

RESEARCH ON THE PRODUCTION POTENTIAL OF ALFALFA MIXED WITH ORCHARD GRASS UNDER INFLUENCE OF MINERAL FERTILISATION

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Abstract

In Romania, the need for performance and the intensification of the sown grasslands is increasing and more and more farmers use the imported seeds of valuable herbaceous species. This study was conducted during three production cycles, and the main objective was to determine the production of dry matter (DM) and crude protein (CP) made under the influence of mixture and fertilization with nitrogen on P₅₀ agrofund to one of the known Romanian cultivar of alfalfa and a more productive European cultivar of orchard grass. Another objective was the evolution of canopy cover structure. To achieve these objectives, three variants of mixture were tested between alfalfa and orchard grass that were applied to four rates of mineral fertilizers. The mixture 75% alfalfa (*Medicago sativa* L.) and 25% orchard grass (*Dactylis glomerata* L.) under the effect of dosing with N₁₀₀P₅₀ and N₇₅P₅₀ achieved the highest production increase of DM on cycle I, 116% (4.68 Mg ha⁻¹ DM) and 113% (4.54 Mg ha⁻¹ DM) compared to the control, unfertilized alfalfa in pure culture (4.02 Mg ha⁻¹ DM). The highest increase for the CP yield was obtained on cycle I from the 100% alfalfa fertilized with doses of N₁₀₀P₅₀, 143% (955 kg ha⁻¹ CP) from 100% alfalfa unfertilized (666 kg ha⁻¹ CP). At all cycles, in terms of canopy cover structure, alfalfa had a higher share in mixtures compared to orchard grass. Exception only on cycle III, where on mixture 50% alfalfa + 50% orchard grass, orchard grass at higher doses of nitrogen had a higher share to alfalfa (56% orchard grass / 44% alfalfa at N₁₀₀P₅₀ dose and 54% orchard grass / 46% alfalfa at N₇₅P₅₀ dose).

Key words: mixture, fertilization, alfalfa, orchard grass, production

INTRODUCTION

With the modernization of Romanian agriculture, of the livestock sector by exploiting a biological material with a high productive potential, it has become imperative the intensification of grasslands. This can be done both through the use of valuable species and very productive cultivars of legumes and perennial grasses, blending perennial legumes and grasses, applying some agro-technology measures and through proper management of grasslands [11], [3]. More and more farmers resort to the use of perennial grasses and legumes seeds imported, but with unknown consequences regarding the expression of the productive potential of these cultivars under the ecological conditions of Romania.

Association of alfalfa in mixture with orchard grass is regarded as one of the best

options for intensive sown grasslands, orchard grass being a specie that has a versatility and a growth rate similar to alfalfa, both cultures, in optimal conditions, have a longevity of at least 4 years [2], [7], [8].

Mixture of alfalfa with orchard grass has some important advantages such as: higher productivity compared with alfalfa grown in pure culture, high yields of protein, nitrogen fertilizer economy [10], obtaining a balanced energy-protein feed [9], good conservation by silage opportunities, better recovery capacity of the soil structure [5] etc.. Magnate alfalfa cultivar, a cultivar that provides very good productions and with a good feed quality, it was and it is highly appreciated by the Romanian farmers and spread on large areas. Ambassador orchard grass cultivar can produce, according to data presented by the producing company DLF Trifolium, from 20 Mg ha⁻¹ DM to 50 Mg ha⁻¹ DM [4]. Therefore, taking into account previous descriptions, the two cultivars Magnate and Ambassador could as well form a superior

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The manuscript was received: 14.02.2012
Accepted for publication: 06.04.2012

mixture for the soil and climate conditions of Central Moldavian Plateau and studies on mixture of the two cultivars are not yet published.

MATERIAL AND METHODS

In order to achieve our objectives it was established an experience on Ezăreni Farm of the Didactic Resort of USAMV Iasi.

The experience was placed on a cambium chernozem soil with pH values between 6.7 and 6.8 and humus content of 2.73-2.93%, 21-25 ppm P_{AL} , 226-232 ppm K_{AL} and 112 - 139 ppm CaO . This study refers to production data from three harvest cycles of the experimental 2010. During the growing season (April-September), the average temperature was 18.8°C with 1.5°C positive deviation from the annual average (17.3°C).

