FORAGE MIXTURES WITH ALFALFA CULTIVARS, PERENNIAL GRASSES AND ANETHUM GRAVEOLENS

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Abstract

Fodder crops consisting of several species are a way to obtain very good quality feed. They have been used more and more recently in Europe because, in addition to the superiority of feed production and quality, sowing mixtures of several species can lead to a significant reduction in the need for nitrogen fertilizer, an increase in performance and animal health. In Romania, there are few studies on the use of multi-species feed mixtures to reduce dependence on expensive inputs in order to increase the profitability and quality of feed, in organic agriculture production system. The objective was to compare forage yield, degree of coverage and weed infestation of alfalfa single crop and perennial grasses mixtures, which include 10 synthetic alfalfa cultivars and 5 varieties, grasses (a cultivar of *Dactylis glomerata*, *Festuca arundinacea*, *Phleum pratense*), mixed with herb *Anethum graveolens*. A field experiment was established in 2022 in the experimental field of the Center for Organic Agriculture at NARDI Fundulea. The results showed that mixtures of alfalfa with dill and festuca had a higher yield than alfalfa in pure crop. *Anethum graveolens* seeded with forage mixtures proved the efficacy as a natural repellent of *Hypera variabilis* in the first year of crop. In general, alfalfa-grass mixtures had beside higher feed yields and lower weed and pests infestations than alfalfa monocultures or mixtures of two species.

Key words: alfalfa, grasses, populations, feed mixtures, biomass

Recent studies have shown that including plants from contrasting functional groups can be beneficial in terms of forage production and the delivery of ecosystem services (Grace *et al*, 2016; Sollenberger *et al*, 2019; Cummins *et al*, 2021, cited by Jaramillo *et al*, 2021). Multi-species crops thus represent a way to obtain very good quality fodder. This has started to be used more and more lately in Europe because, along with the superiority regarding the production and quality of fodder, the sowing of mixtures of several species can lead to a significant reduction in the need for nitrogen fertilizer, increasing the performance and animal health. In this context, it is important that the different species are not in direct competition with each other and can benefit from growing in mixtures (Moga I. *et al*, 2007; Goh *et al*, 2005).

Plant breeders and farmers are using intercropping as an option to reduce their dependence on expensive inputs to increase profitability and especially in organic farming it increase the functional biodiversity of the cultivated crops (Ergon A. *et al*, 2022) Multi-species mixtures produce a higher volume of quality forage in the summer than single-species and their inclusion in the grazing platform can result in a more consistent supply of grazed forage throughout the year. Some farmers even sow these mixes as a drought buffer (https://www.dlf.co.uk/about-dlf/news-and-press/article/multi-species-sward).

In Romania, the researches were focused especially on alfalfa and mixtures of alfalfa with perennial grasses, for which intensive technologies were developed, effective in favorable humidity conditions (Moga I. *et al*, 1996, 2007) and to reduce the effects of drought, studies were carried out on the introduction of sainfoin (*Onobrychis sativa*) and smooth brome (*Bromus inermis*) in feed mixtures (Drăgan L. *et al*, 2009).

The purpose of the work is to present the behavior of multispecies mixtures implemented within the DIVERSILIANCE project (Core organic program) made in order to find solutions for farmers who are looking for advice on how to best implement and manage this type of crops.

MATERIAL AND METHOD

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Experiments were carried out with different perennial and annual fodder species in the experimental field of the Ecological Agriculture center from National Agricultural Research and Development Institute Fundulea situated in south east of Romania.

The experimental variants consisted of forage mixture crops, including ten alfalfa synthetic cultivars and five registered cultivars, perennial grasses, a variety of *Dactylis glomerata* (Marius variety), *Festuca arundinacea* (Adela variety) and *Phleum pratense* (Tirom variety), mixed with *Anethum graveolens*. Experimental subvariants: in pure crop, 15 combinations of alfalfa and perennial grasses in two seeding ratios and various plant combinations (*table 1*).

Table 1

Experimental variant
Alfalfa
Alfalfa + Festuca
Alfalfa + Phleum
Alfalfa + Dactylis
Alfalfa + Anethum
Alfalfa + Anethum + Festuca
Alfalfa + Anethum + Phleum
Alfalfa + Anethum + Dactylis

Based on the assessment, the most promising crop combinations that provide functional biodiversity will be selected for control strategies.

