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THE INFLUENCE OF SOWING TIME, SOWING DISTANCE AND FERTILIZATION ON LEAF SHARE IN GREEN FODDER YIELD 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 leaf mass in the yield of red cloves 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 leaf mass 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 of the leaf in the yield, as well as achieving higher yields per unit area.

Keywords: yield, leaf part, sowing date, sowing distance, fertilization

1. 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, favourable 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.
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. Dehydration of the red clover and the production of flour is less used compared to the alfalfa because the red clover is less suitable for this purpose. If it is performed then it is recommended to dehydrate at the start-of the popping stage, i.e. when the red clover contains a higher percentage of proteins.

Graman and Sakova (1988.) found that the length and weight of the stem, and the proportion and weight of the leaves and the whole plant declined with an increase in altitude. The share of leaves in total green weight ranged from 22.21% to 26.69%.

Uzik and Mišinova (1978) found a significantly higher share of leaves at lower altitudes (160 altitude - arid area) and significantly higher plant height (70 altitude - humid area). The resulting differences in leaf and stem length were caused in particular by early maturity.. They recorded a leaf in green mass from 34.93% to 43.07%.

Leto and co-workers (1998) found the share of the Nada variety of 52.03% at the site of Maksimir, while on Medvednica the share of the Nada variety was 44.37%.

Mišković (1986) states that the red clover leaves are the largest in the time of popping, and later somewhat smaller.

2. 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 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. After mowing, the share of leaves in the yield of green fodder was analysed. 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:

1. Determination of the share of the leaf in the yield of the green mass - after mowing the green mass and its weighing, a randomly selected quantity of 5 kilograms was weighed out. After that, all of the stems that were weighed were torn off and weighed mass of leaves and compared to the mass of the stem.

Statistical data processing was done in the SPSS program.

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3. Results of Research

The leaf and stems make the base of the yield of green mass and red clover hay. A larger or smaller portion of the leaf is a feature of a variety that changes in stages of growth and development of red clover and also by cuts. The leaf is a very important component and quality of the red clover feed. The share of leaf is also very influenced by agro technology of the red clover, as well as the climatic conditions of breeding.

The share of leaf mass in 2015 yield

Table 1. The Influence of Sowing time, Sowing distance and Fertilization of Red Clover on Leaf Share in Green Fodder Yield of Red Clover (%), 2015.

Sowing time **R**	Sowing distance **M**	Fertilizer NPK 15:15:15 **G_1**	Fertilizer NPK 7:20:30 **G_2**	Fertilizer NPK 8:26:26 **G_3**	**X RM**	**X R**
September **R_1**	Manually **M_1**	32,7	36,5	34,8	34,7	**43,7**
	20 cm **M_2**	41,8	47,8	46,9	45,5	
	40 cm **M_3**	45,3	54,1	52,9	50,8	
X R_1G		**39,9**	**46,1**	**44,9**		
April **R2**	Manually **M_1**	29,8	31,2	30,3	30,4	**39,1**
	20 cm **M_2**	38,9	43,3	42,1	41,1	
	40 cm **M_3**	42,3	48,7	46,5	45,8	
X R_2G		**37,0**	**41,1**	**39,6**	**X M**	
X MG		31,3	33,9	32,6	**32,6**	Average **41,4**
		40,4	45,6	44,5	**43,5**	
		43,8	51,4	49,7	**48,3**	
X G		**38,5**	**43,6**	**42,3**		

LSD	Level	**R**	**M**	**G**	**RM**	**RG**	**MG**	**RMG**
	0,05	$11,17^{ns}$	$4,45^{*}$	$9,48^{ns}$	$5,29^{*}$	$14,51^{ns}$	$5,16^{*}$	$3,78^{*}$
	0,01	$15,39^{ns}$	$6,16^{**}$	$13,11^{ns}$	$7,42^{**}$	$20,35^{ns}$	$7,41^{**}$	$5,19^{**}$

In the first year of use, a statistically significant difference is between seeding distances. With the manual sowing, the average yield of leaves in the yield is 32.6%, sowing at an intermediate distance of 20 cm 43.5% and sowing at an intermediate distance of 40 cm 48.3%. The average leaf share in the yield is 41.4%.
The highest average yield of leaf in the yield of 54.1% was achieved by sowing in September at an intermediate distance of 40 cm and variant of fertilizer NPK 7:20:30.
Sowing time did not have a statistically significant impact on the share of leaf in the first year of use.
The fertilization did not significantly influence the share of the leaf.
In relation to the general average, statistically significant influence on the share of the leaf has sowing distance.
In the interaction of the investigated factors, the sowing distance and the time of sowing, as well as the interaction of fertilization and the sowing distance, statistically significantly influence the share of leaf in the feed yield.
Sowing time did not significantly affect the share of leaf in the second year of use.
Sowing distance has a statistically significant influence on the share of leaves in the second year of use.
The fertilization did not significantly affect the share of the list.
In relation to the average, the statistically high significance has an intermittent spacing of sowing or sowing distance.

