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THE INFLUENCE SOWING TIME, SOWING DISTANCE AND FERTILIZATION ON NUMBER OF STEMS PER PLANT OF RED CLOVER (Trifolium pratense L.)

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Abstract: ***In the investigated area, corn silage and hay meadows are dominated by voluminous fodder. Farmers who grew alfalfa were not satisfied with the yield and length of use, as this was mainly used for 2 years. The reason for such a short use of alfalfa is probably the acidity of the soil in which it was grown.***
On the contrary, farmers who grew red clover were more satisfied with the production and were mostly used for three years.
In the area of Northeast Bosnia, the agro-technology of cultivation of the red clover is based on sowing in the spring (April), fertilization of NPK 15:15:15 and sowing manually according to the milk producer's survey on the cultivation of fodder crops and the applied agro-technology.
Red clover could be classified in the second place after the quality of the fodder, behind the alfalfa. The share of number of stems in the yield of red clovers is a very important factor of yield and quality.
The goal of the research was to determine the extent to which the change in the red clover cultivation system (sowing time, intermediate sowing distance and the application of different quantities and combinations of NPK fertilizers) influences the proportion of number of stems in the yield of red clover feed.
The results of the research can provide a significant scientific and practical contribution to the improvement of the red clover cultivation in the agro-ecological conditions of northeastern Bosnia, as a very important component in ensuring quality of livestock feed.
This research will provide an answer to the question of choosing agro-technics and fertilization systems in order to produce better quality of red clover of whose main factor is the share number of stem in the yield, as well as achieving higher yields per unit area.
Keywords: yield, stem, sowing date, sowing distance, fertilization

INTRODUCTION

In recent years, interest in red clover as a leading fodder plant has grown again, and the reasons are multiple. First of all, red clover can be grown on soils that are less suitable for growing alfalfa and can be used in different ways.

It is commonly used as cabbage fodder in the form of green fodder, pure or in direct feeding rations or for hay and silage.

Red clover is an important fodder plant of excellent quality. It is used for the establishment of short-term crops of red clover and in grass-clover mixtures grown on arable land. However, it is mostly cultivated in arable land in pure culture. Much better tolerates mowing than grazing. With the rise begins early in the spring and very quickly arrives for mowing.

The variety of uses, favorable biological assets, relatively modest requirements to the conditions of production, the great possibility of nitrogen fixation (N), good yield and quality of feed, make the red clover very important in providing high-quality fodder for domestic animals.

Red clover is a high-quality animal feed, in the area of North-eastern Bosnia and Herzegovina, known among the people by the names of "cowards, thirds, trotters". According to the nutritional value comes behind the alfalfa.

When preparing the hay from the red clover, it should be careful because the tree is dried slower (because it is thick and juicy), and the leaves are quickly dried up and they fall and thus there are big losses. The hay preparation should be done at the time of the beginning of the flowering of the primary flowers.

As a factor of yield of red clover, in addition to the number of plants per unit of area, a significant factor is the number of stems per plant. By increasing the spacing to the optimum size and shape of vegetation space, the best leaf yield per plant is achieved as well as other positive properties. Good planting is the best use of solar energy during crop rotation, which directly influences yield.

Red clover is one of the most important fodder cultures in humid climate, on shallow, acidic and moist soil and in areas with shorter vegetation. Ecological conditions have a strong influence on the manifestation of genetic features of cultivars and ecotypes of red clover, so that certain cultivars and ecotypes are more or less adapted to certain ecological conditions (Gikic, 1967).

As a forage leguminous, red clover is of importance immediately after the alfalfa (Muhina and Sestepirova, 1978).

Each type of agricultural herb should provide the necessary living or vegetation space in order to ensure the undisturbed influence of the factors from the soil and the atmosphere. The need for vegetation space is different for different cultures, and are conditioned by external factors, the biological characteristics of the species (primarily by growth, habitus) and the goal of breeding (Mihalić, 1976).

Graman and Sakova (1998) found that the length and weight of the stem, and the weight of the leaves and whole plants are regularly reduced with an increase in altitude. Also, for tetraploid cultivars, they recorded longer and wider leaves, and stems of stems.

According to Vasiljevic (1998), the variability within certain properties of the red clover was for plants height of 44.67 cm (BL-4) to 61.01 cm (Tetra-I), the number of stems per plant of 8.58 (M- 12) to 17.38 (BL-4 and Tetra-II), the number of internodes of 4.46 (Orašak I) to 5.16 (Sk-17), the yield of green weight of 155.61 g (Orašak II) to 333 , 17 g (Tetra-I) and yield of dry matter of 36.61 g (Powder II) to 80.55 g (Tetra-I).

