacing of 60 cm. In the second year, crops with a row spacing of 45 cm were more productive.

A comparative analysis of the yield data in the second year showed that the development of alfalfa plants directly depends on the state of crops in the first year (Table 3) [8--10].

The number of generative shoots in the crops of alfalfa in the second year was dependent on their number per year of sowing. Analysis of alfalfa sowings at a seeding rate of 2 kg revealed the effect of crop self-regulation. If in the sowing year, the number of generative shoots was smaller, in the second year, their number increased. On the contrary, in the crops thickened in the first year, a decrease in the growth of shoots was observed.

If in the first year, in crops with a 45 cm row spacing stable production of seeds within 1.6...1.8 c/ha hectare was observed, in the reporting year, the variant of sowing at a rate of 2 kg / ha was more productive. A decrease in yield at 4 kg / ha was determined by thickening the crops. As a result, new green shoots developed which intensified the inhibitory effect on the sown shoots (Fig. 1).

In the second year, the increase coefficient at 2 kg / ha was 3.5. The IC at a rate of 3 kg / ha (KU 3.3) was slightly smaller, and the yield increase at a rate of 4 kg / ha was the smallest (2.3). The maximum increments (6,7 and 4,4) were observed at 3 and 4 kg / ha with a row spacing of 30 cm.

As a result, for two years, the yield varying from 3.9 to 8.6 c / ha was obtained. The maximum yield was obtained at 2 kg / ha with a row spacing of 45 cm (7.9 c / ha). Alfalfa crops at 4 kg / ha were less productive.

Table 3: The main indicators of alfalfa seed productivity in the 1st and 2nd years.

Variant		Generative shoots, pcs/m^2				Seed yield, kg/ha				
seeding rate, kg/ha	row spacing	2017	2018	deviation +-	Increase coeffic-ient	2017	2018	deviation +-	Increase coeffic-ient	amount for 2 years
2	30	105	113	8.0	1.08	1.47	5.9	4.4	4.0	7.4
	45	87	106	19.0	1.22	1.65	6.9	5.3	4.2	8.6
	60	74	123	49.0	1.66	2.1	5.6	3.5	2.7	7.7
3	30	108	129	21.0	1.19	0.76	5.1	4.3	6.7	5.9
	45	91	127	36.0	1.40	1.76	3.8	2.0	2.2	5.6
	60	89	107	18.0	1.20	1.21	3.5	2.3	2.9	4.7
4	30	147	166	19.0	1.13	0.72	3.2	2.5	4.4	3.9
	45	110	179	69.0	1.63	1.58	2.7	1.1	1.7	4.3
	60	119	192	73.0	1.61	1.24	2.3	1.1	1.9	3.5

Figure 1: The state of alfalfa seed sowing depending on sowing rates and methods, 2018.

4. Conclusion

The following conclusions can be drawn:

1. The plant height varied depending on the seeding rate and method. There was an increase in the height of alfalfa plants with an increase in the seeding rate and row spacing.

2. In the first year, generative shoots (74-147 pcs / m^2) were developed. In the second year, their number increased to 1.6 times. At a seeding rate of 2 kg / ha, the effect of self-regulation of crops was revealed. The increase coefficient was smaller for thickened crops.

3. In the 2nd year, the green mass reached 25... 41 t / ha. With an increase in the seeding rate, a decrease in the mass of plants and the number and mass of leaves and beans were observed.

4. The number of seeds was 2.1... 2.2, while at a seeding rate of 4 kg / ha and a row spacing of 60 cm, there were only 1.6 seeds.

5. The seeding rate significantly affected the seed mass. At a seeding rate of 2 kg/h, the number of seeds was maximum (1000 seeds with a mass of 2.49 g). An increase in the row spacing, at an equal seeding rate, thickened the crops, caused poor lighting, ventilation, pollination and decreased the yield of seeds.

6. By the mass of shoots, the number of beans and seeds, and their mass, the most productive variant is the seeding rate of 2 kg / ha and a 45 cm row spacing. The yield was 6.9 c/ha. The total yield for first two years was 8.6 c/ha.

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