In this work were analysed:

1. biomass yield;
2. weeds infestation under the conditions of practicing the ecological agriculture system;
3. normalized Difference Vegetation Index (NDVI) was measured by a spectroradiometer (Green-Seeker Hand Held Crop Sensor, Trimble unit), above the canopy.

RESULTS AND DISCUSSIONS

The evolution of climatic conditions in the 2021-2022 agricultural year indicated significant differences in Fundulea compared to normal conditions, both concerning temperatures and level of rainfall.

The analysis of these conditions in relation to the requirements for the climatic factors of crops sown in the fall highlighted, in general, the provision of the thermal factor within optimal limits during the autumn period (*figure 1*).

It is observed that the temperatures were above the multiannual average, the months of November and December being much warmer (7.7, respectively, 2.6°C) compared to the multiannual average (5.4, respectively, 0°C).

In January and February, temperatures were above the multiannual average (*figure 1*).

From October 2021 to the end of June 2022, the amount of rainfall in Fundulea amounted to 287.6 mm, compared to the multi-year average of 415 mm, which highlights the dry nature of the analyzed period. From November to March there was a lack of rainfall and in April (which corresponds to the intense growth of spring plants) the precipitation was 47.6 mm, only 2.5 mm more than the annual average. It can also be observed that the following months also had rainfall below the multiannual average (*figure 2*).

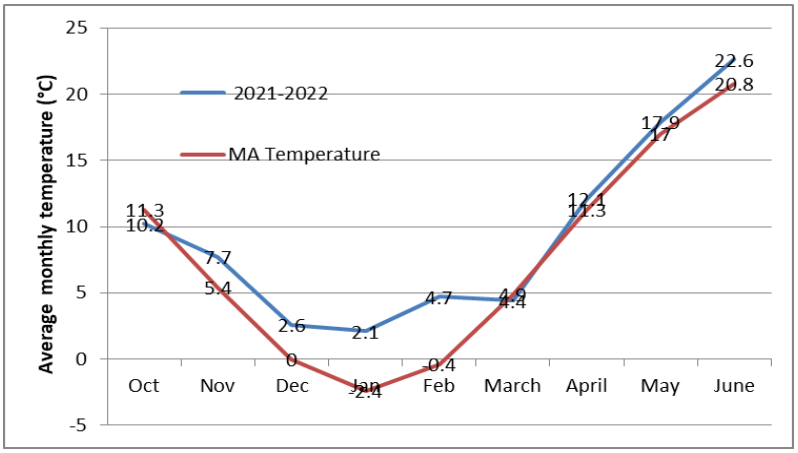

Figure 1 **Average temperatures (°C) from October 2021 to June 2022 compared to the multiannual average over the last 60 years**

In the autumn period, the moisture reserves in the soil were insufficient for a uniform emergence and to support the water requirements of the cultivated plants, which influenced the

emergence, but also the vegetation of the autumn crops.

Moreover, the soil work carried out was carried out in difficult conditions with higher fuel consumption (due to low soil moisture, hard boulders resulted that required repeated passes with the disc harrow for crushing).