Vasiljević (1998) state that the number of stems per plant of red clover varied from 8.97 to 28 stems per plant.

Totev and Volkov (1988) state that increasing the dose of NPK fertilizers increased the yield of red cow hay from 7.08 t / ha to 8.96 t / ha, while the content of raw proteins in dry matter from 15.8% to 17.9 %.

Miladinović (1972) studied domestic populations of red clover in pure sowing. The author found that the number of red clover stems in the first crop, in the second year of the test, ranged from 17.1 to 20.1 stems per plant

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MATERIAL AND METHODS OF RESEARCH

Field tests on red clover were placed in the area of Odzak in the three-year period from 2015 to 2017. The pre-culture on sown surfaces was wheat.

The research included three factors (trifactorial tour), of which: the first - the time of sowing, the second - the sowing distance and the third - the type of fertilizer. The sowing season of autumn, sowing on September 8, and the spring sowing season, on April 4, the sowing distance varied in three variants, and the fertilization varied in three variants. Thus, 18 combinations (2x3x3) were obtained.

The test was set by block method, in three repetitions with random plots. The size of the base parcel was 6 m2 (4x1.5 m). The red clover is sowed manually in the amount of 20.0 kg / ha, at a distance of 20 cm (in quantity of 16.5 kg / ha) and 7 rows on one plot and at a distance of 40 cm (in quantity 10.8 kg / ha) or 4 rows on one plot.

In 2014, on whole experimental plot the seeded maize was in basic preparation fertilized (ploughed in the fall of 2013) with 40 tons of manure and 300 kg / ha NPK 8:26:26. In the autumn of 2014, the experimental plot wheat was sowed, where 300 kg / ha NPK 10:30:20 was ploughed during basic cultivation.

In the preparation of the land for the sowing of red clover, or for setting up the experiment, three different varieties of fertilizers were applied, the results of which were investigated in this experiment.

- Variant 1. (G1) traditional way of production - fertilization with NPK 15:15:15 in the amount of 250 kg / ha in pre-sowing preparation (37.5 kg pure N, 37.5 kg of pure P, 37.5 kg pure K). Fertilizing in autumn after mowing with 250 kg / ha NPK 15:15:15 (37.5 kg pure N, 37.5 kg of pure P, 37.5 kg pure K).
- Variant 2. (G2) fertilization in the basic treatment with 250 kg / ha NPK 7:20:30 (17.5 kg of pure N, 50 kg of pure P, 75 kg of pure K) and pre-seed preparation (under plow) with 100 kg / ha NPK 7:20:30 (7 kg of pure N, 20 kg of pure P, 30 kg pure K). In autumn every year after using fertilizer with 300 kg / ha NPK 7:20:30 (21 kg pure N, 60 kg of pure P, 90 kg pure K).
- Variant 3. (G3) fertilization in the basic treatment with 250 kg / ha NPK 8:26:26 (20 kg of pure N, 65 kg of pure P, 65 kg of pure K) and in pre-seed preparation (under plow) with 100 kg / ha NPK 8:26:26 (8 kg of pure N, 26 kg of pure P, 26 kg pure K). In autumn every year after using fertilizer with 300 kg / ha NPK 8:26:26 (24 kg pure N, 78 kg of pure P, 78 kg pure K).

The selected surfaces on which the experiments were placed were of uniform fertility, straight, without micro depression and groundwater.

For the research, the variety Nada was produced in the BC Institute, Zagreb. The sowing was carried out manually, autumn seeding dated on September 8, 2014 and spring sowing on April 4, 2015, the depth of sowing was from 1 to 2 cm.

The mowing of the experimental plot was carried out manually at the beginning of the flowering stage. After mowing, the share of leaves in the yield of green fodder was analyzed. All obtained data are systematized by year of research, as well as by parameters of research.

Material and methods for determining the share of leaf in the yield of green fodder:

- Determination of the number of plants - on each experimental plot by random selection on the surface of 0.25 m^2 the number of plants is counted. This was done three times before every cut at the stage of the red clover. Based on these three counts, the annual average is counted.

Statistical data processing was done in the SPSS program.