The share of leaf mass in 2016 yield

Table 2. The Influence of Sowing time, Sowing distance and Fertilization on Leaf Share in Green Fodder Yield of Red Clover (%), 2016.

Sowing time **R**	Sowing distance **M**	Fertilization 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**	31,7	35,1	34,6	33,8	**42,4**
	20 cm **M_2**	38,5	49,7	47,9	45,4	
	40 cm **M_3**	41,9	51,9	50,1	48,0	
X R_1G		**37,4**	**45,6**	**44,2**		
April **R2**	Manually **M_1**	31,1	34,9	34,1	33,4	**42,0**
	20 cm **M_2**	39.2	48,9	48,0	45,4	
	40 cm **M_3**	42,0	50,1	49,1	47,1	
X R_2G		**37,4**	**44,6**	**43,7**	**X M**	
X MG		31,4	35,0	34,4	**33,6**	Average **42,2**
		38,9	49,3	48,0	**45,4**	
		42,0	51,0	49,6	**47,5**	
X G		**37,4**	**45,1**	**44,0**		

LSD	Level	**R**	**M**	**G**	**RM**	**RG**	**MG**	**RMG**
	0,05	$5,34^{ns}$	$4,94^{*}$	$8,46^{ns}$	$12,59^{*}$	$21,61^{ns}$	$2,59^{*}$	3.65^{*}
	0,01	$7,36^{ns}$	$6,84^{**}$	$11,70^{ns}$	17,66	$30,31^{ns}$	3.77^{**}	$5,01^{**}$

The highest average share of leaf 47.5% was obtained by sowing at an intermediate distance of 40 cm, sowing at an intermediate distance of 20 cm 45.4% and sowing manually 33.6%. In the second year of usage, there is no statistically significant difference between the 20 cm spacing and the 40 cm distance, as was the first year of use.
The highest average share of leaf 45.1 was recorded in fertilizer variant NPK 7:20:30, fertilizer NPK 8:26:26 44.0% share of the leaf was obtained and fertilizer NPK 15:15:15 achieved 37.4% of the leaf in yield.
In the second year of use, the effect of fertilization on the share of leaves in the yield is noticeable.
The average share of the leaf in the yield is 42.2%.
The fertilization and sowing distance in interaction statistically significantly affect the share of leaf yields in the second year of use.
Intermediate distance of sowing and sowing time in interaction statistically significantly influence the leaf share of the yield in the second year of use.

The share of leaf mass in 2017 yield

Table 3. The Influence of Sowing time, Sowing distance and Fertilization Red Clover on Leaf Share in Green Fodder Yield of Red Clover (%), 2017.

Sowing time **R**	Sowing distance **M**	Fertilization 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	30,8	29,1	29,0	**37,6**
	20 cm **M_2**	36,5	44,3	43,1	41,3	
	40 cm **M_3**	37,8	45,7	44,2	42,6	
X R_1G		**33,8**	**40,3**	**38,8**		
April **R2**	Manually **M_1**	27,3	31,0	30,8	29,7	**37,7**
	20 cm **M_2**	35,9	44,1	43,5	41,2	
	40 cm **M_3**	36,9	45,2	44,9	42,3	
X R_2G		**33,4**	**40,1**	**39,7**	**X M**	
		27,2	30,9	30,0	**29,4**	

X MG	36,2	44,2	43,3	**41,2**	Average **37,7**
	37,4	45,5	44,6	**42,5**	
X G	**33,6**	**40,2**	**39,3**		

	Level	**R**	**M**	**G**	**RM**	**RG**	**MG**	**RMG**
LSD	0,05	$5,05^{ns}$	$4,18^{*}$	$8,08^{ns}$	$10,65^{*}$	$20,66^{ns}$	$2,40^{*}$	$3,42^{*}$
	0,01	$5,95^{ns}$	$5,78^{**}$	$11,17^{ns}$	$14,94^{**}$	$28,96^{ns}$	$3,45^{**}$	$4,69^{**}$