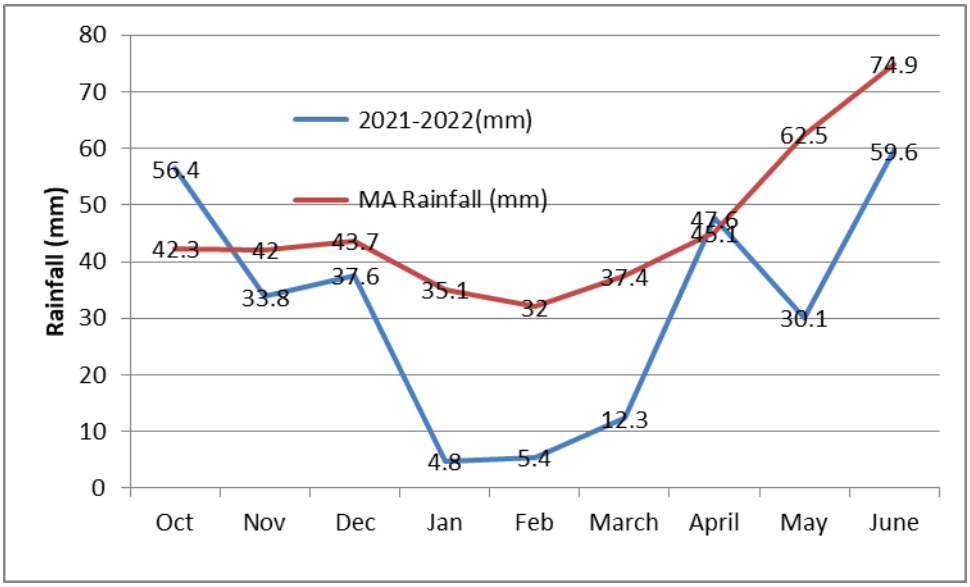

Figure 2 **Rainfall (mm) from October 2021 to June 2022, compared to the multi-year average**

The analysis of variance regarding fresh matter accumulation shows a very significant influence of the treatment, genotype and their interaction, (*table 2*).

Table 2

Analysis of variance for biomass accumulation

Source of variation	DF	Fresh matter		
		Sum of squares	Mean square	F value
Treatment	7	362146.3	51735.19	982.2913***
Error A	14	737.3501	52.66787	
Genotype	14	78169.43	5583.53	998,42***
Interaction	98	235528.3	2403.35	429.7595***
Error B	196	1252.678	5.592314	

*** significant for P < 0.01%

The growth of plants, as measured by fresh weight accumulation was lower in alfalfa pure crop than in forages mixture, except mixture by alfalfa (*Medicago sativa*) and timothy (*Phleum pratense*). What is explained by sensitivity to drought of timothy. Timothy (*Phleum pratense L.*) is the main forage grass species cultivated with alfalfa (*Medicago sativa* L.) in eastern Canada, yet its regrowth under dry and warm conditions (as it was in our experience) is poor (Pomerleau-Lacasse F. *et al*, 2019). The mixtures with three species, had higher total FM yields due to the contribution made by dill. The yields ranged from 429 g fresh matter/square meter up to 499 g fresh matter/sm for alfalfa-dill-timothy (*figure 3*).

Data from the scientific literature show that increasing the number of species within a forage mixtures does not always result in a positive response in terms of biomass accumulation (Sanderson M.A. *et al*, 2004; Moloney T., 2018).

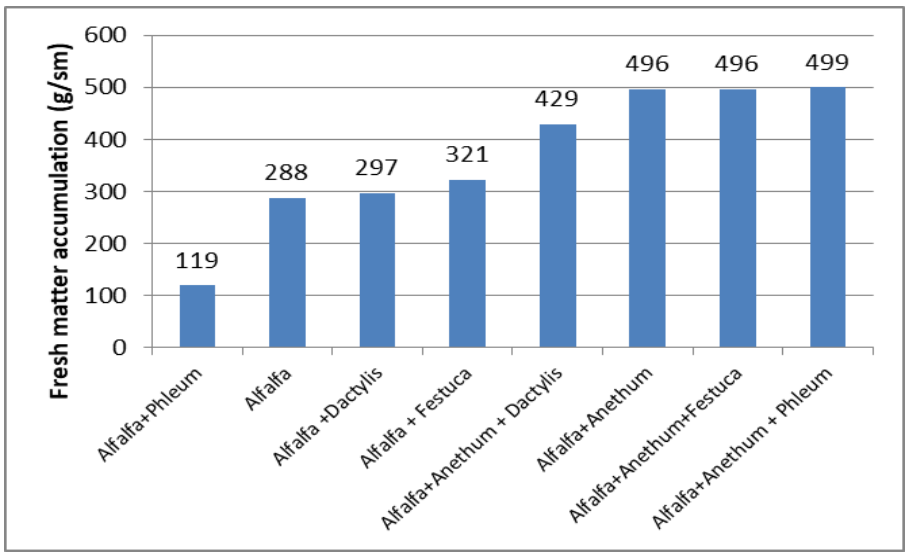

Figure 3. **The biomass accumulation (average fresh matter) in alfalfa pure crop and different mixtures**

There was a genetic variability for biomass accumulation of the alfalfa cultivars studied in different mixtures. Highest average yields were obtained in cultivars F 2315-14, F 2010-08, and Teodora. In the multispecies forage crop with three species, the yields were higher (up to 841 g) (in cultivar F 2315-14). In the pure crop, the yield did not exceed 171 g fresh matter (in cultivar F 2616-12), (*table 3*).