RESULTS OF RESEARCH

Number of stems per plant of red clover in 2015

Table 1. Effect of sowing time, sowing distance and different doses of mineral fertilizers on the number of stems per plant, 2015

Sowing time **R**	Sowing distance **M**	Mineral fertilizer NPK 15:15:15 **G_1**	7:20:30 **G_2**	8:26:26 **G_3**	**X RM**	**X R**
September **R_1**	Manually **M_1**	12,2	13,4	12,8	12,8	**19,1**
	20 cm **M_2**	17,1	18,9	18,5	18,2	
	40 cm **M_3**	23,8	29,0	25,7	26,2	
X R_1G		**17,7**	**20,4**	**19,0**		
April **R2**	Manually **M_1**	9,8	10,1	9,8	9,9	**15,4**
	20 cm **M_2**	14,3	16,2	14,8	15,1	
	40 cm **M_3**	19,5	23,5	20,7	21,2	
X R_2G		**14,5**	**16,6**	**15,1**	**X M**	
X MG		11,0	11,8	11,3	**11,4**	Average **17,3**
		15,7	17,6	16,7	**16,7**	
		21,7	26,3	23,2	**23,7**	
X G		**16,1**	**18,6**	**17,1**		

	Level	**R**	**M**	**G**	**RM**	**RG**	**MG**	**RMG**
LSD	**0,05**	**0,30***	**0,435***	**0,435***	**0,521***	**0,521^{ns}**	**0,635***	**0,898***

The sowing time, the inter-spacing of sowing and fertilization statistically significantly affect the number of stems per plant in the first year of use.

The interaction between sowing time and inter-spacing, fungus and inter-spacing, as well as the interaction between sowing time, inter-spacing and fungus has a statistically significant effect on the number of stems per plant.

The sowing time statistically significantly influences the number of stems per plant. In September, 19.1 stems / plants were harvested and in April 15.4 stems / plants were harvested.

The cross-section of sowing has a statistically significant effect on the number of stems per plant. Sowing on the 40 cm spacing has a statistically significant influence on sowing of sowing and sowing on a spacing of 20 cm. Sowing on the 20 cm spacing has a statistically significant effect

on the sowing of mussels. The highest average number of stems per plant of 23.7 stems / plants was achieved by sowing on a spacing of 40 cm.

Inflorescence statistically significantly affects the number of stems per plant. The NPK 7: 20: 30 has a statistically significant effect on the number of stems compared to NPK 8: 26: 26 fertilization and NPK 15: 15: 15 fertilization. The highest average number of stems 18,6 stems / plants was achieved by fertilizing NPK 7: 20: 30

The interaction between sowing time and inter-spacing has a statistically significant effect on the number of stems per plant. The sowing in September at the 40 cm spacing has a statistically significant influence on the sowing of the mussels and the 20 cm spacing with the sowing time in September and April. The highest number of stems per plant 26.2 was achieved in sowing in September at an intercept of 40 cm.

Interaction between the inter-spacing of sowing and fertilization has a statistically significant effect on the number of stems per plant. Grenade NPK 7: 20: 30 and sowing on the 40 cm spacing has a statistically significant effect on the number of stems compared to the sowing of the bush and at a distance of 20 cm with the NPK 8: 26: 26 and the NPK 15: 15: 15 fertilizer. The highest average number of stems per plant 26.3 was achieved by sowing on the 40 cm spacing and the fertilizer NPK 7: 20: 30.

Number of stems per plant of red clover in 2016

Table 2. Effect of sowing time, sowing distance and different doses of mineral fertilizers on the number of stems per plant, 2006

Sowing time **R**	Sowing distance **M**	Mineral fertilizer NPK 15:15:15 **G_1**	7:20:30 **G_2**	8:26:26 **G_3**	**X RM**	**X R**
September **R_1**	Manually **M_1**	15,7	17,3	16,5	16,5	**24,3**
	20 cm **M_2**	22,3	26,4	24,3	24,3	
	40 cm **M_3**	29,7	34,8	31,7	32,1	
X R_1G		**22,6**	**26,2**	**24,2**		
April **R2**	Manually **M_1**	13,8	15,0	14,2	14,3	**20,8**
	20 cm **M_2**	19,6	20,4	20,2	20,1	
	40 cm **M_3**	26,2	29,7	27,9	27,9	
X R_2G		**19,9**	**21,7**	**20,8**	**X M**	
X MG		14,8	16,2	15,4	**15,5**	Average **22,6**
		20,9	23,4	22,3	**22,2**	
		27,9	32,3	29,8	**30,0**	
X G		**21,2**	**24,0**	**22,5**		

	Level	**R**	**M**	**G**	**RM**	**RG**	**MG**	**RMG**
LSD	**0,05**	**0,406***	**0,498***	**0,498***	**0,704***	**0,704***	**0,864***	**1,219***

The sowing time, the inter-spacing of sowing and fertilization statistically significantly affect the number of stems per plant in the second year of use.

