LÜHIÜLEVAATED

Käesolevast numbrist alates hakkab "Agraarteadus" avaldama APSi liikmete teadustööde lühikokkuvõtteid (3…4 lk.), mis on kirjutatud inglise keeles. Eesmärgiks on teha meie teadustöö tulemusi paremini välisteadlastele kättesaadavaks.

Käesolevat seeriat alustab rohumaateadlane mag. agr. R. Lillak, kes annab lühidalt aru oma mitmeaastasest eksperimentaalsest tööst, mille ta on esitanud Ph. D. kraadi saamiseks EPMÜ põllumajandus- ja majandusteaduste doktorikraadide omistamise nõukogule.

FORMATION OF BOTANICAL COMPOSITION, PHYTOMASS AND HERBAGE QUALITY OF ALFALFA SWARD DEPENDENT UPON CUTTING REGIME, IRRIGATION AND WEATHER CONDITIONS

R. Lillak

Introduction. Alfalfa was already known in Estonia 200 years ago as a good, and in our conditions well growing, fodder crop. Regardless of the long history of its cultivation, the distribution of the crop is still restricted. One of the main reasons is its unstable seed production. The crop is also comparatively sensitive to growing conditions, therefore its cultivation is restricted mainly to North-Estonia and the carbonate-rich well-drained soils of the larger islands. Alfalfa requires precise harvest management. Any mistakes made while determining the optimum harvest intensity can cause the crop's insufficient persistence.

The purpose of this research, which was conducted from 1985...1989, was to clarify the dependency of the development, growth, persistence, phytomass and component formation (DM yield, stubble and root weight) of an alfalfa-rich sward on the time of the first and last cuts (harvests were reaped from May 9 to July 25 and from September 20 to October 13, respectively), number of cuts (2...4 cuts during a vegetation period), and soil water regime in slightly-acid soil, typical of the South-Estonian region. We also examined the dynamics of concentration of total N and its accumulation in different parts of the phytomass. Special attention has been paid to the biochemical composition of herbage, removal of major macroelements (P, K, Ca, Mg) from soil to herbage, as well as to the relations between weather conditions and alfalfa sward's quantitative and qualitative factors.

Material and methods. The experiment with pure alfalfa (*Medicago media Martyn*) cv. 'Jõgeva 118' was conducted in Tartu, 1984 on brown pseudopodzolic soil with humus layers up to 26 cm deep. The content of organic matter in the 0...20 cm layer of the soil was 1.88...2.24 %, and pH_{KCl} resultant of regular liming – 6.50...6.65. The trial field consisted of two equal blocks – on one of them alfalfa grew in conditions of water-stress, on the other irrigation was used to optimize the soil water regime. Both blocks consisted of 12 plots, which were varied as to the time of the 1st cut and number of cuts made during the vegetation period. The fertilizer background was N-0, P-44, K-208 kg/ha and the height of cutting – 8...10 cm.

The herbage yield was determined in 4.4 m^2 area subplots in 3 replications from which DM yield was calculated from the DM content in herbage. Relative DM yield of alfalfa was calculated from the proportion of alfalfa in the above-ground PM and DM yield. The root weight (by soil-core method) and stubble mass were determined immediately after each cut. Before cutting, the stage of development, the average length of tillers of alfalfa and height of

the sward were determined, and samples were taken for the determination of the botanical composition of the above-ground PM.

Proceeding from the climate conditions of the vegetation period, the trial years could be divided into 2 groups: comparatively warm and dry years favourable for cultivating alfalfa – 1986, 1988, 1989, and cool and wet years unfavourable for alfalfa – 1985 and especially 1987. Winter conditions were comparatively favourable for overwintering of alfalfa during the trial period, with the exception of 1985/86 and 1987/88 when the air temperature varied strongly.

The chemical constitution of plant material was determined at the Chemical Laboratory of the Department of Grassland Husbandry and Botany (Estonian University of Agriculture) by commonly used methods: total N according to Kjeldahl, crude fibre and fat by the Weende and Soxhlet method respectively. For analysis the content of crude ash of the plant material was ignited in a muffle furnance at 550 °C. For the determination of the content of different macroelements wet digestion was used, whereafter P and Mg were determined with a spectrophotometer, K with a flame photometer and Ca complexiметrically by titration with EDTA-sodium salt. The total energy content was calculated according to equations widely used in Germany and the Netherlands, and the metabolizable energy according to the equation suggested by the former All-Union Institute of Animal Husbandry. For the calculation of digestible values of crude protein, fat, fibre and N-free extractive matters, the coefficients suggested by Oll et al., (1974) were used.

Statistical analyse of variance and regression were made in order to interpret the results.

Results. As a result of a large invasion of nonsown species the alfalfa sward became a mixed community during the 1st year of cultivation, where besides forage species like red clover, timothy, orchardgrass etc. different weeds like *Taraxacum officinale*, *Tripleurospermum inodorum* etc. were widespread. Under such conditions the competitive ability of alfalfa depended mainly on the cutting regime. The persistence of alfalfa was highest (even at the end of the trial period the proportion of alfalfa in the sward exceeded 71 %) when the 2-cut harvest management system was used and if the 1st cut was made in the 2nd half of July. If the harvest intensity increased, the persistence of alfalfa reduced significantly. No correlation between persistence of alfalfa and the date of the final cut was observed.