The amount of growing season rainfall (375 mm) was only with 39.5 mm higher than the annual average (335.5 mm). Spring was wet, but July (25.0 mm precipitation) was the month which recorded the highest negative deviation, 44.2 mm, compared to annual average (69.2 mm), considering it under this aspect and temperature as a dry month.

The studied factors were: Factor A: type of crop, three graduations: a1 - 100% alfalfa (Mt.), a2 - 75% alfalfa + 25% orchard grass, a3 - 50% alfalfa + 50% orchard grass. Factor B: mineral fertilization with four graduations: b1 - N_0P_0 (Mt.), b2 - $N_{50}P_{50}$, b3 - $N_{75}P_{50}$, b4 - $N_{100}P_{50}$. For sowing it was used seeds of Romanian alfalfa (*Medicago sativa* L.) Magnate cultivar and seeds of Danish orchard grass (*Dactylis glomerata* L.) Ambassador cultivar. Seed mix was done manually calculating and weighing the proportions and quantities depending on the quality parameters of each.

For fertilization were used ammonium nitrate ($N_{33.5}$) and nitrogen-phosphorus complex ($N_{20}P_{20}$). Mineral fertilizers were applied to the establishment of experience, with doses calculated for each variant. The harvest of cycle I was made at full flowering of alfalfa and at boot stage of orchard grass and the next two at full bud stage of alfalfa, orchard grass being at different vegetative and transition stages.

Canopy cover structure was determined by gravimetric method at the time of each harvest.

The statistical interpretation of data was performed by analysis of variance and differences limit calculation using SPSS software - ANOVA (Statistical Package for the Social Sciences).

RESULTS AND DISCUSSIONS

Influence of mixture and fertilization on the production of dry matter (DM)

Both alfalfa and orchard grass are very productive and both species have high demands on soil nutrients. In this study, we sought to emphasize the performance of mixture compared to alfalfa in pure culture, using low doses of nitrogen fertilizers based on the fact that orchard grass can also benefit of alfalfa's nitrogen produced by symbiotic bacteria attached to its roots.

On cycle I, both alfalfa grown in pure culture and mixture 75% alfalfa + 25% orchard grass, showed significant differences in the DM yield compared to the control at all doses of fertilizer. The mixture 50% alfalfa + 50% orchard grass showed significant differences only at fertilized variants with doses of $N_{100}P_{50}$ and $N_{75}P_{50}$ (Table 1). The mixture 75% alfalfa + 25% orchard grass had the highest yield of DM, of 4.68 Mg ha⁻¹ DM (116% increase) at $N_{100}P_{50}$ dose, but also the yield obtained by it at $N_{75}P_{50}$ dose (4.54 Mg ha⁻¹ DM, 113% increase) has surpassed the maximum yields obtained both by 100% alfalfa (4.46 Mg ha⁻¹ DM) and by 50% alfalfa + 50% orchard grass mixture (4.45 Mg ha⁻¹ DM).

The best efficiency, both for alfalfa and for mixtures was recorded using $N_{50}P_{50}$ dose of fertilizer (85, 86 and 81 kg DM kg⁻¹ N). On the cycle II of production, only 100% alfalfa variant had significant differences compared to the control and the highest yield of DM, 3.25 Mg ha⁻¹ DM for the variant fertilized with dose of $N_{100}P_{50}$ and also surpassing at dose of $N_{50}P_{50}$ (3.14 Mg ha⁻¹ DM) the maximum yields obtained by the two mixtures with 0.11 Mg ha⁻¹ the yield of mixture 75% alfalfa + 25% orchard grass (3.03 Mg ha⁻¹ DM) and respectively, with 0.32 Mg ha⁻¹ the yield of mixture 50% alfalfa + 50% orchard grass (2.82 Mg ha⁻¹ DM). The mixture 50% alfalfa + 50% orchard grass had negative significant differences on all variants of fertilization.