Interaction of the investigated factors has a statistically significant effect on the number of stems per plant in the second year of use.

The sowing time statistically significantly affects the number of stems per plant in the second year of use. In September, the average number of stems per plant was 24.3 and in April 20.8 stems per plant.

The inter-spacing of sowing has a statistically significant effect on the number of stems per plant in the second year of use. Sowing on the 40 cm spacing has a statistically significant effect on the number of stems compared to the sowing of the bush and at a distance of 20 cm. Sowing at a distance of 20 cm has a statistically significant effect on the number of stems compared to the sowing of the sesame. The highest average number of stems per plant 30.0 was achieved by sowing on a 40 cm spacing.

Gnocchi has a statistically significant effect on the number of stems per plant. The NPK 7: 20: 30 has a statistically significant effect on the number of stems per plant relative to fertilizer NPK 8: 26: 26 and fertilizer NPK 15: 15: 15. The highest average number of stems per plant 24.0 was achieved by NPK 7: 20: 30.

The interaction between sowing time and inter-spacing has a statistically significant effect on the number of stems per plant. The sowing in September at the 40 cm spacing has a statistically significant influence on the sowing of the mussels and the 20 cm spacing with the sowing time in September and April. The highest number of stems per plant 32.1 was achieved in September in a 40 cm spacing.

Interaction between the inter-spacing of sowing and fertilization has a statistically significant effect on the number of stems per plant. The icy NPK 7: 20: 30 and sowing on the 40 cm spacing has a statistically significant effect on the number of stems compared to the sowing of the mulch and at a distance of 20 cm with the fertilizer NPK 8: 26: 26 and the fertilizer NPK 15: 15: 15. The highest average number of stems per plant 32.3 was achieved by sowing on the 40 cm spacing and the fertilizer NPK 7: 20: 30.

The interaction between sowing and fertilization time has a statistically significant effect on the number of stems per plant in the second year of use. Sowing in September and fertilizer NPK 7: 20: 30 statistically significantly affects the number of stems per plant relative to the sowing in April and September, and the fertilizer NPK 8: 26: 26 and fertilizer NPK 15: 15: 15. The highest average number of stems per 26.2 plants were harvested in September and fertilizer NPK 7: 20: 30.

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Number of stems per plant of red clover in 2017

Table 3. Effect of sowing time, sowing distance and different doses of mineral fertilizers on the number of stems per plant, 2007

Sowing time **R**	Sowing distance **M**	Mineral fertilizer NPK			**X RM**	**X R**
		15:15:15 **G_1**	7:20:30 **G_2**	8:26:26 **G_3**		
September **R_1**	Manually **M_1**	10,5	12,5	11,7	11,6	**19,1**
	20 cm **M_2**	15,8	24,2	20,3	20,1	
	40 cm **M_3**	23,2	28,4	25,3	25,6	
X R_1G		**16,5**	**21,7**	**19,1**		
April **R2**	Manually **M_1**	10,1	12,1	11,2	11,1	**17,6**
	20 cm **M_2**	13,6	21,2	18,2	17,7	
	40 cm **M_3**	21,3	26,5	24,3	24,0	
X R_2G		**15,0**	**19,9**	**17,9**	**X M**	
X MG		10,3	12,3	11,5	**11,4**	Average **18,3**
		14,7	22,7	19,3	**18,9**	
		22,2	27,5	24,8	**24,8**	
X G		**15,8**	**20,8**	**18,5**		

	Level	**R**	**M**	**G**	**RM**	**RG**	**MG**	**RMG**
LSD	**0,05**	**0,312***	**0,383***	**0,383***	**0,541***	**$0,541^{ns}$**	**0,664***	**0,939***

The sowing time, the inter-spacing of sowing and fertilization statistically significantly affect the number of stems per plant in the third year of use.

The interaction between sowing time and inter-spacing, fungus and inter-spacing, as well as the interaction between sowing time, inter-spacing and fungus has a statistically significant effect on the number of stems per plant.

The sowing time statistically significantly influences the number of stems per plant. In September, 19.1 stems / plants were harvested, and in April, 17.6 stems / plants were harvested.

