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The Influence of Sowing Time, Sowing Distance and Fertilization on Green Fodder Yield of Red Clover (Trifolium pratense L.)

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Abstract: ***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 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 on 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 higher yields per unit area and better quality of red clover.***
Keywords: yield, sowing date, sowing distance, fertilization

Introduction:

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.

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.

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.

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Silage from red clover is difficult to prepare, because the plant contains significant amounts of water, from this reason before silage preparation it is necessary to dry on a certain content of dry matter. Silage is better off if the red clover is grown in the grass with the grass. When preparing silage, attention should be paid to the amount of sugar, therefore, when preparing the silage, add corn flakes or some other sugar-rich substance. The first mow of the red clover has a higher amount of sugar compared to the second and third, and in the phase of the popping and the beginning of the flowering, there is more sugar compared to the earlier stages of development (Vorlicek, 1995). Red clover can be successfully used as silage, but it is necessary to dry the silage mass to a minimum of 20% dry matter (the optimum content of dry matter for silage is 30 to 35%). To prepare silage, mowing should be done at full bloom time.

The yield of green fodder in the average years ranged from 40-50 t / ha, and the hay was 10-12 t / ha. Mowing are 2 - 3 times per vegetative cycle, 4 times less (Pavešić-Popovic and Vuckovic, 1997).

Red clover yields is from 10 t/ha to 15 t/ha of hay (Mišković, 1986). The average height of the plants is about 70 cm and the share of the leaves is about 40%. The average content of crude protein in the dry matter is 17%, crude cellulose 27%, crude fat 2,7%, crude ash 8,5% and 45,6% BEM.

Užik (1994) states that the longevity of red clover cultivars significantly depends on the amount of precipitation in the year of sowing.

Korošec and Čop (1985) obtained the average yield of hay 8.5 t / ha with Poljanka cultivar, the average content of crude proteins in dry matter was 16.5% and crude cellulose 23.0%.

In the examination of Korošec et al. (1985), the cultivar Marino gave an average yield of 11.1 t/ha of hay, the average height of the plants was 51.6 cm, the share of leaves in the total dry matter yield was 42.5%, the crude protein content was 12.6% and crude cellulose 22.0%.

According to Andries (1982), in the first year of use, the average yield of hay red clover from two branches was 8.1 t / ha. In the second year, yield of 12.5 t/ha was obtained from three cuttings, and the third year from three branches was 7.1 t/ha. The average yield of hay red clover in Belgium is about 10 t/ha.

According to Vojin (2000), the three-year average yield of green fodder was 34.5 t/ha, and hay 8.7 t/ha, average crude protein content of 17.0%, crude cellulose 33.8% crude fat 2.6%, raw ash 6.3%, and the average share of BEM was 40.3%.

Materials and Methods:

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 experiments), 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

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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 2002) 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.
Statistical data processing was done in the SPSS program.

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Results and Discussion:

The yield of green fodder in 2015

Table 1. Effect of sowing time, sowing distance and different doses of mineral fertilizers on the yield of green fodder (t/ha), 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**	41,8	53,2	49.1	48,0	**56,0**
	20 cm **M_2**	59,1	66,7	61,5	62,4	
	40 cm **M_3**	53,9	60,4	58,9	57,7	
X R_1G		**51,6**	**60,1**	**56,5**		
April **R2**	Manually **M_1**	31,1	40,5	35,7	35,8	**43,7**
	20 cm **M_2**	47,9	51,1	49,1	49,4	
	40 cm **M_3**	43,8	47,8	45,9	45,8	
X R_2G		**40,9**	**46,5**	**43,6**	**X M**	
X MG		36,5	46,9	42,4	**41,9**	Average **49,9**
		53,5	58,9	55,3	**55,9**	
		48,9	54,1	52,4	**51,8**	
X G		**46,3**	**53,3**	**50,0**		

	Level	**R**	**M**	**G**	**RM**	**RG**	**MG**	**RMG**
LSD	**0,05**	**0,582***	**0,712***	**0,712***	**1,008^{ns}**	**1,008***	**1,234***	**1,745^{ns}**

Sowing time, sowing distance and fertilization statistically significantly influence the yield of red clover in the first year of use.

The interaction of the factors of sowing and fertilizing time, as well as fertilization and intermediate sowing distance, statistically significantly influences the yield.

In the interaction between sowing and intermediate spacing, as well as the time of sowing, the intermittent spacing of spawning and fertilization does not have a statistically significant effect on yield.

A statistically significant effect on yield is sowing in September in relation to sowing in April. Sowing in September was achieved an average yield of 56.0 t/ha of green forage, and sowing in April has been offering from 43.7 t/ha of green forage. Sowing in a gap of 20 cm row crops was achieved yield from 55.9 t/ha, at a distance of sowing of 40 cm row crops was achieved yield from 51.8 t/ha, and the sowing time was achieved a return of 41.9 t/ha.