On cycle III, both mixtures had negative alfalfa (Table 1). significant differences compared to unfertilized

Table 1 Influence of mixture x fertilization interaction on the production of dry matter (DM) of harvest cycles in 2010

Variant	N ₀ P ₀ (unfertilized-mt.)			N ₅₀ P ₅₀			N ₇₅ P ₅₀			N ₁₀₀ P ₅₀		
	Cycle I	Cycle II	Cycle III	Cycle I	Cycle II	Cycle III	Cycle I	Cycle II	Cycle III	Cycle I	Cycle II	Cycle III
	Mg ha ⁻¹	Mg ha ⁻¹	Mg ha ⁻¹	Mg ha ⁻¹	Mg ha ⁻¹	Mg ha ⁻¹	Mg ha ⁻¹	Mg ha ⁻¹	Mg ha ⁻¹	Mg ha ⁻¹	Mg ha ⁻¹	Mg ha ⁻¹
100% Alfalfa (Mt.)	4.02	3.01	2.01	4.28*	3.14*	2.05	4.34*	3.18*	2.10	4.46*	3.25*	2.14
75% Alfalfa + 25% Orchard grass	3.94	2.81 ⁰	1.70 ⁰	4.23*	2.91	1.76 ⁰	4.54*	2.96	1.78 ⁰	4.68*	3.03	1.81 ⁰
50% Alfalfa + 50% Orchard grass	3.85	2.66 ⁰	1.58 ⁰	4.05	2.71 ⁰	1.63 ⁰	4.30*	2.76 ⁰	1.65 ⁰	4.45*	2.82 ⁰	1.66 ⁰
LSD 5% Mg ha ⁻¹	0.21	0.14	0.14	0.21	0.14	0.14	0.21	0.14	0.14	0.21	0.14	0.14

A significant positive correlation between the dose of nitrogen and the yield of DM was obtained only at 100% alfalfa, r² = 991*, for p = 5% at cycle I (Fig. 1). In 2010, combined the yields from the all three cycles, the highest DM production was obtained from 100% alfalfa (9.85 Mg ha⁻¹ DM, N₁₀₀P₅₀ dose), higher by 0.33 Mg ha⁻¹ from the total production of mixture 75% alfalfa + 25% orchard grass (9.52 Mg ha⁻¹ DM) and by 0.92 Mg ha⁻¹ DM from the total production of mixture of 50% alfalfa + 50% orchard grass which produced 8.93 Mg ha⁻¹ DM at N₁₀₀P₅₀ dose (Table 3). Unfertilized variants of both mixtures showed negative significant differences compared to the control production.

Between dose of nitrogen applied and total DM yield in 2010 were obtained positive correlations (p = 5%) for both 100% alfalfa, r² = 0.9964* and for the two mixtures, r² = 0.9926* for the mixture 75% alfalfa + 25% orchard grass and r² = 0.9908* for the mixture 50% alfalfa + 50% orchard grass (Fig. 2).

Yields obtained are higher than yields obtained from mixtures of alfalfa Selena, Romanian cultivar and orchard grass Regent also Romanian cultivar using double-dose of fertilizer (N₂₀₀P₁₀₀) in the same area, in the second year of vegetation (2007), from which were obtained 9.51 Mg ha⁻¹ DM on alfalfa-orchard grass mixture at 70%:30% ratio, 9.19 Mg ha⁻¹ DM on mixture 60%:40% ratio, and 8.32 Mg ha⁻¹ on mixture 50%:50% ratio [1].

Therefore, the two cultivars studied by us may be recommended for the establishment of

superior temporary grasslands in the Central Moldavian Plateau ecological conditions.

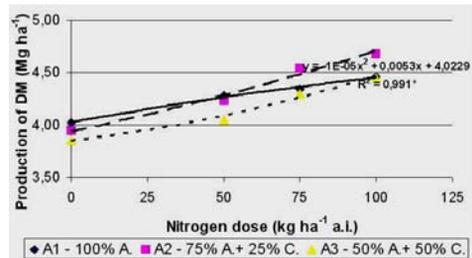


Fig. 1 Polynomial regression line between N dose and yield of DM, cycle I

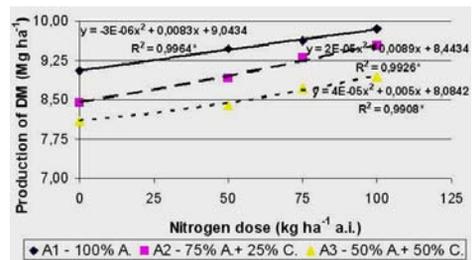


Fig. 2 Polynomial regression line between N dose and total yield of DM

Influence of mixture and fertilization on the production of crude protein (CP)

On harvest cycle I, 100% alfalfa showed significant differences on the yield of crude protein (CP) compared to the control at all doses of fertilizer applied. The mixture 75% alfalfa + 25% orchard grass and mixture 50% alfalfa + 50% orchard grass showed significant differences only on variants that were fertilized with N₁₀₀P₅₀ and N₇₅P₅₀ doses (Table 2).