The cross-section of sowing has a statistically significant effect on the number of stems per plant. Sowing on the 40 cm spacing has a statistically significant influence on sowing of sowing and sowing on a spacing of 20 cm. Sowing on the 20 cm spacing has a statistically significant effect on the sowing of mussels. The highest average number of stems per plant 24.8 stems / plants was achieved by sowing on a spacing of 40 cm.

Inflorescence statistically significantly affects the number of stems per plant. The NPK 7: 20: 30 has a statistically significant effect on the number of stems compared to fertilizer NPK 8: 26: 26 and fertilizer NPK 15: 15: 15. The highest average number of stems 20.8 stems / plants was achieved with fertilizer NPK 7: 20: 30.

The interaction between sowing time and inter-spacing has a statistically significant effect on the number of stems per plant. The sowing in September at the 40 cm spacing has a statistically

significant influence on the sowing of the mussels and the 20 cm spacing with the sowing time in September and April. The highest number of stems per plant 25.6 was achieved in sowing in September at an intercept of 40 cm.

Interaction between the inter-spacing of sowing and fertilization has a statistically significant effect on the number of stems per plant. The icy NPK 7: 20: 30 and sowing on the 40 cm spacing has a statistically significant effect on the number of stems compared to the sowing of the mulch and at a distance of 20 cm with the fertilizer NPK 8: 26: 26 and the fertilizer NPK 15: 15: 15. The highest average number of stems per plant 28.4 was achieved by sowing on the 40 cm spacing and the fertilizer NPK 7: 20: 30.

Three-year average number of stems per plant

Table 4. Impact of sowing time, sown spacing and different doses of mineral fertilizers on the number of stems per plant, 2015-2017

Sowing time **R**	Sowing distance **M**	Mineral fertilizer NPK			**X RM**	**X R**
		15:15:15 **G_1**	7:20:30 **G_2**	8:26:26 **G_3**		
September **R_1**	Manually **M_1**	12,8	14,4	13,6	13,6	**20,8**
	20 cm **M_2**	18,4	23,2	21,0	20,9	
	40 cm **M_3**	25,6	30,7	27,6	28,0	
X R_1G		**18,9**	**22,8**	**20,7**		
April **R2**	Manually **M_1**	11,2	12,4	11,7	11,8	**17,9**
	20 cm **M_2**	15,8	19,3	17,7	17,6	
	40 cm **M_3**	22,3	26,6	24,3	24,4	
X R_2G		**16,4**	**19,4**	**17,9**	**X M**	
X MG		12,0	13,4	12,7	**12,7**	Average **19,4**
		17,1	21,3	19,4	**19,3**	
		24,0	28,7	25,9	**26,2**	
X G		**17,7**	**21,1**	**19,3**		

	Level	**R**	**M**	**G**	**RM**	**RG**	**MG**	**RMG**
LSD	**0,05**	**0,30***	**0,369***	**0,369***	**0,521***	**$0,521^{ns}$**	**0,639***	**0,902***

The sowing time, the inter-spacing of sowing and fertilization statistically significantly affect the number of stems per plant in the three-year average.

The interaction between sowing time and spacing, fertilization and inter-spacing, as well as the interaction between sowing, intercepting, and fertilization, has a statistically significant effect on the number of stems per plant over a three-year average.

The sowing time statistically significantly influences the number of stems per plant. In September, 20.8 stems / plants were harvested, and in April, 17.9 stems / plants were harvested.