A statistically significant difference between the sowing on the distance of 20 cm and 40 cm row crops in relation to sowing time, as well as sowing on distance of 20 cm from the sowing to the distance of 40 cm. NPK Fertilization has been 7:20:30 yield of 53.3 t/ha, NPK fertilization was 8:26:26 yield of 50.0 t/ha, and NPK fertilization was 15:15:15 return of 46.3 t/ha.

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Statistically significant difference of NPK and NPK 7:20:30 fertilization 8:26:26 in relation to fertilization with NPK 15:15:15, as well as fertilization NPK 7:20:30 in relation to the fertilizing NPK 8:26:26. The interaction of fertilization and sowing, the largest yield t/ha of 60.1 accomplished sowing in September and NPK fertilization for 7:20:30, and the minimum yield 40.9 t/ha was achieved in April, fertilization and sowing of NPK 15:15:15.

Interaction of sowing in September and fertilizer NPK 7:20:30 is statistically significant in relation to the interaction of NPK 8:26:26 and sowing in September and April, the interaction of NPK 15:15:15 and sowing in September in April as well as the interaction of NPK 7:20:30 and sowing in April. Also a statistically significant impact of interacting NPK 8:26:26 and sowing in September in relation to the interaction of NPK 15:15:15 and sowing in September and April. The interaction of sowing distance and fertilization, the largest yield 58.9 t/ha sowing has been made on row crop of 20 cm space and NPK fertilization for 7:20:30, and the minimum yield of 36.5 t/ha was achieved by the sowing time and fertilization NPK 15:15:15. Interaction of sowing distance of 20 cm and fertilization with NPK 7:20:30 statistically significantly affect forage yield in relation to sowing on the row crop distance of 40 cm and the sowing time in interaction with NPK fertilization 8:26:26 and NPK 15:15:15. The greatest yield t/ha, 66.7 has been made sowing in September, on the row crops with distance of 20 cm and fertilization NPK 7:20:30.

The yield of green fodder in 2016

The sowing time, the intermittent spacing of the sowing and fertilization statistically significantly affect the yield in the second year of use. The interaction of the factors of sowing and fertilizing, as well as fertilization and intermediate spacing, statistically significantly influences the yield of feed in the second year of use. In the interaction between sowing and intermediate spacing, as well as the time of sowing, the intermittent spacing of spawning and fertilization does not have a statistically significant effect on yield.

A statistically significant effect on yield is sowing in September in relation to sowing in April. Sowing in September was achieved an average yield of 65.4 t/ha of green forage, and sowing in April has been offering from 63.1 t/ha of green forage.

Table 2. Effect of sowing time, sowing distance and different doses of mineral fertilizers on the yield of green fodder (t/ha), 2016

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**	49,9	60,1	58,7	56,2	**65,4**
	20 cm **M_2**	69,1	75,1	70,1	71,4	
	40 cm **M_3**	64,5	72,9	68,7	68,7	
X R_1G		**61,2**	**69,4**	**65,8**		
April	Manually **M_1**	47,9	58,7	55,5	54,0	**63,1**
	20 cm **M_2**	66,8	72,1	67,3	68,7	

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R2	40 cm **M_3**	63,1	70,9	65,6	66,5	
X R_2G		**59,3**	**67,2**	**62,8**	**X M**	
X MG		48,9	59,4	57,1	**55,1**	Average **64,3**
		68,0	73,6	68,7	**70,1**	
		63,8	71,9	67,2	**67,6**	
X G		**60,2**	**68,3**	**64,3**		

	Level	**R**	**M**	**G**	**RM**	**RG**	**MG**	**RMG**
LSD	**0,05**	**0,290***	**0,301***	**0,301***	**$0,427^{ns}$**	**0,427***	**0,523***	**$0,739^{ns}$**

Sowing distance significantly affects the yield of feed in the second year of use, row spacing planting of 20 cm and 40 cm in relation to sowing omissions. The average yield of sowing at an intermediate spacing of 20 cm amounted to 70.1 t/ha, with seedling at a 40 cm spacing yield of 67.6 t/ha, and the yield of manually yield was 55.1 t/ha.

Fertilization significantly affects the yield of feed in the second year of use. The highest realized yield of green feed was 68.3 t/ha by fertilizing NPK 7: 20: 30, NPK 8: 26: 26 fertilization yielded 64.3 t/ha and NPK 15: 15: 15 fertilization yielded 60.2 t/ha.

A statistically significant effect of fertilization with NPK 7:20:30 in relation to the fertilizing NPK 15:15:15 and 8:26:26, it is also statistically significant effect of fertilization with NPK 8:26:26 in relation to the fertilizing NPK 15:15:15. The interaction of fertilization and sowing, the largest yield t/ha of 69.4 accomplished sowing in September and NPK fertilization for 7:20:30, and the minimum yield 59.3 t/ha was achieved in April, fertilization and sowing of NPK 15:15:15.