The 100% alfalfa variant had the highest yield of CP, 955 kg ha⁻¹ CP (143% increase) at dose of N₁₀₀P₅₀ and surpassed the maximum yields obtained by mixture 75% alfalfa + 25% orchard grass (911 kg ha⁻¹ CP, 137% increase) and the mixture 50% alfalfa + 50% orchard grass (780 kg ha⁻¹ CP, 117% increase) by 44 kg ha⁻¹ CP and by 175 kg ha⁻¹

CP, respectively. Best efficiency was recorded using dose of N₅₀P₅₀ fertilizer which gave 15.2 kg CP kg⁻¹ N, 14.6 kg CP kg⁻¹ N and 13.1 kg CP kg⁻¹ N. On cycle II, the 100% alfalfa variant and the two mixtures had negative significant differences compared to the control that made the biggest production, of 603 kg ha⁻¹ CP.

Table 2 Influence of mixture x fertilization interaction on the production of crude protein (CP) of harvest cycles in 2010

Variant	N ₀ P ₀ (unfertilized-mt.)			N ₅₀ P ₅₀			N ₇₅ P ₅₀			N ₁₀₀ P ₅₀		
	Cycle I	Cycle II	Cycle III	Cycle I	Cycle II	Cycle III	Cycle I	Cycle II	Cycle III	Cycle I	Cycle II	Cycle III
	kg ha ⁻¹	kg ha ⁻¹	kg ha ⁻¹	kg ha ⁻¹	kg ha ⁻¹	kg ha ⁻¹	kg ha ⁻¹	kg ha ⁻¹	kg ha ⁻¹	kg ha ⁻¹	kg ha ⁻¹	kg ha ⁻¹
100% Alfalfa (Mt.)	666	603	453	759*	602	438	835*	576	448	955*	549 ⁰	445
75% Alfalfa + 25% Orchard grass	589 ⁰	512 ⁰	368 ⁰	728	519 ⁰	355 ⁰	826*	525 ⁰	355 ⁰	911*	514 ⁰	342 ⁰
50% Alfalfa + 50% Orchard grass	551 ⁰	431 ⁰	287 ⁰	655	440 ⁰	293 ⁰	730*	421 ⁰	280 ⁰	780*	399 ⁰	267 ⁰
LSD 5% Kg ha ⁻¹	64	35	31	64	35	31	64	35	31	64	35	31

Table 3 Influence of mixture x fertilization interaction on the total production of dry matter (DM) and crude protein (CP) of 2010

Variant	N ₀ P ₀ (unfertilized-mt.)		N ₅₀ P ₅₀		N ₇₅ P ₅₀		N ₁₀₀ P ₅₀	
	Total	Total	Total	Total	Total	Total	Total	Total
	Mg ha ⁻¹ DM	kg ha ⁻¹ CP	Mg ha ⁻¹ DM	kg ha ⁻¹ CP	Mg ha ⁻¹ DM	kg ha ⁻¹ CP	Mg ha ⁻¹ DM	kg ha ⁻¹ CP
100% Alfalfa (Mt.)	9.04	1722	9.47	1799	9.62*	1859*	9.85*	1949*
75% Alfalfa + 25% Orchard grass	8.45 ⁰	1468 ⁰	8.90	1601	9.28	1706	9.52*	1768
50% Alfalfa + 50% Orchard grass	8.09 ⁰	1269 ⁰	8.39 ⁰	1388 ⁰	8.71	1432 ⁰	8.93	1446 ⁰
LSD 5%	0.46 Mg/ha	122 kg ha ⁻¹	0.46 Mg ha ⁻¹	122 kg ha ⁻¹	0.46 Mg ha ⁻¹	122 kg ha ⁻¹	0.46 Mg ha ⁻¹	122 kg ha ⁻¹