The maximum productivity of the alfalfa sward formed towards the end of the trial period – root weight towards the 4th year of cultivation when there was 5,97...9,49 T/ha root DM in the 0...20 cm soil layer, and the total phytomass (PM) towards the 5th year of cultivation (16,06...23,53 T/ha DM). During the 1st year the relationship between the cutting regime and the productivity of the sward was practically non-existent. A strong relationship appeared after the unfavourable for cultivating alfalfa year of 1987. Beginning from that year the total DM yield of the sward, relative DM yield of alfalfa, root weight and total PM were highest if the 2-cut harvest management system was used. When the number of harvests was increased from 2 to 4, the yielding capacity, formation of PM and root weight decreased by 36 % and the sward became more sensitive to weather conditions. On the other hand the use of such a relatively extensive cutting schedule (the growing period before the cut – 76...90 days) caused a strong lodging of alfalfa tillers and increase of stubble mass, especially before the 1st cut, when the length of tillers exceeded 70 cm, on average 26 % taller. However the lodging has an insignificant influence on the relationship between leaves, stems and dead parts of grasses contained in the stubble.

The productivity of the alfalfa sward depended largely on climate conditions. The vegetation processes began at the end of April, when the air temperature rose steadily above 5 °C, and were most intensive at the end of May. Despite this the maximum height of tillers and the highest DM yield were formed only at the end of July (130 cm and 6,52 T/ha, respectively). During the formation of aftermath, the most intensive growth of tillers and formation of DM yield was observed in the early or middle summer and the slowest in the autumn. Unlike the above-ground PM, the root weight steadily grew from spring to autumn.

Though the reproductive growth and DM yield increased by a total of 9 % for the alfalfa sward, irrigation had a negative impact – the growth of tillers became slower in spring and autumn, the accumulation of root mass and PM decreased, the yield formation decreased in

spring, the persistence of alfalfa in the sward reduced; and as a result of the strong lodging of tillers, the stubble mass increased. As a rule, the negative effect of irrigation was stronger with aged swards and when the number of cuts per year was higher.

The chemical composition and nutritive value of alfalfa herbage depended mainly on the length of the growing period before the cut, on weather conditions during the yield formation, and on the portion of alfalfa in the sward. The highest content of crude fat, ash, metabolizable energy and major mineral elements (N, P, K) and the lowest content of crude fibre in herbage were obtained at the beginning of the vegetative period in the early stage of development of alfalfa. With advancing development, the overall quality of herbage declined steadily. Moisture deficit, connected with relatively high temperatures in June-July, and the lack of warmth in September-October caused the deterioration of nutritive value by way of changing the mineral and crude fibre content in herbage. Forage quality improved when the number of alfalfa in the sward was increased. If the herbage was harvested at the same physiological age of alfalfa, only little difference in quality between years was observed.

Feeding cows with herbage rich in alfalfa may cause problems due to its too high concentration of K, especially at the early stage of development. As the content of Mg was at the same time relatively low, the ratio between K, Ca and Mg shifted considerably in favour of K. Therefore it will be necessary to limit the feeding of cows with such herbage, and add to their diet components rich in DM and Mg and poor in protein and K. In the advanced stages of development of alfalfa (at flowering) the energy and P will be the limiting factors for high-yielding cows.

The relationship between cutting regime and total crude protein yield was not consistent. The yield was equally high (on average 1232...1297 kg/ha) with the 2- or 3-harvest systems. When the more intensive 4-harvest system was used, the crude protein yield was up to 20 % smaller. In trial years, the highest crude protein yield was obtained in the 2nd year of the alfalfa sward management. If during the 1st years the yield was the highest when the 3-harvest schedule was used, then beginning from 1987 the 2-harvest system proved the most efficient. Increasing the number of harvests from 2 to 4, the crude protein yield became more dependent on weather conditions.

The content of nitrogen was different in different parts of PM. The highest concentration of total N (3,52 %) was observed in DM yield. In stubble, which consisted mostly of stems and dead parts of grass, the concentration was by 1.50...1.69 times smaller and in roots by up to 2.50 times. The concentration of N in the above-ground PM declined with the maturity of the grass whereas the below-ground PM was not influenced by the development. The relatively high temperature, moisture and decreasing the number of alfalfa in the sward had a negative effect on the concentration of total N in the PM.

The amount of N accumulated in the PM of alfalfa sward was greater (354...375 kg/ha) when the 2-harvest system was used. If the number of cuts was increased from 2 to 4 the accumulation of N decreased by 16...21 %. The main part of total N (55...65 %) accumulated in the yield, 25...34 % in the roots and 10...16 % in the stubble. The highest accumulation of N by the plants was observed in the 2nd and 5th year of utilization of sward. In the relatively cold, for alfalfa, year of 1987 and following in 1988, the total accumulation of N compared with other years decreased on average by 21 %. The share of N decreased in the yield and increased in roots.

P and Ca removal from soil to herbage was highest (respectively 28 and 77 kg/ha) when the 3-harvest system was applied with plots cut in the bud stage for the first time. The highest mean K and Mg uptakes (respectively 213 and 18 kg/ha) were obtained using the 2-cut schedule (1st defoliation at the flowering stage of alfalfa). In years unfavourable for growing alfalfa the uptake of these elements decreased by 16...23 %.

The irrigation of alfalfa sward resulted in a decrease in the concentrations of total N and crude fat, accumulation of N, K and Ca uptake and total yield of crude protein, and an increase of crude fibre and removal of P and Mg.

Conclusions. The best results for the cultivation of alfalfa cv. 'Jõgeva 118' on brown pseudopodzolic soil were obtained by using the 2-cut harvesting schedule with the 1st cut at the flowering stage. The more intensive 3-cut harvesting system caused improvement of

herbage quality, however it also reduced the persistence and productivity of alfalfa. For that reason the use of the 3-cut system will be recommended only in warmer years which are more favourable for the cultivation of alfalfa.

There was no evidence for the neccessity of irrigation for alfalfa-rich swards under such soil and climate conditions.