In the third year of use, significant influence on the leaves share in the yield of red clover feed had climatic factors, significant drought in April and July, so that in the third mow there was a very small share of leaf yields.
The fertilization did not have a statistically significant influence on the share of the leaf. Thus, the average share of leaves in fertilizer variant NPK 7:20:30 was 40.2%, fertilizer NPK 8:26:26 was 39.3% and fertilizer NPK 15:15:15 was 33.6%.
The sowing time, as in the second year, did not have a significant impact on the share of leaf in feed yield. The average share of leafs by sowing in September was 37.6% and the sowing in April was 37.7%.
The difference in leaf yield in the third year of use is not significant between the sowing distance of 40 cm - 42.5% and the sowing distance of 20 cm - 41.2%, while the sowing manually produced leaf yields in the amount of 29.4% , which is a statistically significant difference in relation to the other two sowing intervals.
The average leaf share in the yield of red clover was 37.7%.
In the third year of use in the interaction of the investigated factors, the intermittent spacing of the sowing and the sowing period as well as the fertilization and the intermediate spacing of the sowing statistically significantly influence the share of the leaf in the yield of red clover feed.

The three-year average share of the leaf mass in yield

Table 4. The Influence of Sowing time, Sowing distance and Fertilization on Leaf Share in Green Fodder Yield of Red Clover (%), 2015 – 2017.

Sowing time **R**	Sowing distance **M**	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**	30,5	34,1	32,8	32,5	**41,2**
	20 cm **M_2**	38,9	47,3	46,0	44,1	
	40 cm **M_3**	41,7	50,6	49,1	47,1	
X R_1G		**37,0**	**44,0**	**42,6**		
April**R2**	Manually **M_1**	29,4	32,4	31,7	31,2	**39,6**
	20 cm **M_2**	38,0	45,4	44,5	42,6	
	40 cm **M_3**	40,4	48,0	46,8	45,1	
X R_2G		**35,9**	**41,9**	**41,0**	**X M**	
X MG		30,0	33,3	32,3	**31,9**	Average **40,4**
		38,5	46,4	45,3	**43,4**	
		41,1	49,3	48,0	**46,1**	
X G		**36,5**	**43,0**	**41,9**		

	Level	**R**	**M**	**G**	**RM**	**RG**	**MG**	**RMG**
LSD	0,05	$5,15^{ns}$	$5,97^{*}$	$8,52^{ns}$	$10,39^{*}$	$21,61^{ns}$	$5,41^{*}$	$3,54^{*}$
	0,01	$7,10^{ns}$	$8,25^{**}$	$11,79^{ns}$	$14,57^{**}$	$30,30^{ns}$	$7,77^{**}$	$4,87^{**}$

The highest average share of the leaf in the yield of red clover 50.6% was achieved by sowing in September, by fertilizing NPK 7:20:30 and by an intermittent spacing of 40 cm.
Sowing time did not significantly affect the share of leaf in the three-year average.
Intermediate spacing of sowing statistically significantly influences the share of leaf in a three-year average, a sowing distance of 20 cm and 40 cm relative to the sowing manually.

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Fertilization did not significantly affect the share of the leaf in a three-year average.
In relation to the general average, the statistically significant importance on the share of the leaf has an intermittent spacing and fertilization, relative to the sowing manually and fertilization with NPK 15:15:15.
The fertilization and intermediate spacing of sowing in interaction statistically significantly affect the share of leaves in feed yield in a three-year average.
Intermediate spacing of sowing and seeding time in interaction statistically significantly affect the share of leaves in feed yield in a three-year average.

4. Conclusion

The share of leaf mass is a varietal characteristic that changes in the growth stages and development of red clover, development stages, and also by cuttings. In addition to influencing the yield of red clover feed, the share of leaves in the upper mass also affects the quality of the red clover feed.
The highest average share of the leaf of 43,0% was realized with fertilization of NPK 7:20:30, while with fertilizer NPK 8:26:26 share of leaf was 41,9%, while fertilizer NPK 15:15:15 realized 36,5% of the leaf share in green mass.
A significantly higher average leaf density in green mass was achieved by sowing at an intermediate spacing of 40 cm - 46.1% and sowing at an intermediate spacing of 20 cm - 43.4% in relation to the sowing manually 31.9%.
Sowing time did not have a significant effect on the share of leaf in the green mass of feed. Sowing in September was achieved 41.2% and sowing in April 39.6% the share of leaves in the green mass of the red clover.
By interaction of the interstitial spacing of 40 cm and fertilization of NPK 7:20:30, the largest share of the leaf mass in the yield of green fodder of the red clover was achieved.
The average weight of green leaf mass in the red clover is 40.4%.
The general conclusion is that the traditional cultivation of red clover in this area is achieved by the smallest share of leaves in the yield of green fodder, which is the application of NPK fertilizer 15:15:15, sowing manually and with the sowing date in April.

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