Table 3

The biomass accumulation (fresh matter) for studied alfalfa genotypes in alfalfa pure crop and different mixtures

Variants	SYN 1-20	SYN 1-6-20	SYN 6-20	F 2404-15	F 2312-14	F 2315-14	F 2616-12	F 2014-08	F 2010-08	F 1918-07	Anastasia	Pompilia	Teodora	Catinca	Dorinela
Alfalfa + Phleum	124	56	70	188	327	189	124	118	121	76	42	53	148	64	89
Alfalfa	249	287	288	288	308	379	171	250	275	332	384	221	362	338	187
Alfalfa+ Dactylis	364	270	221	299	116	196	148	344	458	356	500	308	332	293	255
Alfalfa+ Anethum	278	456	275	247	360	254	299	277	372	243	368	298	353	352	390
Alfalfa + Festuca	634	278	607	329	302	518	202	196	395	668	490	381	618	400	416
Alfalfa+ Anethum+ Dactylis	537	624	466	653	537	841	459	282	693	370	362	373	374	352	518
Alfalfa+ Anethum+ Festuca	547	686	484	479	642	618	286	516	513	469	276	238	823	480	434
Alfalfa+ Anethum+ Phleum	409	410	360	391	391	482	269	283	438	361	348	281	423	330	350

One of the main constraints of organic farming is weed infestation, production losses due to weeds being very high.

There is evidence to suggest that increased forage plant diversity might suppress weed invasion in pasture ecosystems (Tracy B.F., Sanderson M.A., 2004).

Our results showed the very significant influence of different mixtures of plant species on the degree of weeding in the experimental plots (*table 4*).

Table 4

Analysis of variance for degree of weeding

Source of variation	DF	Number of weeds		
		Sum of squares	Mean square	F value
Total	23	246738.5	-	
Replicates	2	156.25	-	
Variants	7	245884.5	35126.36	704.792***
Error B	14	697.75	49.83929	

*** significant for P < 0.01%

The specific mechanisms for weed suppression in multispecies crop are difficult to define, since increased forage diversity is often positively correlated with high productivity (Tracy B.F., Sanderson M.A., 2004).

The number of weeds and the normalized vegetation index correlated very significantly, (*figure 4*).

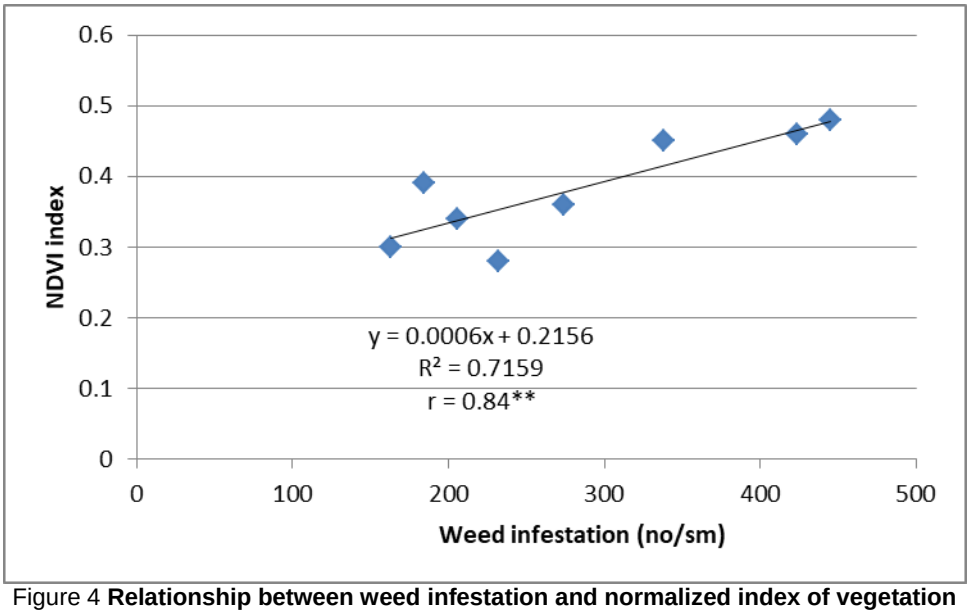

Figure 4 **Relationship between weed infestation and normalized index of vegetation for alfalfa pure crop and different mixtures**

However, it is suggested that increased soil cover improves resource use efficiency and reduces space for weeds to encroach and establish themselves in the culture.