Interaction of sowing in September and fertilizer NPK 7:20:30 is statistically significant in relation to the interaction of NPK 8:26:26 and sowing in September and April, the interaction of NPK 15:15:15 and sowing in September in April as well as the interaction of NPK 7:20:30 and sowing in April. Also statistically significant influence is in the interaction of NPK 8: 26: 26 and sowing in September relative to the interaction of NPK 15: 15: 15 and sowing in September and April.

By interaction of the interstitial spacing of sowing and fertilization, the highest yield of 75.1 t/ha was achieved by sowing at an intermediate spacing of 20 cm and by fertilizing NPK 7: 20: 30, and the smallest yield of 47.9 t/ha was achieved by sowing the mud and fertilizer NPK 15 : 15: 15.

Interaction of space sowing distance of 20 cm and of fertilization with NPK 7:20:30 statistically significantly affects forage yield in relation to sowing on the row crop distance of 40 cm and the sowing time in interaction with NPK fertilization 8:26:26 and NPK 15:15:15. The highest average yield 75.1 t/ha was achieved in the second year of use with sowing in September, fertilizer NPK 7:20:30, and on the row crop distance of 20 cm.

The yield of green fodder in 2017

A considerable influence on the yield of green fodder red clover in the third year of use were climatic factors expressed by drought and lack of rainfall and exceptionally warm winter. Such

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climatic conditions also had a significant impact on the quality of red clover fodder in the third year of use.

Comparing the yield achieved in 2017. year, the overall average 35.6 t/ha, with the yield achieved in 2016. year, the overall average of 64.3 t/ha, the yield is lower by 44.6%.

Table 3. Effect of the sowing time, sowing distance and different doses of fertilizers on the yield of green forage (t/ha), 2017

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**	27,1	30,5	29,1	28,9	**35,1**
	20 cm **M_2**	33,1	43,2	41,5	39,3	
	40 cm **M_3**	31,7	40,5	39,2	37,1	
X R_1G		**30,6**	**38,1**	**36,6**		
April **R2**	Manually **M_1**	28,1	29,1	30,1	29,1	**36,0**
	20 cm **M_2**	32,9	43,3	40,3	38,8	
	40 cm **M_3**	32,0	49.8	38,1	40,0	
X R_2G		**31,0**	**40,7**	**36,2**	**X M**	
X MG		27,6	29,8	29,6	**29,0**	Average **35,6**
		33,0	43,3	40,9	**39,1**	
		31,9	45,2	38,7	**38,6**	
X G		**30,8**	**39,5**	**36,4**		

	Level	**R**	**M**	**G**	**RM**	**RG**	**MG**	**RMG**
LSD	**0,05**	**0,228***	**0,279***	**0,279***	**0,394***	**0,394***	**0,482***	**0,684***

Sowing time, sowing distance and fertilization significantly affect the yield in the third year of use. The interaction of the investigated factors statistically significantly influences the yield of feed during the third year of use.

The statistically significant effect on yield is sown in April compared to the sowing in September. Sowing in September saw an average yield of 35.1 t/ha of green fodder, and in April, yield of 36.0 t/ha of green fodder was achieved.

Row spacing sowing significantly affects the yield of feed in the third year of use, row spacing planting of 20 cm and 40 cm in relation to sowing omissions. The average yield of the sowing on the 20 cm spacing was 39.1 t/ha, with the sowing on the 40 cm spacing, the yield was 38.6 t/ha and the seed yield was 29.0 t/ha.

Fertilization significantly affects the yield of feed in the third year of use. The highest achieved yield of green fodder 39.5 t/ha was fertilized by NPK 7: 20: 30, fertilization NPK 8: 26: 26 yield of 36.4 t/ha and NPK fertilization 15: 15: 15 yield was obtained from 30.8 t/ha. Statistically significant effect of fertilization NPK 7: 20: 30 with respect to fertilization NPK 8:

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26: 26 and NPK 15: 15: 15, is also a statistically significant effect of fertilization NPK 8: 26: 26 with respect to fertilization NPK 15: 15: 15.

By interaction of fertilization and sowing time, the highest yield of 40.7 t/ha was achieved in sowing in April and NPK 7: 20: 30 fertilization and the lowest yield of 30.6 t/ha was achieved in sowing in April and fertilization of NPK 15: 15: 15.

The interaction between sowing time in April and fertilization of NPK 7: 20: 30 is statistically significant in relation to the interaction of NPK 8: 26: 26 and sowing in September and April, interaction of NPK 15: 15: 15 and sowing in September in April as well as NPK interactions 7: 20: 30 and sowing in April. Also statistically significant is the interaction of NPK 8: 26: 26 and sown in September compared to the interaction of NPK 15: 15: 15 and sowing in September and April.