On mixture 75% alfalfa + 25% orchard grass the yield of protein increased from 512 kg ha⁻¹ CP for the variant unfertilized to 525 kg ha⁻¹ CP for the variant fertilized with N₇₅P₅₀ and decreased at 514 kg ha⁻¹ CP due to a decrease in share of alfalfa in the mixture. The mixture 50% alfalfa + 50% orchard grass had obtained higher production on the variants that alfalfa had a higher proportion, of 440 kg ha⁻¹ CP at N₅₀P₅₀ dose and of 431 kg ha⁻¹ CP unfertilized, respectively. On the cycle III, both mixtures had negative significant differences from unfertilized alfalfa who achieved 453 kg ha⁻¹ CP (Table 2). The CP production of mixture 75% alfalfa + 25% orchard grass ranged from 342 kg ha⁻¹ CP on N₁₀₀P₅₀ dose to 368 kg ha⁻¹ CP for the unfertilized variant, and the

production of mixture 50% alfalfa + 50% orchard grass ranged from 267 kg ha⁻¹ CP on N₁₀₀P₅₀ dose to 293 kg ha⁻¹ CP on N₅₀P₅₀ dose.

Significantly positive correlation between the dose of nitrogen and the yield of CP were recorded on cycle I, on both alfalfa and mixtures. Thus, for p = 5% was obtained for 100% alfalfa, r² = 9989*, for mixture 75% alfalfa + 25% orchard grass, r² = 9985* and for 50% alfalfa + 50% orchard grass, r² = 9955* (Fig. 3).

Significant differences compared to the control and the highest total yield of CP in 2010 was obtained from 100% alfalfa (1949 kg ha⁻¹ CP, 113% increase on N₁₀₀P₅₀ dose), higher by 181 kg ha⁻¹ CP to total production of the mixture 75% alfalfa + 25% orchard grass

(1768 kg ha⁻¹ CP on N₁₀₀P₅₀ dose) and by 503 kg ha⁻¹ CP to total production of CP from mixture 50% alfalfa + 50% orchard grass which produced 1446 kg ha⁻¹ CP on N₁₀₀P₅₀ dose (table 3). The mixture 50% alfalfa + 50% orchard grass showed negative significant differences from unfertilized alfalfa (control) on all variants of fertilization.

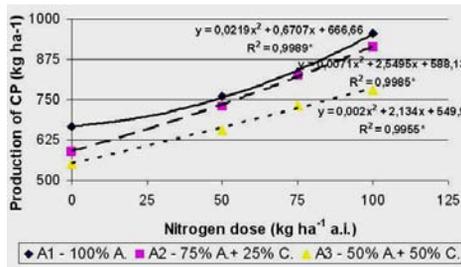


Fig. 3 Polynomial regression line between N dose and yield of CP, cycle I

Between the dose of nitrogen applied and the total yield of CP in 2010 were obtained positive correlations (p = 5%) for both 100% alfalfa, r² = 0.9993* and for the two mixtures, r² = 0.9925* for the mixture 75% alfalfa + 25% orchard grass and r² = 0.9984* for the mixture 50% alfalfa + 50% orchard grass (Fig. 4).

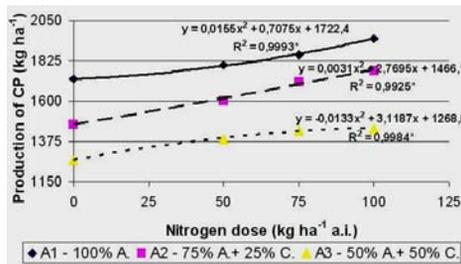


Fig. 4 Polynomial regression line between N dose and total yield of CP

Influence of mixture and fertilization on canopy cover structure in 2010

Mineral fertilization and organic generally produce significant changes in canopy cover structure in grasslands, sown or permanent [6]. Alfalfa and alfalfa mixtures with orchard grass produce high yields of DM and CP even unfertilized and their floristic evolution is more influenced by nitrogen fertilizers than by their seeding structure [12]. In this study, in the year of experience establishment, alfalfa dominated

in mixtures. On cycles II and III, orchard grass proportion in mixtures increased compared to cycle I, but only on the mixture 50% alfalfa + 50% orchard grass on cycle III orchard grass had a higher proportion than alfalfa in the mixture, 54% and 56% on variants fertilized with higher doses of nitrogen. Thus, on 100% alfalfa the share of various plants ranged on cycle I between 14% (unfertilized) and 9% (N₁₀₀P₅₀) and on the cycle II ranged from 6% (unfertilized) to 2% on N₁₀₀P₅₀ dose (Fig. 5).