The alfalfa weevil (*Hypera variabilis*) is among the alfalfa pests, spread to almost all grown areas of alfalfa in Romania and cause significant crop losses if no control measures is made. In the variants of mixtures with dill there was no attack by *Hypera variabilis* (Alfalfa leaf weevil), (*table 5*).

Table 5

Effect of experimental variant of attack by *Hypera variabilis*

Experimental variants	*Hypera variabilis*
Alfalfa	+++
Alfalfa + Festuca	++
Alfalfa+Phleum	+++
Alfalfa +Dactylis	++
Alfalfa+Anethum	0
Alfalfa+Anethum+Festuca	0
Alfalfa+Anethum+ Phleum	0
Alfalfa+Anethum + Dactylis	0

+: increase, 0: little or no attack

CONCLUSIONS

The alfalfa-dill-festuca, alfalfa-dill-dactiliys, and alfalfa-dill-timothy mixtures generally performed as well as the alfalfa-timothy mixture, and they represent valuable alternatives for forage production. In these variants, no attack by *Hypera variabilis* was reported, which is all the more recommended for the organic farming system.

ACKNOWLEDGEMENTS

This research is funded by ERA-NET Cofund Program. European and International Collaboration Subprogramme 3.2 Horizon 2020, project: ”Diversification of organic crop production for increasing resilience” – DIVERSILIANCE under the contract 250/2021 with UEFISCDI, Romanian Ministry of Research.

REFERENCES

Drăgan L., Schitea M., Dihoru A., Epure Cîrstea V., 2009 - *Agrotehnica culturilor cercetări privind cultura în amestec a unor specii de plante furajere rezistente la secetă*. An. INCDA Fundulea, 77:159-169.

Ergon Å., Bakken A.K., **2022**. *Breeding for intercropping: the case of red clover persistence in grasslands*. Euphytica 218, 98.

Goh K.; Bruce,G., 2005 - *Comparison of biomass production and biological nitrogen fixation of multi-species pastures (mixed herb leys) with perennial ryegrass-white clover pasture with and without irrigation in Canterbury, New Zealand*. Agric. Ecosyst. Environ., 110:230–240.

Pomerleau-Lacasse F., Seguin P., Tremblay G.F., Bélanger G., Lajeunesse J., Charbonneau E., 2019 - *Alternatives to timothy grown in mixture with alfalfa in Eastern Canada*. Journal of Agron. J., 111:1-14, doi:10.2134/agronj2018.05.030.

Moga I., Schitea M., Mateiaş M., 1996 - *Plante furajere*. Edit. Ceres, Bucureşti.

Moga I., Drăgan L., Răducanu C., 2007 - *Cercetări privind agrotehnica plantelor furajere la Fundulea şi în reţeaua experimentală*. An. INCDA Fundulea, vol. LXXV, volum jubiliar: 317-341.

Moloney T., 2018 - *Multi-species swards for silage production*. Ph.D. Dissertation, University College Dublin, Dublin, Ireland.

Sanderson M.A., Skinner R.H., Barker D.J., Edwards G., Tracy B.F., Wedin, D.A., 2004 - *Plant species diversity and management of temperate forage and grazing land ecosystems*. Crop. Sci., 44:1132-1144.

Tracy B.F., Sanderson M.A., 2004 - *Forage productivity, species evenness and weed invasion in pasture communities*. Agric. Ecosyst. Environ., 102:175-183.

Jaramillo D.M., Sheridan H., Soder K., Dubeux J.C.B., 2021 - *Enhancing the Sustainability of Temperate Pasture Systems through More Diverse Swards*. Agronomy,11, 1912.

******* *https://www.dlf.co.uk/about-dlf/news-and-press/article/multi-species-sward*