By interaction of sown seeds and fertilization, the highest yield of 49.8 t/ha was achieved by sowing on the 40 cm spacing and fertilization of NPK 7: 20: 30 and the lowest yield of 27.1 t/ha was achieved by sowing of peat and fertilization of NPK 15: 15: 15. Interaction of 20 cm sow spacing and fertilization of NPK 7: 20: 30 statistically significantly affected the yield of the stalk compared to the sowing on the 40 cm spacing and the sowing of the fungus in interaction with the fertilization of NPK 8: 26: 26 and NPK 15: 15: 15.

Interaction of sowing and row spacing sowing significantly affects the yield of feed in the third, dry year. Significant impact is sowing at a distance of 20 cm and sowing in April and September versus sowing at a distance of 40 cm and sowing of the sesame with the sowing time in September and April. There is also a statistically significant relationship between sowing in September and April, and 40 cm in relation to the sowing in September and April and the sowing of moss.

The highest average yield of 49.8 t/ha was achieved in sowing in April, NPK 7: 20: 30 fertilization, and a 40 cm spacing.

Three-year average yield of green fodder

Table 4. Effect of the sowing time, sowing distance and different doses of fertilizers on the yield of green forage (t/ha), 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**	39,6	47,9	45,6	44,4	**52,2**
	20 cm **M_2**	53,8	61,7	57,7	57,7	
	40 cm **M_3**	50,0	57,9	55,6	54,5	
X R_1G		**47,8**	**55,8**	**53,0**		
April **R2**	Manually **M_1**	35,7	42,8	40,4	39,6	**47,6**
	20 cm **M_2**	49,2	55,6	52,2	52,3	
	40 cm **M_3**	46,3	56,2	49,9	50,8	
X R_2G		**43,7**	**51,5**	**47,5**	**X M**	

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X MG	37,7	45,4	43,0	**42,0**	Average **49,9**
	51,5	58,7	55,0	**55,1**	
	48,2	57,1	52,8	**52,7**	
X G	**45,8**	**53,7**	**50,3**		

	Level	**R**	**M**	**G**	**RM**	**RG**	**MG**	**RMG**
LSD	**0,05**	**0,551***	**0,674***	**0,674***	**0,954^{ns}**	**0,954^{ns}**	**1,168^{ns}**	**1,591^{ns}**

The sowing time, sowing distance and fertilization statistically significantly affect the yield in a three-year average.
The interaction of the tested factors statistically has no effect on forage yield in the three-year average.
The statistically significant impact on the yield is sowing in September relative to the sowing in April. Sowing in September recorded an average yield of 52.2 t/ha of green fodder and sowing in April, the yield was 47.6 t/ha of green fodder.
Sowing distance statistically significantly influences the yield of fodder on a three-year average, the sowing distance of 20 cm and 40 cm in relation to the sowing of the manually. The average yield of sowing distance of 20 cm was 55.1 t/ha, with seedling at a 40 cm distance, yield is 52.7 t/ha, and the manually sowing yield is 42.0 t/ha.
Fertilization statistically significantly affects the yield of fodder in a three-year average. The highest realized yield of green fodder was 53.7 t/ha by fertilization of NPK 7: 20: 30, fertilization of NPK 8: 26: 26 yield of 50.3 t/ha, and fertilizer NPK 15: 15: 15 yield from 45.8 t/ha. A statistically significant influence on NPK fertilization 7: 20: 30 compared to fertilization of NPK 8: 26: 26 and NPK 15: 15: 15 was also statistically significant effect of fertilization of NPK 8: 26: 26 compared to NPK 15: 15: 15.
The highest average yield of green fodder of red clover 61.7 t/ha, in a three-year average, was achieved by sowing in September, at a 20 cm sowing distance and fertilizing NPK 7: 20: 30.

Conclusion:

The highest yield was achieved by sowing distance of 20 cm, fertilizing NPK 7: 20: 30 and sowing in September.
All yield indicators had the worst results in traditional manually sowing as well as fertilizer NPK 15: 15: 15 where all yield indicators had the worst results.
The advantage of sowing time is very important in the first year of use, for the purpose of achieving one more mowing.
The largest difference in yield is compared to fertilizer variant NPK 15: 15: 15, while the difference in varieties of fertilizers NPK 7: 20: 30 and NPK 8: 26: 26 is lower, which is in line with all previous research and indicators, as a red clover plant that requires greater fertilization with phosphorous and potassium fertilizers.

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The positive effect of the fertilization of NPK fertilizers with increased content of phosphorus and potassium is significantly expressed in the third year of use, which is significant in these research, considering the fact that 2017 was a very drought year.

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