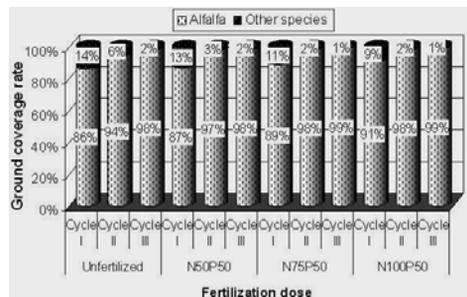


Fig. 5 Evolution of canopy cover structure of 100% alfalfa

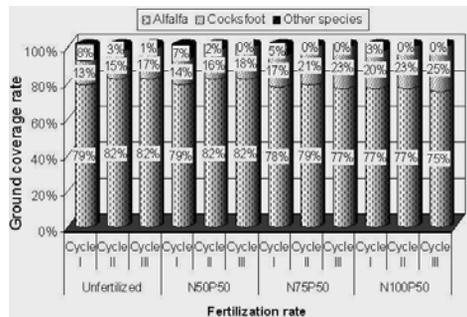


Fig. 6 Evolution of canopy cover structure of mixture 75% alfalfa + 25% orchard grass

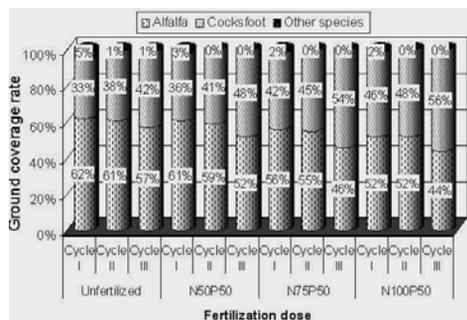


Fig. 7 Evolution of canopy cover structure of mixture 50% alfalfa + 50% orchard grass

On the mixture 75% alfalfa + 25% orchard grass, alfalfa / orchard grass ratio ranged on cycle I, between 79/13% (unfertilized) to 77/20% fertilized with $N_{100}P_{50}$, on cycle II, ranged between 82/15% (unfertilized) to 77/23% on $N_{100}P_{50}$ dose and on cycle III, between 82/17% and 75/25% on $N_{100}P_{50}$ dose, respectively (Fig. 6).

On the mixture 50% alfalfa + 50% orchard grass, alfalfa / orchard grass ratio on cycle I ranged between 62/33% (unfertilized) to 52/46% fertilized with $N_{100}P_{50}$, on cycle II, between 61/38% (unfertilized) to 52/48% on $N_{100}P_{50}$ dose and on cycle III, between 57/42% and 44/56% on $N_{100}P_{50}$ dose, respectively (Fig. 7).

CONCLUSIONS

On the cycle I, the mixture 75% alfalfa + 25% orchard grass gave greater yields than 100% alfalfa on fertilized variants with $N_{100}P_{50}$ and $N_{75}P_{50}$ and greater than mixture 50% alfalfa + 50% orchard grass on all variants of fertilization.

The highest total yield of DM was obtained from 100% alfalfa (9.85 Mg ha⁻¹ DM, on $N_{100}P_{50}$ dose), higher by 0.33 Mg ha⁻¹ compared to the total yield of the mixture 75% alfalfa + 25% orchard grass (9.52 Mg ha⁻¹ DM, on $N_{100}P_{50}$ dose) and by 0.92 Mg ha⁻¹ DM of total yield from mixture 50% alfalfa + 50% orchard grass which produced 8.93 Mg ha⁻¹ DM on $N_{100}P_{50}$ dose.

Yields of DM obtained are higher than yields obtained from mixtures of alfalfa Selena, Romanian cultivar and of orchard grass Regent, also Romanian cultivar on double-dose of fertilizer ($N_{200}P_{100}$) in the same area, in the second year of vegetation (2007). Therefore, the two varieties studied may be recommended for the establishment of superior temporary grasslands in the ecological conditions of Central Moldavian Plateau.

Alfalfa grown in pure culture gave the best yields of CP in all variants of fertilization and in all three production cycles.

At all cycles, in terms of canopy cover structure, alfalfa had a higher share in mixtures compared to orchard grass.

Exception only on cycle III, where on mixture 50% alfalfa + 50% orchard grass, orchard grass at higher doses of nitrogen had a higher share to alfalfa (56% orchard grass / 44% alfalfa at $N_{100}P_{50}$ dose and 54% orchard grass / 46% alfalfa at $N_{75}P_{50}$ dose).

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