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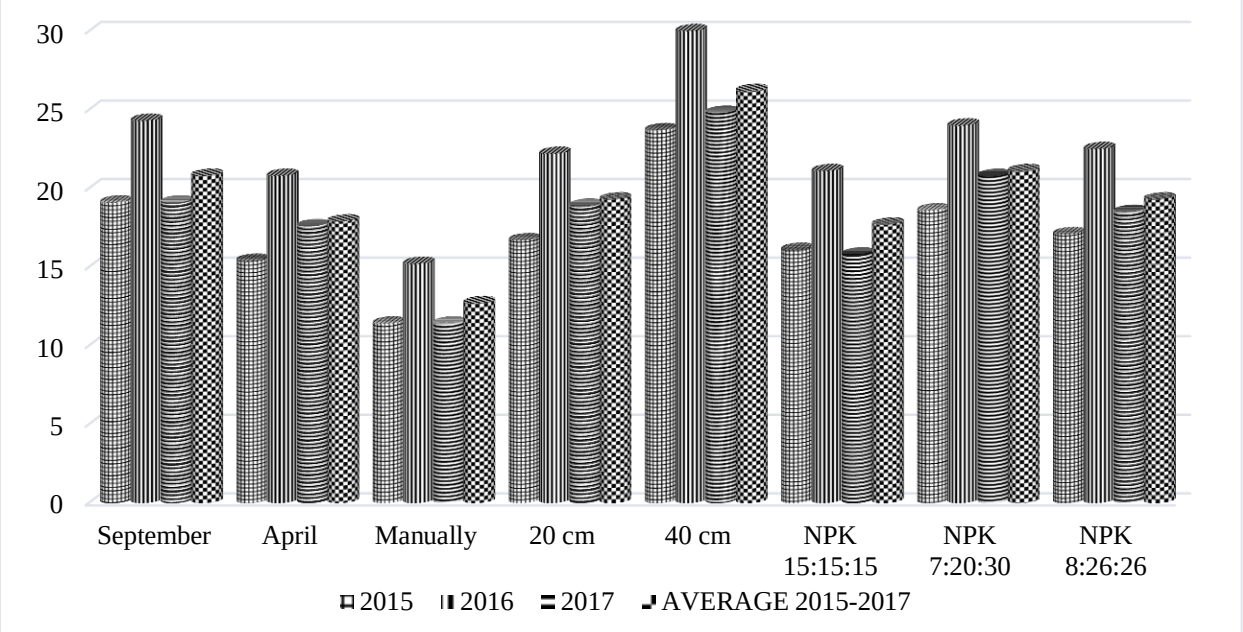
The cross-section of sowing has a statistically significant effect on the number of stems per plant. Sowing on the 40 cm spacing has a statistically significant influence on sowing of sowing and sowing on a spacing of 20 cm. Sowing on the 20 cm spacing has a statistically significant effect on the sowing of mussels. The highest average number of stems per plant 26.2 stems / plants was achieved by sowing on a spacing of 40 cm.

Inflorescence statistically significantly affects the number of stems per plant. The NPK 7: 20: 30 has a statistically significant effect on the number of stems compared to fertilizer NPK 8: 26: 26 and fertilizer NPK 15: 15: 15. The highest average number of stems 21.1 stems / plants was achieved with fertilizer NPK 7: 20: 30.

The interaction between sowing time and inter-spacing has a statistically significant effect on the number of stems per plant. The sowing in September at the 40 cm spacing has a statistically significant influence on the sowing of the mussels and the 20 cm spacing with the sowing time in September and April. The highest number of stems per plant 28.0 was achieved in sowing in September on a 40 cm spacing.

Interaction between the inter-spacing of sowing and fertilization has a statistically significant effect on the number of stems per plant. The compost NPK 7: 20: 30 and sowing on the 40 cm spacing has a statistically significant effect on the number of stems compared to the sowing of the mulch and at a distance of 20 cm with the fertilizer NPK 8: 26: 26 and the fertilizer NPK 15: 15: 15. The highest average number of stems per plant 28.7 was achieved by sowing on the 40 cm spacing and the fertilizer NPK 7: 20: 30.



Graph 1. Effect of sowing time, sowing distance and different doses of mineral fertilizers on the number of stems per plant, 2015 – 2017.

CONCLUSION

The results of the study indicate a large difference in the number of stems per plant as an important factor in the yield of feed.

The variability of the number of stems per plant was primarily dependent on the intermittent spacing of the sowing, as well as other factors, primarily the impact of fertilization and climatic conditions.

At an average distance of 40 cm, an average of 26.2 stems per plant was achieved, with seedling at a distance of 20 cm, 19.3 trees per plant were produced, and 12.7 stems per plant were sowed.

Due to the influence of different doses and combinations of NPK fertilizers, a slightly higher number of stems per plant were achieved. 21.1 using NPK 7: 20: 30, NPK 8: 26: 26 19.3 stems per plant, and NPK 15: 15: 15 17.1 stems per plant were achieved.

By sowing in September, 20.8 stems per plant were produced, and in April 17.9 stems per plant were planted.

The greatest influence on the number of stems per plant, ie the use of different doses and combinations of NPK fertilizers, and the intermittent spacing of sowing, were in the third, extremely dry year. The number of stems per plant in the third year with fertilizer NPK 7: 20: 30 was 20.8 stems per plant, NPK 8: 26: 26 was 18.5 stems per plant, NPK 15: 15: 15 was 15.8 stems per plant.

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